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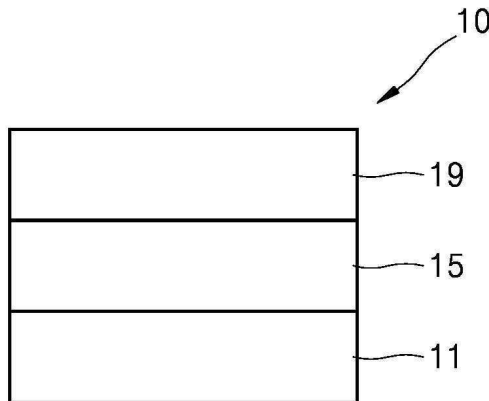
전체 청구항 수 : 총 20 항

(54) 발명의 명칭 **축합환 화합물 및 이를 포함한 유기 발광 소자**

(57) 요약

축합환 화합물 및 상기 축합환 화합물을 포함한 유기 발광 소자가 제시된다.

대표도 - 도1



(52) CPC특허분류

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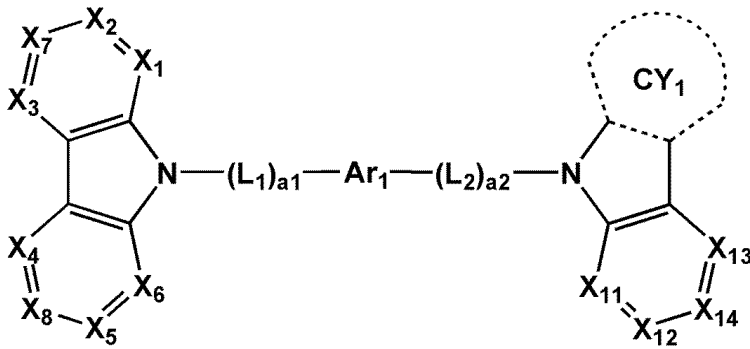
명세서

청구범위

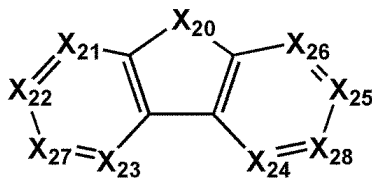
청구항 1

하기 화학식 1로 표시되는, 축합환 화합물:

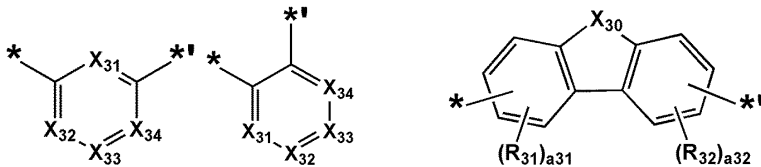
<화학식 1>



<화학식 2>



<화학식 3A> <화학식 3B><화학식 3C>



상기 화학식 1, 2 및 화학식 3A 내지 3C 중,

X<sub>1</sub>은 N 또는 C(R<sub>1</sub>)이고, X<sub>2</sub>는 N 또는 C(R<sub>2</sub>)이고, X<sub>3</sub>은 N 또는 C(R<sub>3</sub>)이고, X<sub>4</sub>는 N 또는 C(R<sub>4</sub>)이고, X<sub>5</sub>는 N 또는 C(R<sub>5</sub>)이고, X<sub>6</sub>은 N 또는 C(R<sub>6</sub>)이고, X<sub>7</sub>은 N 또는 C(R<sub>7</sub>)이고, X<sub>8</sub>은 N 또는 C(R<sub>8</sub>)이고,

X<sub>11</sub>은 N 또는 C(R<sub>11</sub>)이고, X<sub>12</sub>는 N 또는 C(R<sub>12</sub>)이고, X<sub>13</sub>은 N 또는 C(R<sub>13</sub>)이고, X<sub>14</sub>는 N 또는 C(R<sub>14</sub>)이고,

CY<sub>1</sub>은 상기 화학식 2로 표시되고,

X<sub>20</sub>은 O, S, N(R<sub>20</sub>) 및 C(R<sub>20</sub>)(R<sub>29</sub>) 중에서 선택되고,

X<sub>21</sub>은 N 또는 C(R<sub>21</sub>)이고, X<sub>22</sub>는 N 또는 C(R<sub>22</sub>)이고, X<sub>23</sub>은 N 또는 C(R<sub>23</sub>)이고, X<sub>24</sub>는 N 또는 C(R<sub>24</sub>)이고, X<sub>25</sub>는 N 또는 C(R<sub>25</sub>)이고, X<sub>26</sub>는 N 또는 C(R<sub>26</sub>)이고, X<sub>27</sub>은 N 또는 C(R<sub>27</sub>)이고, X<sub>28</sub>은 N 또는 C(R<sub>28</sub>)이고,

CY<sub>1</sub>은 X<sub>21</sub> 및 X<sub>22</sub>, X<sub>22</sub> 및 X<sub>27</sub>, X<sub>27</sub> 및 X<sub>23</sub>, X<sub>24</sub> 및 X<sub>28</sub>, X<sub>28</sub> 및 X<sub>25</sub> 또는 X<sub>25</sub> 및 X<sub>26</sub>를 통해 N을 고리 구성 원자로 포함하는 이웃한 5각 고리와 융합되어 있고,

R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기(CN), 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기

또는 이의 염, 인산기 또는 이의 염, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알키닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 및 -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) 중에서 선택되고,

X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub> 및 X<sub>21</sub> 내지 X<sub>28</sub> 중 적어도 하나는 C(CN)이고,

Ar<sub>1</sub>은 상기 화학식 3A 내지 3C 중 하나로 표시되고,

X<sub>30</sub>은 O, S, N(R<sub>30</sub>), C(R<sub>30</sub>)(R<sub>35</sub>), Si(R<sub>30</sub>)(R<sub>35</sub>), Se 및 P(=O)(R<sub>30</sub>) 중에서 선택되고,

X<sub>31</sub>은 N 또는 C(R<sub>31</sub>)이고, X<sub>32</sub>는 N 또는 C(R<sub>32</sub>)이고, X<sub>33</sub>은 N 또는 C(R<sub>33</sub>)이고, X<sub>34</sub>는 N 또는 C(R<sub>34</sub>)이고,

R<sub>30</sub> 내지 R<sub>35</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, C<sub>1</sub>-C<sub>4</sub>알킬기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,

a<sub>31</sub> 및 a<sub>32</sub>는 서로 독립적으로, 0 내지 3의 정수 중에서 선택되고, a<sub>31</sub>이 2 이상일 경우 2 이상의 R<sub>31</sub>은 서로 동일하거나 상이하고, a<sub>32</sub>가 2 이상일 경우 2 이상의 R<sub>32</sub>는 서로 동일하거나 상이하고,

L<sub>1</sub> 및 L<sub>2</sub>는 서로 독립적으로,

페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조푸라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기; 및

중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>) 중 적어도 하나로 치환된, 페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조푸라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기;

중에서 선택되고,

a<sub>1</sub> 및 a<sub>2</sub>는 서로 독립적으로, 0 내지 5의 정수 중에서 선택되고, a<sub>1</sub>이 2 이상일 경우 2 이상의 L<sub>1</sub>은 서로 동일하거나 상이하고, a<sub>2</sub>가 2 이상일 경우 2 이상의 L<sub>2</sub>는 서로 동일하거나 상이하고,

단, Ar<sub>1</sub>이 화학식 3A 또는 3B로 표시되고, a<sub>1</sub> 및 a<sub>2</sub>의 합이 1이고, L<sub>1</sub> 또는 L<sub>2</sub>가 페닐렌기일 경우, 상기 화학식 1 중 \*(L<sub>1</sub>)<sub>a1</sub>-Ar<sub>1</sub>-(L<sub>2</sub>)<sub>a2</sub>-\*로 표시되는 그룹은 치환기로서 시아노기(CN)를 포함하고,

\* 및 \*'은 각각 서로 이웃한 원자와의 결합 사이트이고,

상기 치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환된 C<sub>2</sub>-C<sub>60</sub>알키닐기, 치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환된 1가 비-방향족 축합다환 그룹 및 치환된 1가 비-방향족 헤테로축합다환 그룹 중 적어도 하나의 치환기는, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>2</sub>-C<sub>60</sub>알케닐기, C<sub>2</sub>-C<sub>60</sub>알키닐기, C<sub>1</sub>-C<sub>60</sub>알콕시기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>6</sub>-C<sub>60</sub>아릴옥시기, C<sub>6</sub>-C<sub>60</sub>아릴티오기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중에서 선택되고,

상기 Q<sub>1</sub> 내지 Q<sub>3</sub>, Q<sub>11</sub> 내지 Q<sub>13</sub>, Q<sub>21</sub> 내지 Q<sub>23</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>1</sub>-C<sub>60</sub>알콕시기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹 중에서 선택된다.

**청구항 2**

제1항에 있어서,

상기 화학식 1 및 2 중,

R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로,

수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>20</sub>알킬기 및 C<sub>1</sub>-C<sub>20</sub>알콕시기;

중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 중 적어도 하나로 치환된, C<sub>1</sub>-C<sub>20</sub>알킬기 및 C<sub>1</sub>-C<sub>20</sub>알콕시기;

시클로펜틸기, 시클로헥실기, 시클로헵테닐기, 시클로헥세닐기, 시클로헵테닐기, 페닐기, 펜탈레닐기, 인테닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-플루오레닐기, 페날레닐기, 페난트레닐기, 안트라세닐기, 플루오란트레닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페틸레닐기, 펜타페닐기, 헥사세닐기, 피롤일기, 이미다졸일기, 피라졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조옥사졸일기, 벤조이미다졸일기, 푸라닐기, 벤조푸라닐기, 티오펜일기, 벤조티오펜일기, 티아졸일기, 이소티아졸일기, 벤조티아졸일기, 이소옥사졸일기, 옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조푸라닐기, 디벤조티오펜일기, 이미다조피리디미디닐기 및 이미다조피리디닐기;

중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>20</sub>알킬기, C<sub>2</sub>-C<sub>20</sub>알케닐기, C<sub>2</sub>-C<sub>20</sub>알키닐기, C<sub>1</sub>-C<sub>20</sub>알콕시기, 페닐기, 나프틸기, 안트라세닐기, 파이레닐기, 페난쓰레닐기, 플루오레닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 프탈라지닐기, 퀴녹살리닐기, 시놀리닐기, 퀴나졸리닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 시클로펜틸기, 시클로헥실기, 시클로헵테닐기, 시클로헥세닐기, 시클로헵테닐기, 페닐기, 펜탈레닐기, 인테닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-플루오레닐기, 페날레닐기, 페난트레닐기, 안트라세닐기, 플루오란트레닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페틸레닐기, 펜타페닐기, 헥사세닐기, 피롤일기, 이미다졸일기, 피라졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조옥사졸일기, 벤조이미다졸일기, 푸라닐기, 벤조푸라닐기, 티오펜일기, 벤조티오펜일기, 티아졸일기, 이소티아졸일기, 벤조티아졸일기, 이소옥사졸일기, 옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조푸라닐기, 디벤조티오펜일기, 이미다조피리디미디닐기 및 이미다조피리디닐기; 및

-Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) ;

중에서 선택되고,

상기 Q<sub>1</sub> 내지 Q<sub>3</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>20</sub>알킬기, C<sub>1</sub>-C<sub>20</sub>알콕시기, 페닐기, 나프틸기, 안트라세닐기, 파이레닐기, 페난쓰레닐기, 플루오레닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 프탈라지닐기, 퀴놀살리닐기, 시놀리닐기 및 퀴나졸리닐기 중에서 선택된, 축합환 화합물.

### 청구항 3

제1항에 있어서,

상기 화학식 1 및 2 중,

R<sub>1</sub> 내지 R<sub>6</sub>, R<sub>11</sub> 내지 R<sub>13</sub>, R<sub>20</sub> 내지 R<sub>26</sub> 및 R<sub>29</sub>는 서로 독립적으로,

수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기;

페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기;

중수소, -F, -Cl, -Br, -I, 히드록실기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기; 및

-Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>);

중에서 선택되고,

R<sub>7</sub>, R<sub>8</sub>, R<sub>14</sub>, R<sub>27</sub> 및 R<sub>28</sub>은 서로 독립적으로,

수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기;

페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기;

중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기; 및

-Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>);

중에서 선택되고,

상기 Q<sub>1</sub> 내지 Q<sub>3</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기 중에서 선택된, 축합환 화합물.

### 청구항 4

제1항에 있어서,

상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>21</sub> 및 X<sub>26</sub> 내지 X<sub>28</sub> 중 적어도 하나는 C(CN)인, 축합환 화합물.

### 청구항 5

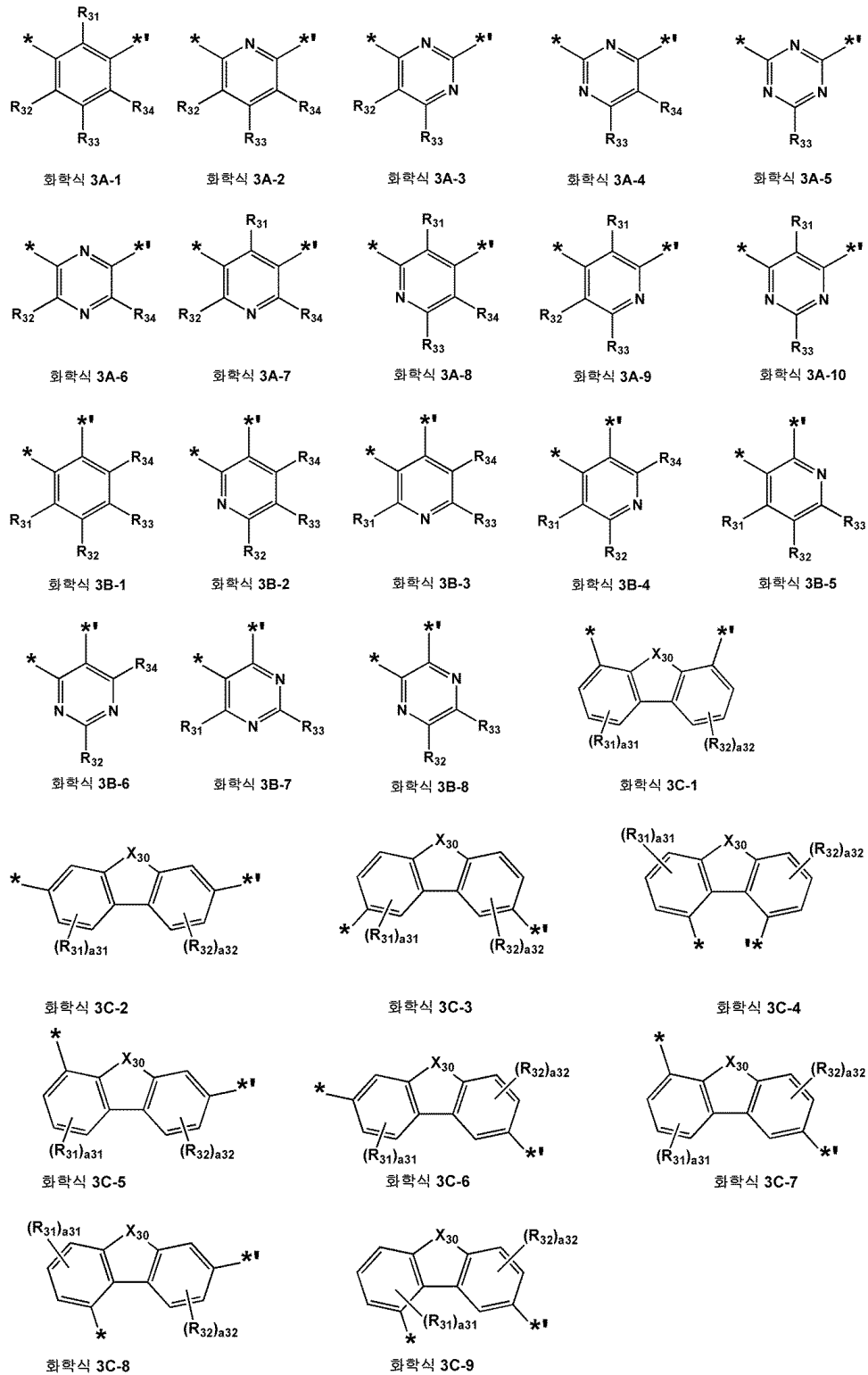
제1항에 있어서,

상기 화학식 1 및 2 중,  $X_1$  내지  $X_6$ ,  $X_{11}$  내지  $X_{13}$  및  $X_{22}$  내지  $X_{25}$ 은 C(CN)이 아닌, 축합환 화합물.

청구항 6

제1항에 있어서,

상기 화학식 1 중  $Ar_1$ 은 하기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-1 내지 3C-9 중 하나로 표시된, 축합환 화합물:



상기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-1 내지 3C-9 중,

$X_{30}$ 은 O, S, N( $R_{30}$ ), C( $R_{30}$ )( $R_{35}$ ), Si( $R_{30}$ )( $R_{35}$ ), Se 및 P(=O)( $R_{30}$ ) 중에서 선택되고,

$R_{31}$  내지  $R_{34}$ 는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및  $-Si(Q_{11})(Q_{12})(Q_{13})$  중에서 선택되고,

$R_{30}$  및  $R_{35}$ 는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기 중에서 선택되고,

상기  $Q_{11}$  내지  $Q_{13}$ 는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택되고,

$a_{31}$  및  $a_{32}$ 는 서로 독립적으로 0 또는 1이고,

\* 및 \*'은 각각 이웃한 원자와의 결합 사이트이다.

### 청구항 7

제1항에 있어서,

상기 화학식 1 중,  $L_1$  및  $L_2$ 는 서로 독립적으로,

페닐렌기, 피리디닐렌기, 피리미디닐렌기 및 트리아지닐렌기; 및

중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및  $-Si(Q_{21})(Q_{22})(Q_{23})$  중 적어도 하나로 치환된, 페닐렌기, 피리디닐렌기, 피리미디닐렌기 및 트리아지닐렌기;

중에서 선택되는, 축합환 화합물.

### 청구항 8

제1항에 있어서,

상기 화학식 1 중,  $L_1$  및  $L_2$ 는 서로 독립적으로,

페닐렌기; 및

중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및  $-Si(Q_{21})(Q_{22})(Q_{23})$  중 적어도 하나로 치환된 페닐렌기;

중에서 선택되고,

상기  $Q_{21}$  내지  $Q_{23}$ 는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택되고,

$a_1$  및  $a_2$ 는 서로 독립적으로, 0 또는 1인, 축합환 화합물.

### 청구항 9

제6항에 있어서,

상기 화학식 1 중  $a_1$  및  $a_2$ 는 0이고,  $Ar_1$ 은 상기 화학식 3A-1, 3A-2, 3B-1 및 3C-3로 표시되는 그룹 중에서 선택된, 축합환 화합물.

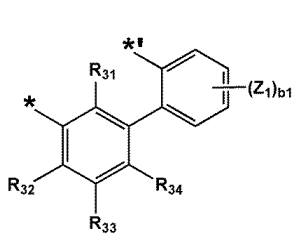
### 청구항 10

제1항에 있어서,

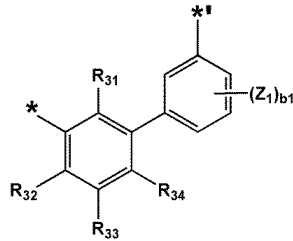
상기 화학식 1 중  $a_1$  및  $a_2$ 의 합이 1 이상이고,  $*(L_1)_{a_1}-Ar_1-(L_2)_{a_2}-*$ 이 하기 화학식 3-1 내지 3-57 중 하나로



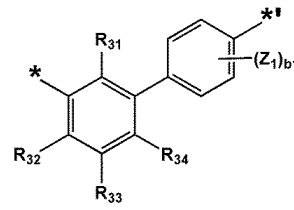
표시되는, 축합환 화합물:



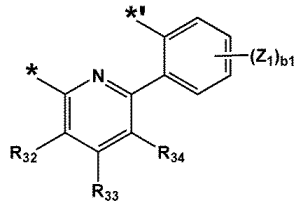
화학식 3-1



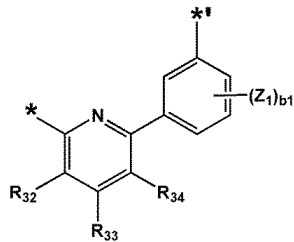
화학식 3-2



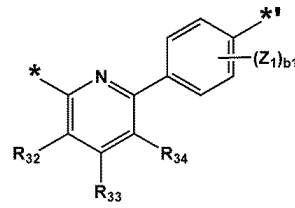
화학식 3-3



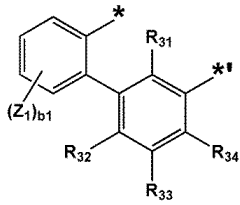
화학식 3-4



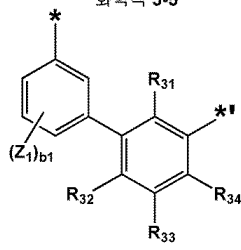
화학식 3-5



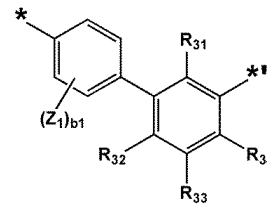
화학식 3-6



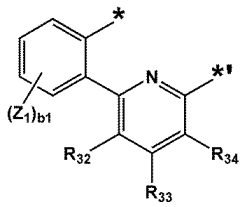
화학식 3-7



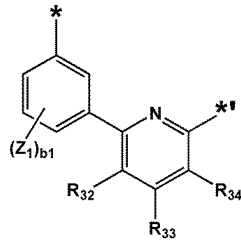
화학식 3-8



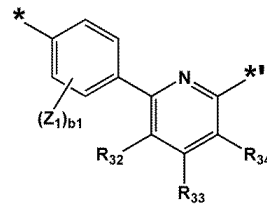
화학식 3-9



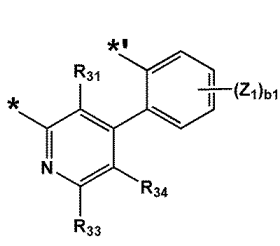
화학식 3-10



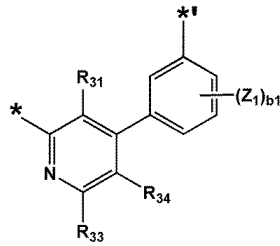
화학식 3-11



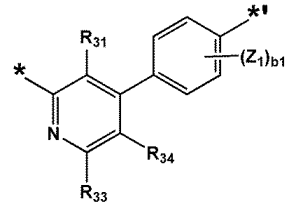
화학식 3-12



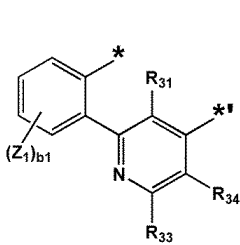
화학식 3-13



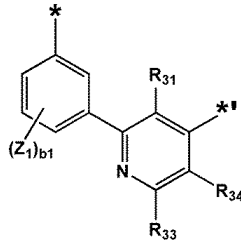
화학식 3-14



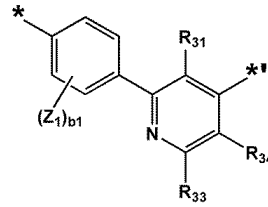
화학식 3-15



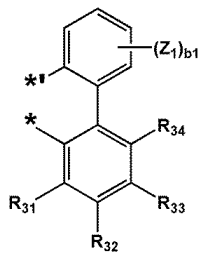
화학식 3-16



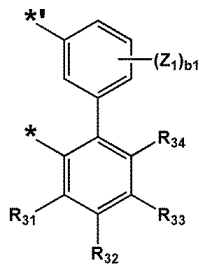
화학식 3-17



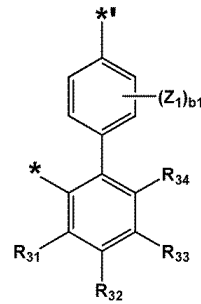
화학식 3-18



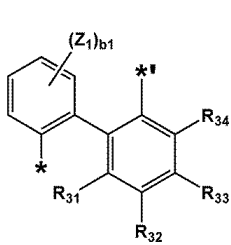
화학식 3-19



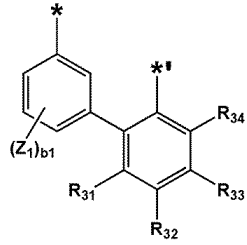
화학식 3-20



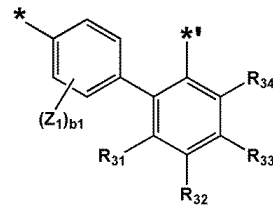
화학식 3-21



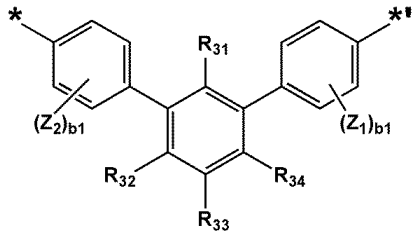
화학식 3-22



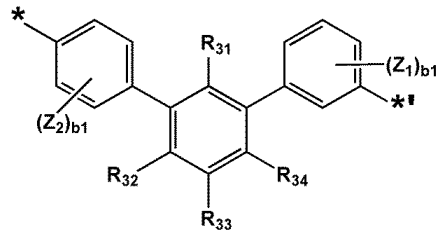
화학식 3-23



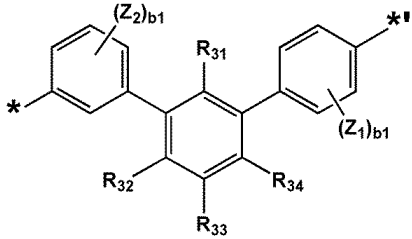
화학식 3-24



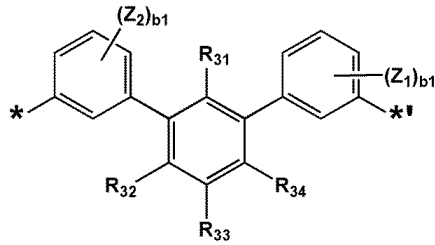
화학식 3-25



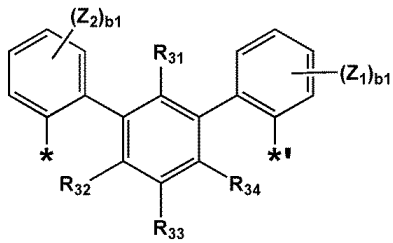
화학식 3-26



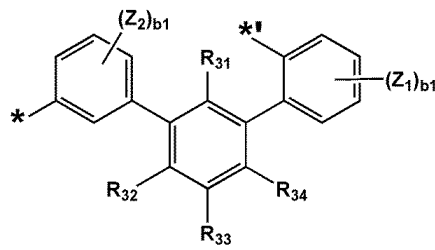
화학식 3-27



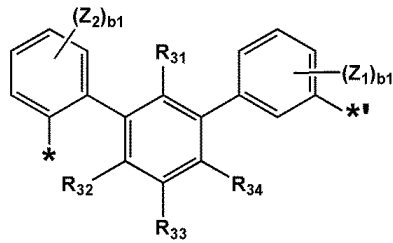
화학식 3-28



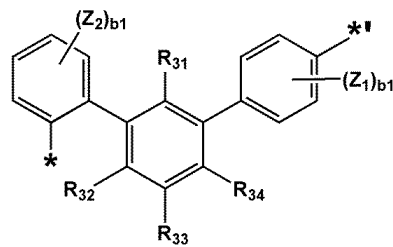
화학식 3-29



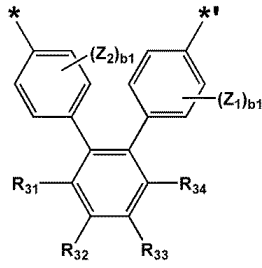
화학식 3-30



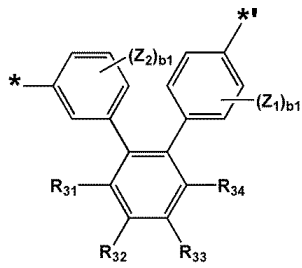
화학식 3-31



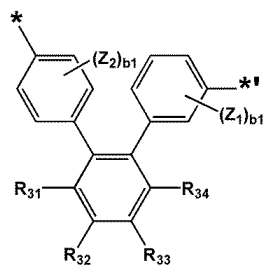
화학식 3-32



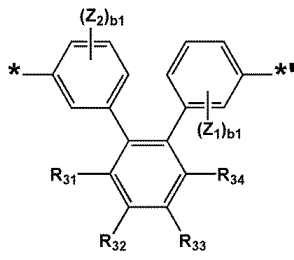
화학식 3-33



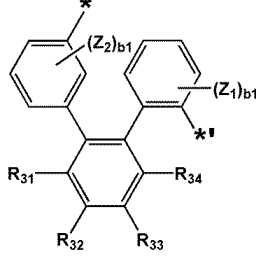
화학식 3-34



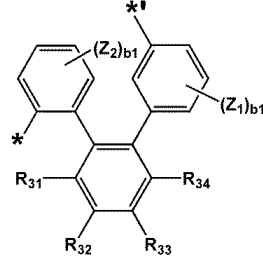
화학식 3-35



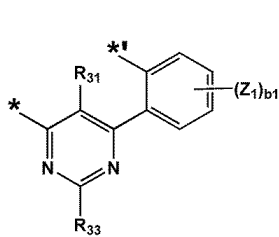
화학식 3-36



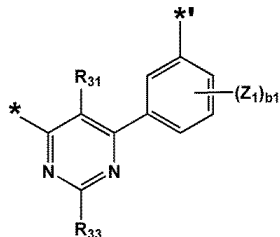
화학식 3-37



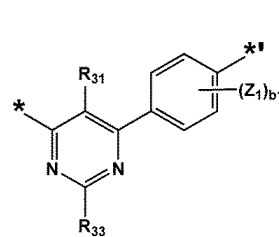
화학식 3-38



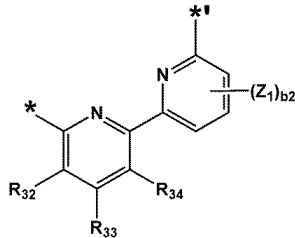
화학식 3-39



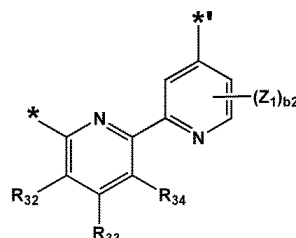
화학식 3-40



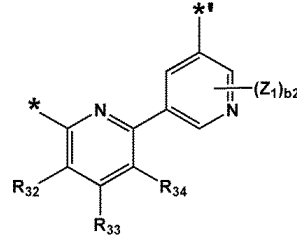
화학식 3-41



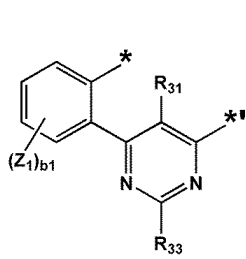
화학식 3-42



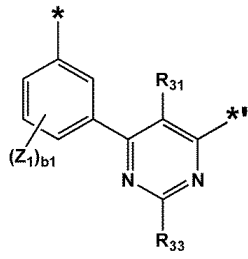
화학식 3-43



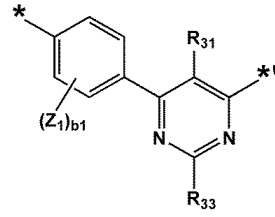
화학식 3-44



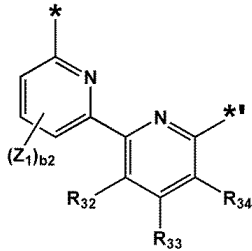
화학식 3-45



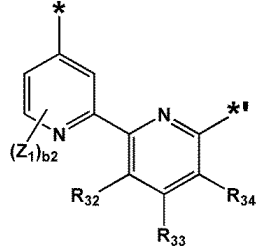
화학식 3-46



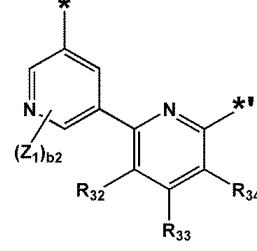
화학식 3-47



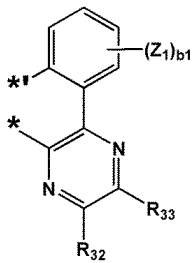
화학식 3-48



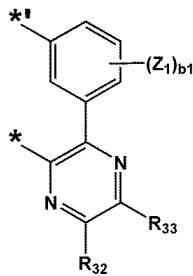
화학식 3-49



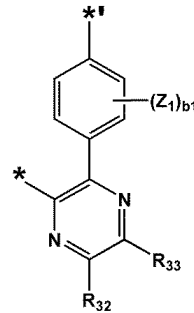
화학식 3-50



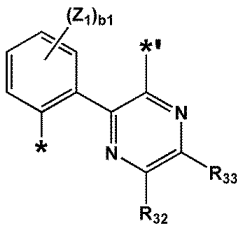
화학식 3-51



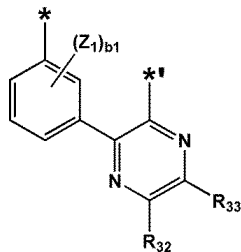
화학식 3-52



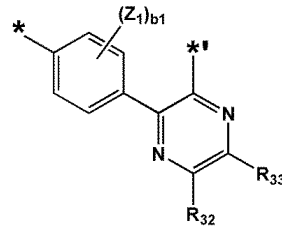
화학식 3-53



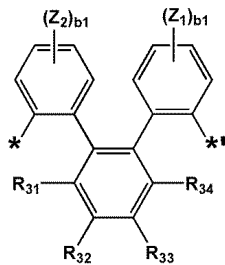
화학식 3-54



화학식 3-55



화학식 3-56



화학식 3-57

상기 화학식 3-1 내지 3-57 중

R<sub>31</sub> 내지 R<sub>34</sub>, Z<sub>1</sub> 및 Z<sub>2</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피라다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,

상기 Q<sub>11</sub> 내지 Q<sub>13</sub>는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택되고,

b<sub>1</sub>은 0 내지 4의 정수 중에서 선택되고, b<sub>2</sub>는 0 내지 3의 정수 중에서 선택되고,

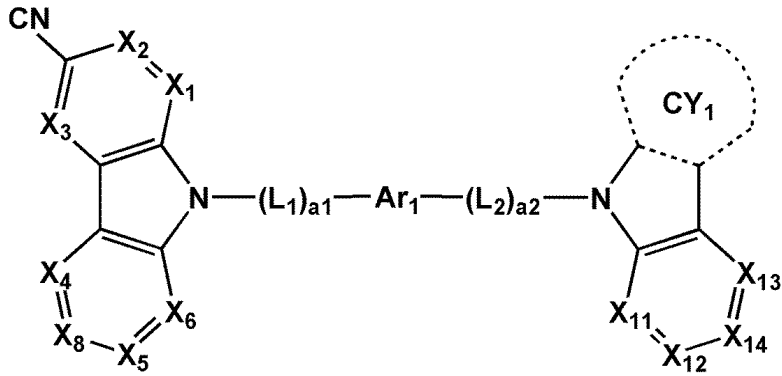
\* 및 \*'은 각각 이웃한 질소 원자와의 결합 사이트이다.

**청구항 11**

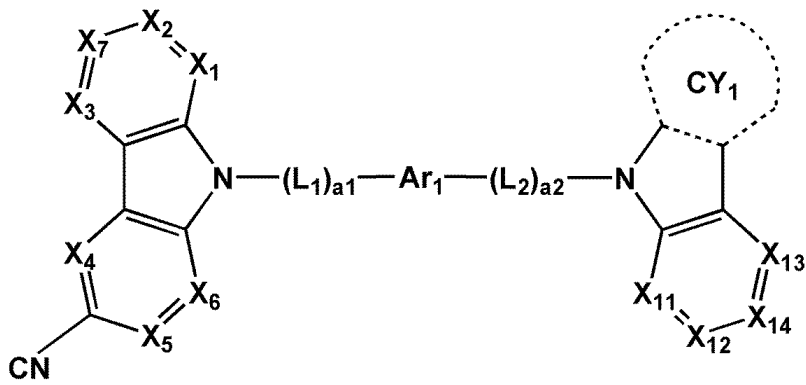
제1항에 있어서,

하기 화학식 1(1) 내지 1(7) 중 하나로 표시되는, 축합환 화합물:

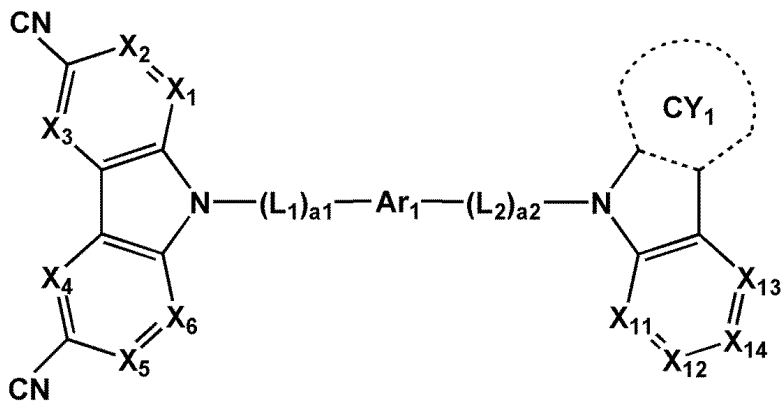
<화학식 1(1)>



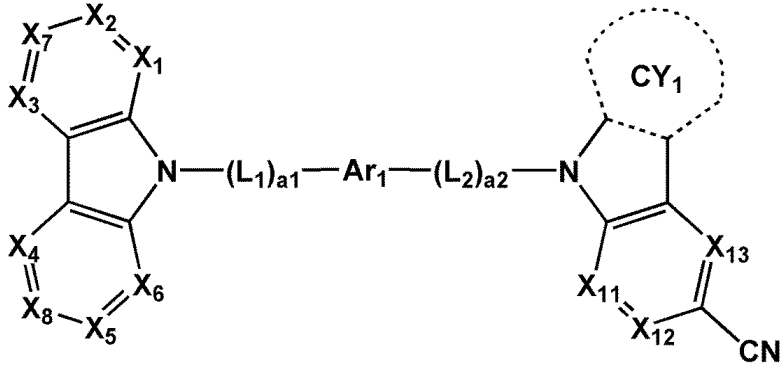
<화학식 1(2)>



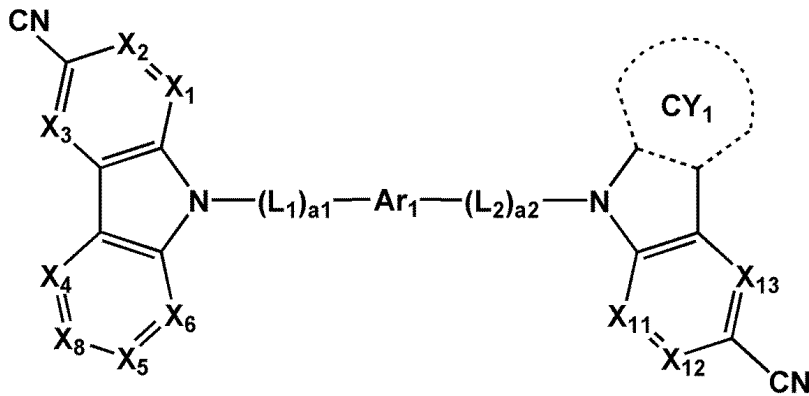
<화학식 1(3)>



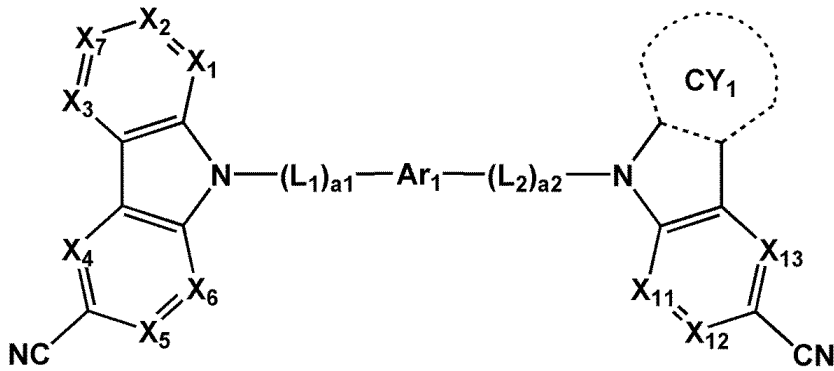
<화학식 1(4)>



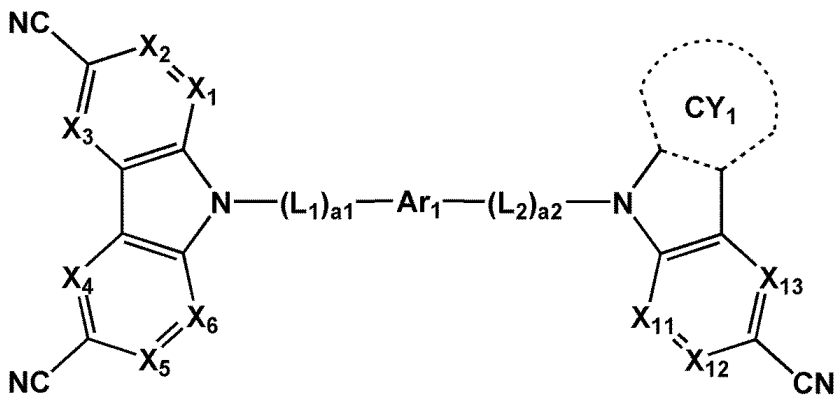
<화학식 1(5)>



<화학식 1(6)>



<화학식 1(7)>



상기 화학식 1(1) 내지 1(7) 중, X<sub>1</sub> 내지 X<sub>8</sub>, X<sub>11</sub> 내지 X<sub>14</sub>, CY<sub>1</sub>, Ar<sub>1</sub>, L<sub>1</sub>, L<sub>2</sub>, a<sub>1</sub> 및 a<sub>2</sub>는 제1항에 기재된 바와

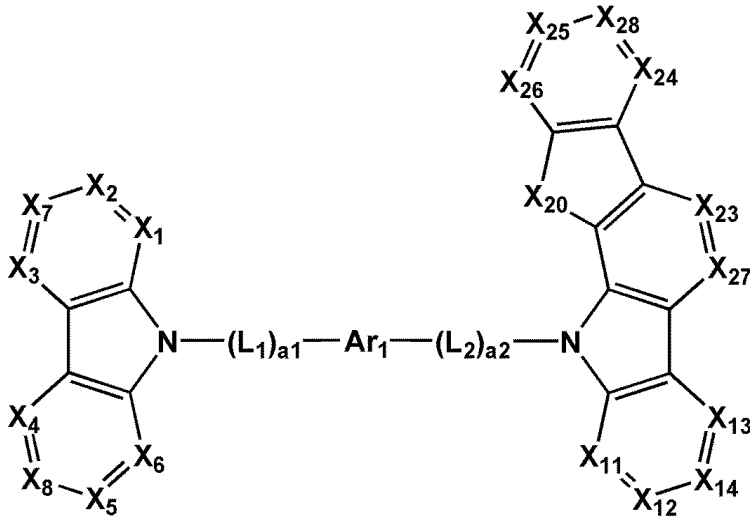
동일하다.

청구항 12

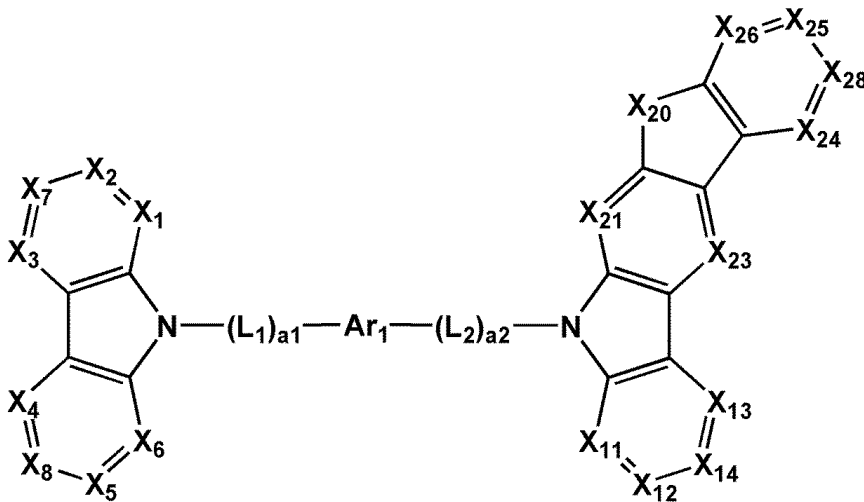
제1항에 있어서,

하기 화학식 1A 내지 1F 중 하나로 표시되는, 축합환 화합물:

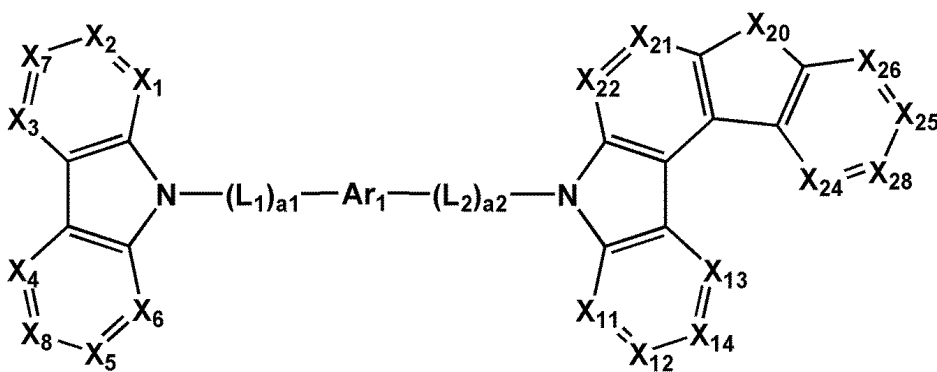
<화학식 1A>



<화학식 1B>

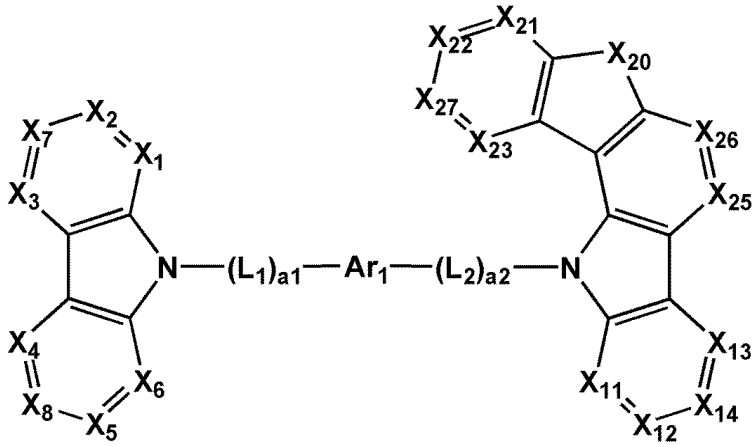


<화학식 1C>

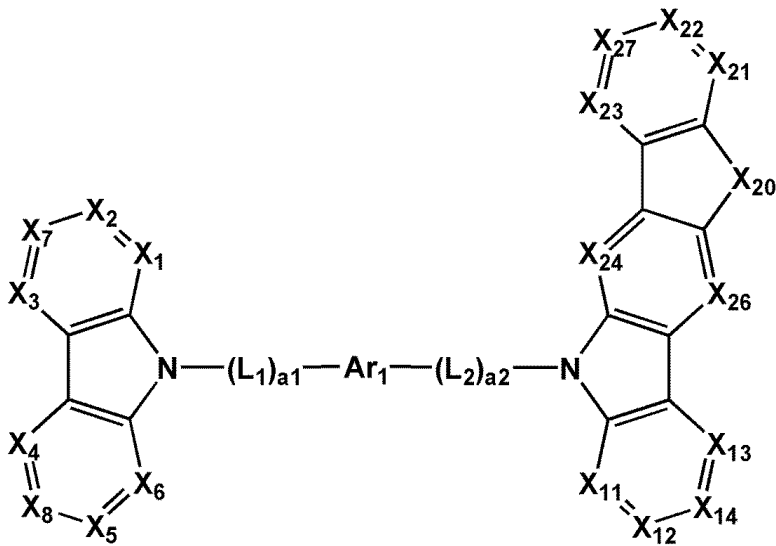




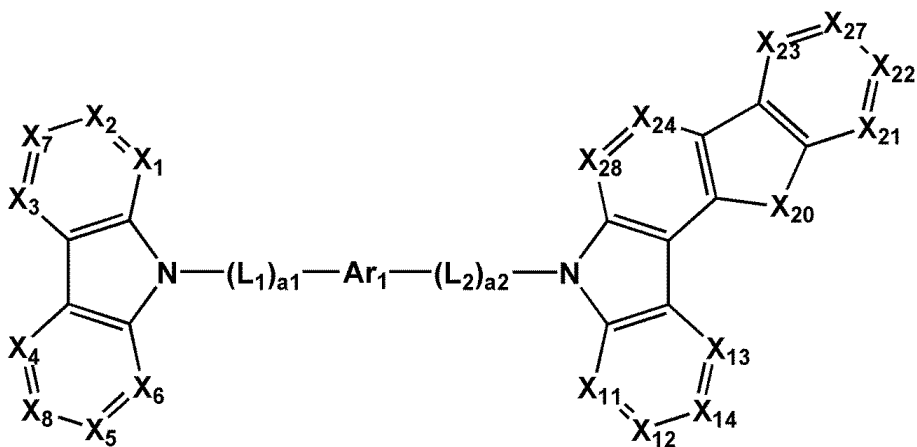
<화학식 1D>



<화학식 1E>



<화학식 1F>



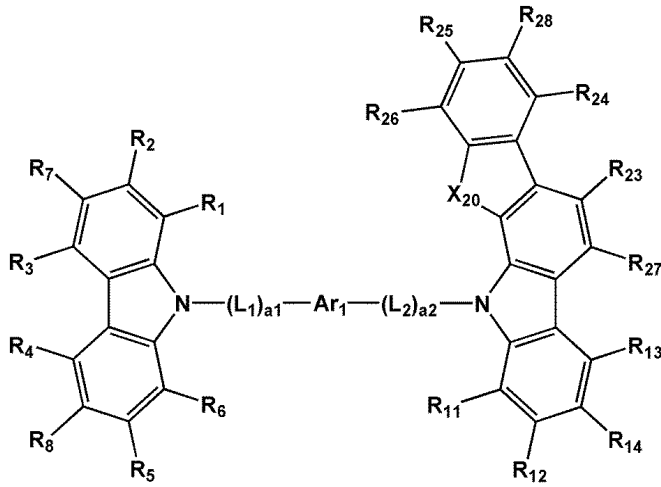
상기 화학식 1A 내지 1F 중, X<sub>1</sub> 내지 X<sub>8</sub>, X<sub>11</sub> 내지 X<sub>14</sub>, X<sub>20</sub> 내지 X<sub>28</sub>, Ar<sub>1</sub>, L<sub>1</sub>, L<sub>2</sub>, a<sub>1</sub> 및 a<sub>2</sub>에 대한 설명은 제1항에 기재된 바와 동일하다.

청구항 13

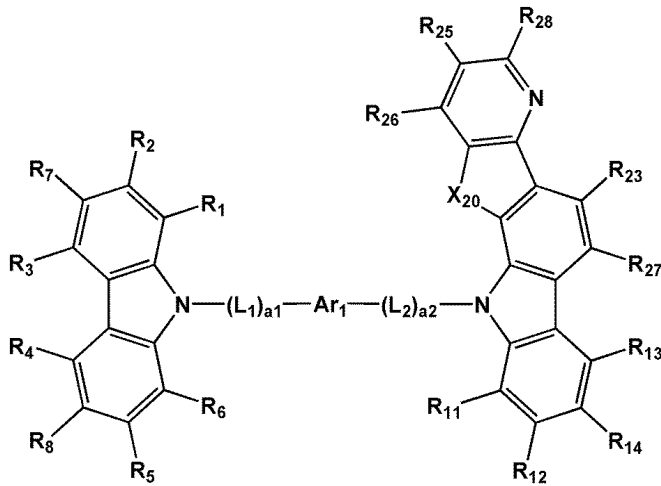
제1항에 있어서,

하기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중 하나로 표시된, 축합환 화합물:

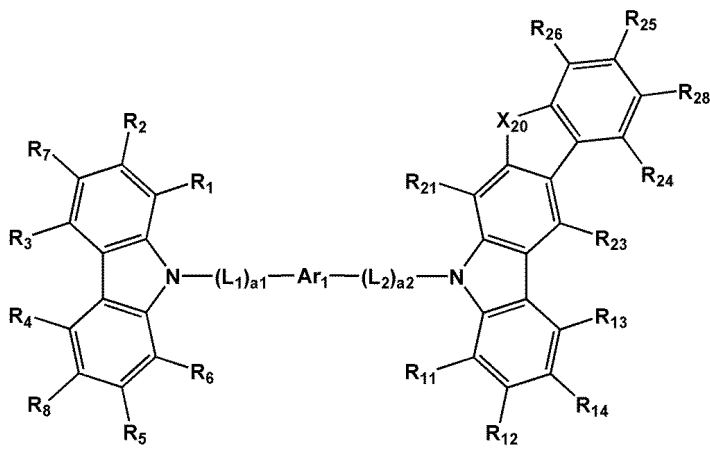
<화학식 1A(1)>



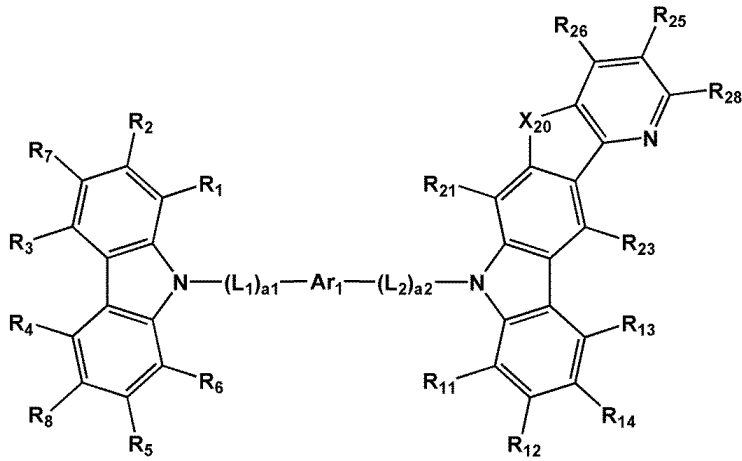
<화학식 1A(2)>



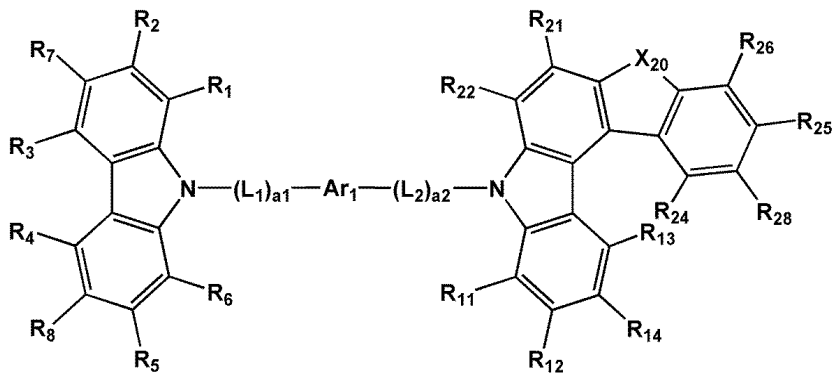
<화학식 1B(1)>



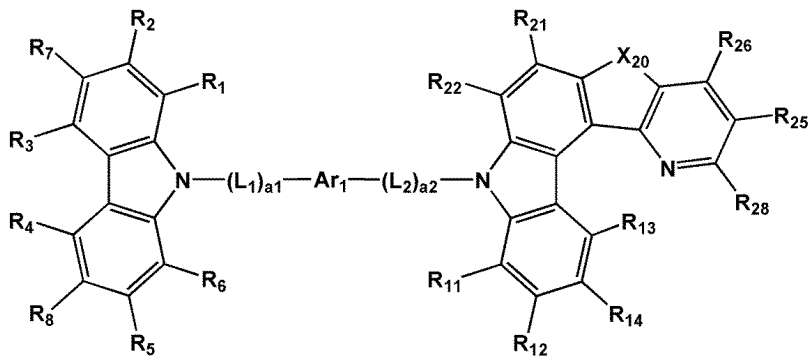
<화학식 1B(2)>



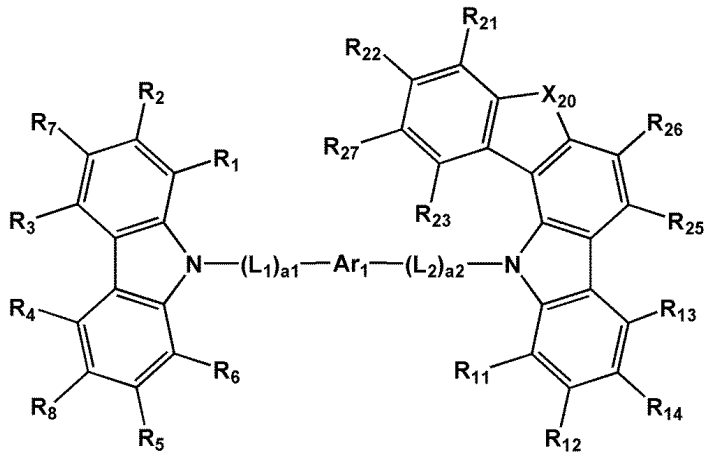
<화학식 1C(1)>



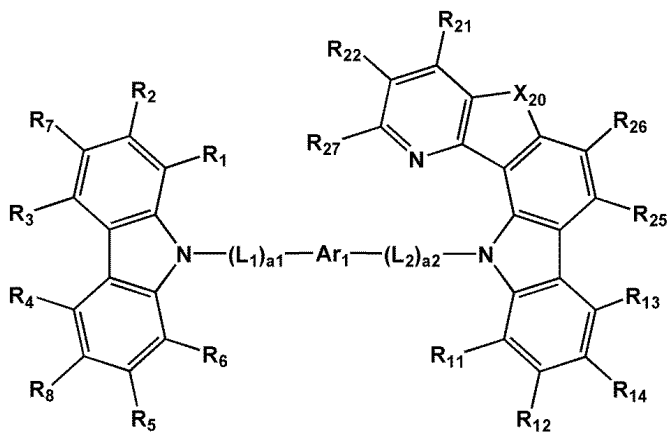
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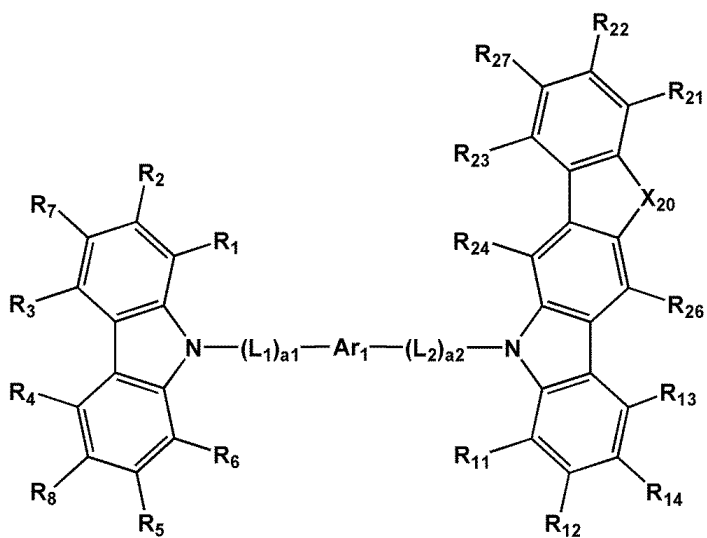
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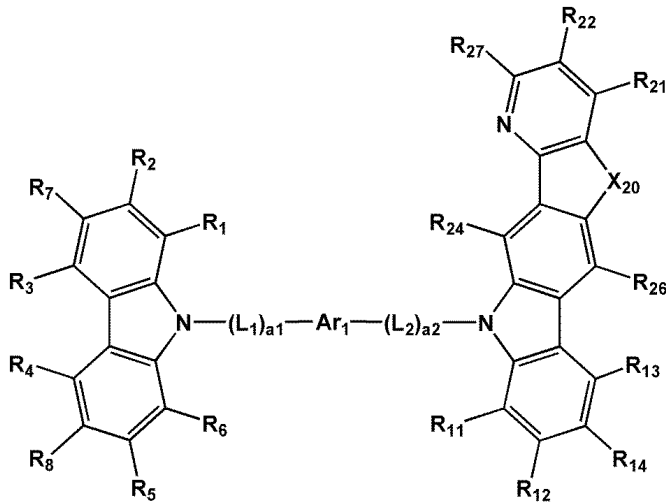
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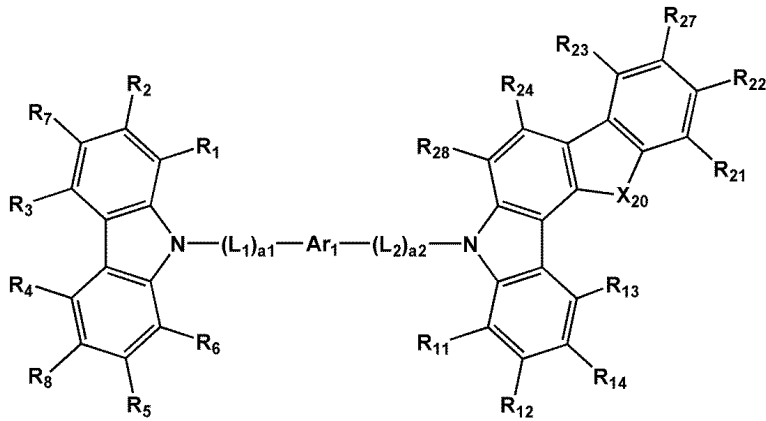
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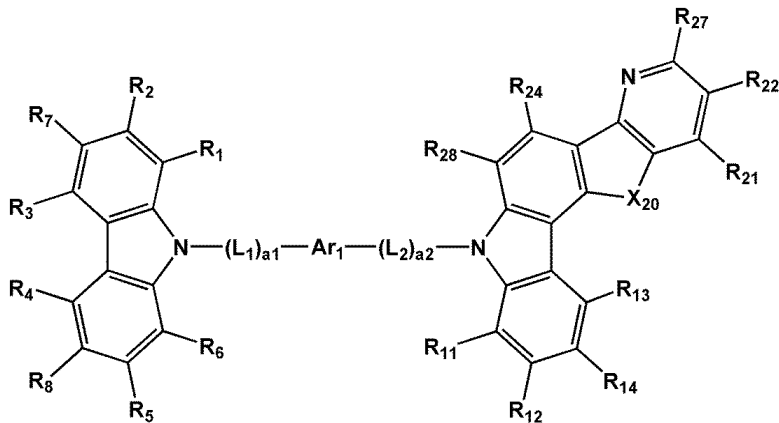
<화학식 1E(2)>



<화학식 1F(1)>



<화학식 1F(2)>



상기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중,  $Ar_1, L_1, L_2, a_1, a_2$  및  $X_{20}$ 은 제1항에 기재된 바와 동일하고,

$R_1$  내지  $R_8, R_{11}$  내지  $R_{14}$  및  $R_{20}$  내지  $R_{29}$ 는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아마이드기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, n-펜틸기, 이소펜틸기, sec-펜틸기, tert-펜틸기, n-헥실기, 이소헥실기, sec-헥실기, tert-헥실기, n-헵틸기, 이소헵틸기, sec-헵틸기, tert-헵틸기, n-옥틸기, 이소옥틸기,

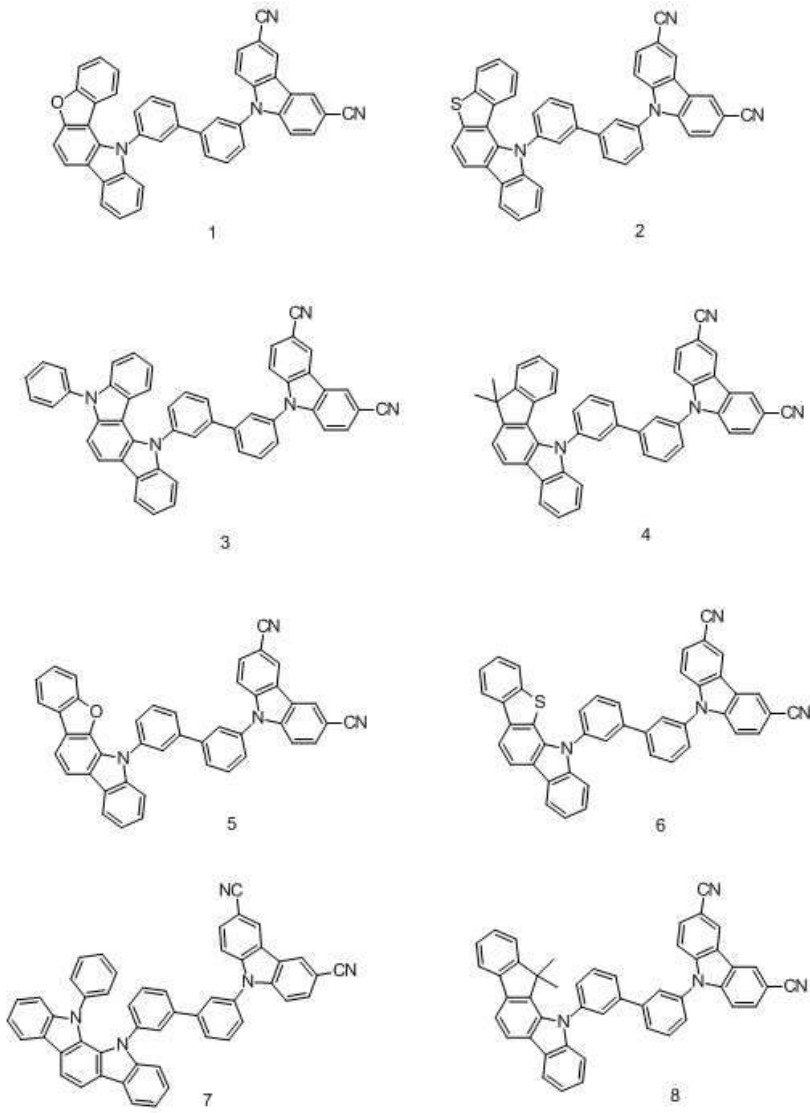
sec-옥틸기, tert-옥틸기, n-노닐기, 이소노닐기, sec-노닐기, tert-노닐기, n-데실기, 이소데실기, sec-데실기, tert-데실기, 메톡시기, 에톡시기, 프로폭시기, 부톡시기, 펜톡시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 트리아지닐기 및  $-Si(Q_1)(Q_2)(Q_3)$  중에서 선택되고,

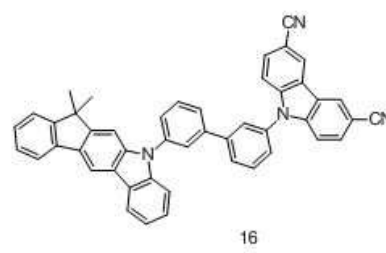
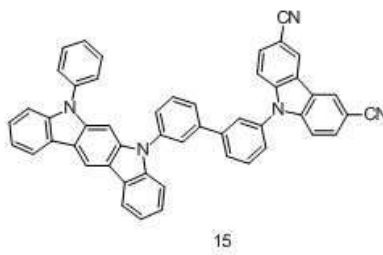
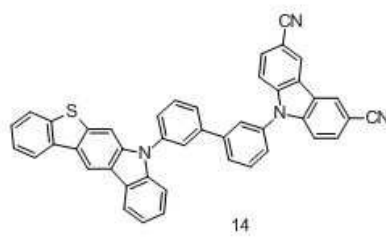
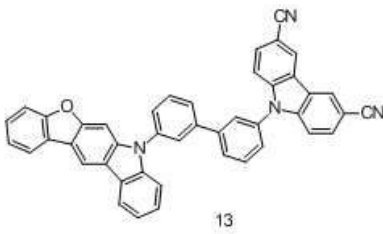
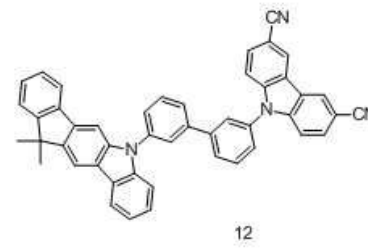
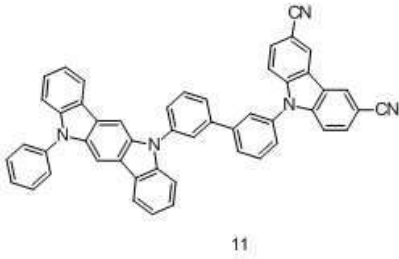
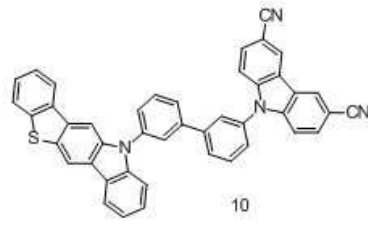
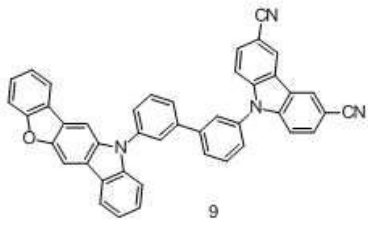
R<sub>7</sub>, R<sub>8</sub>, R<sub>14</sub>, R<sub>27</sub> 및 R<sub>28</sub> 중 적어도 하나는 시아노기이다.

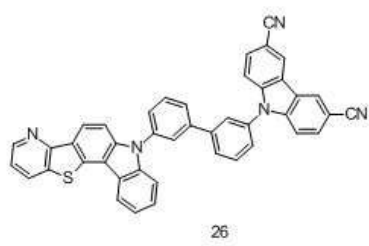
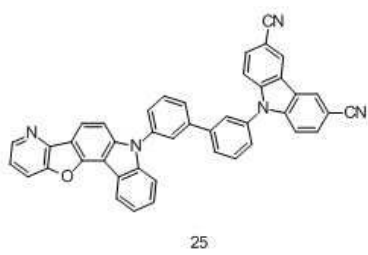
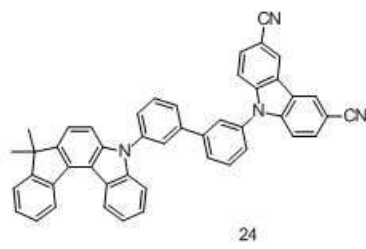
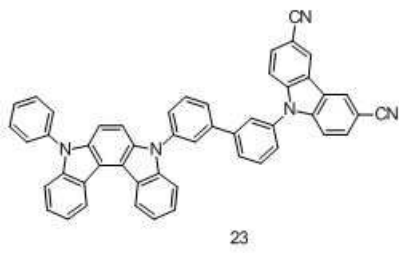
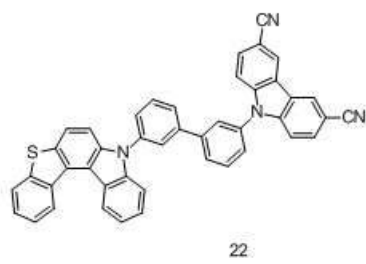
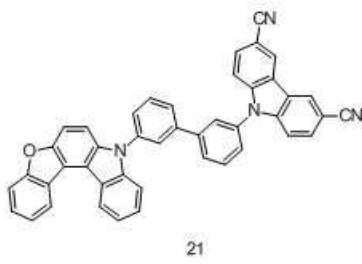
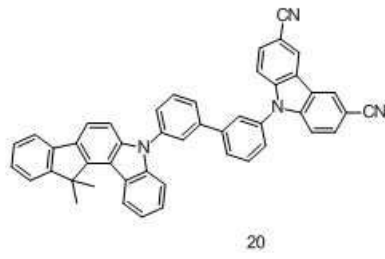
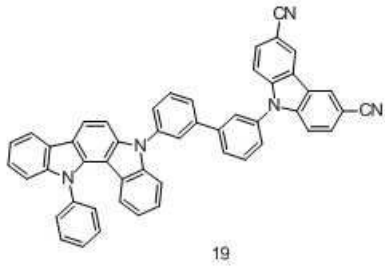
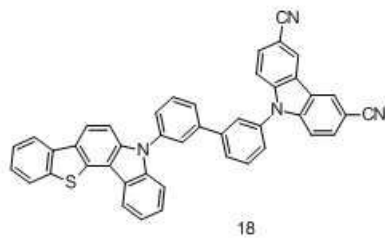
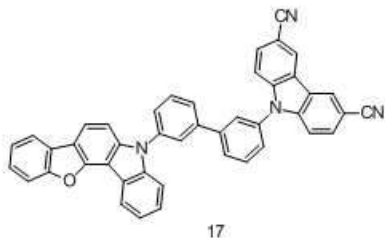
**청구항 14**

제1항에 있어서,

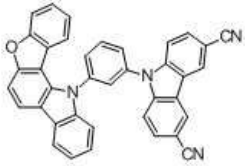
하기 화합물 1 내지 876 중에서 선택된, 축합환 화합물:



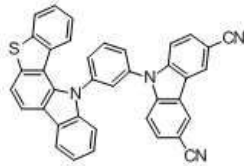




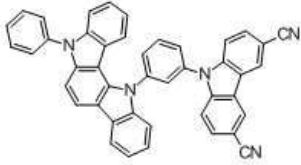




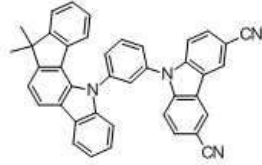
27



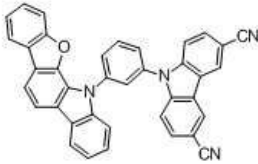
28



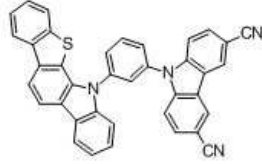
29



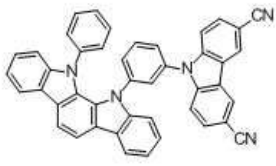
30



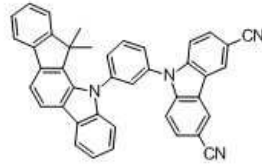
31



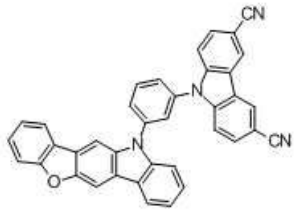
32



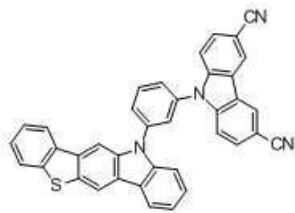
33



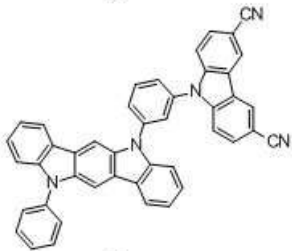
34



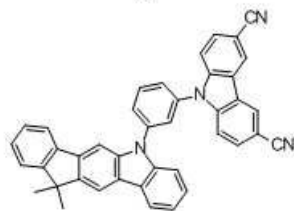
35



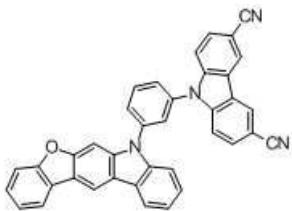
36



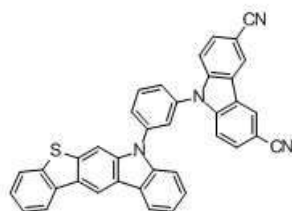
37



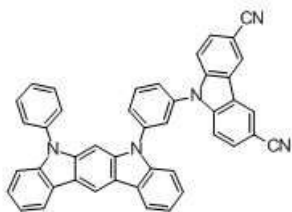
38



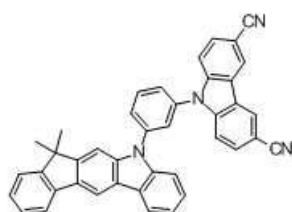
39



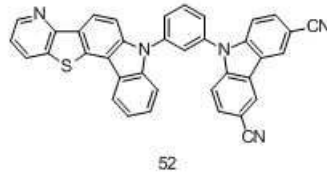
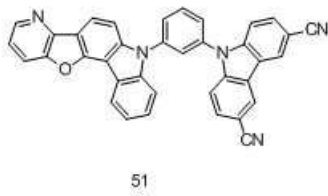
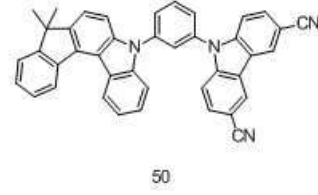
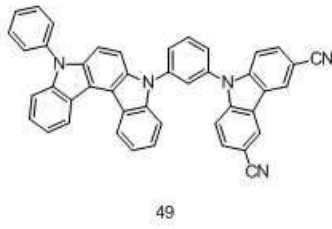
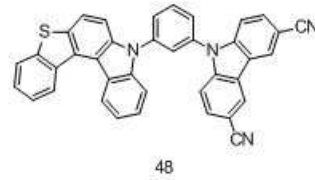
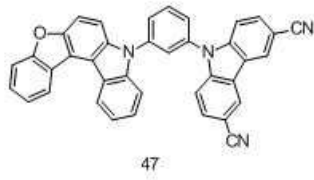
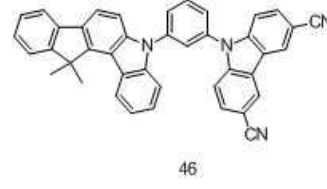
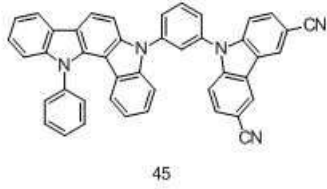
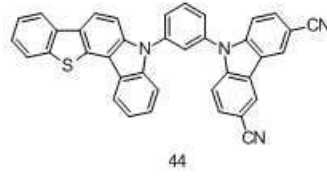
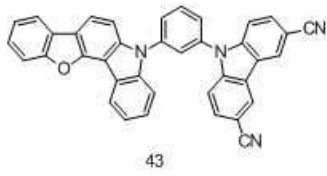
40

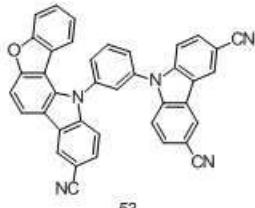


41

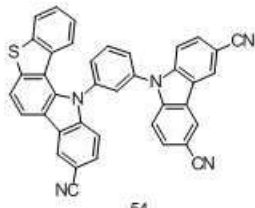


42

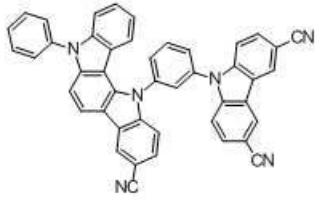




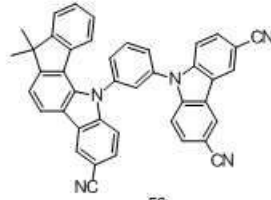
53



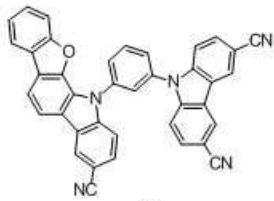
54



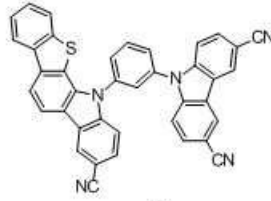
55



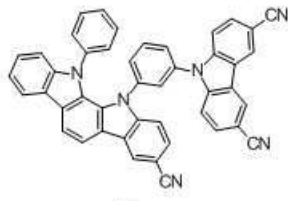
56



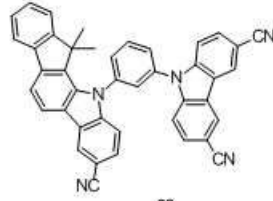
57



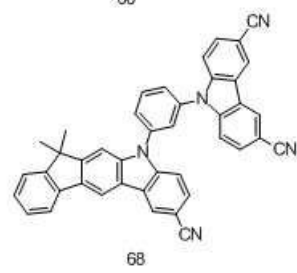
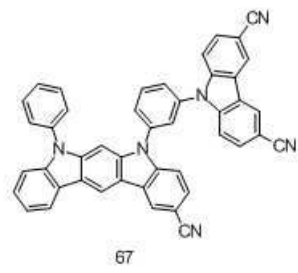
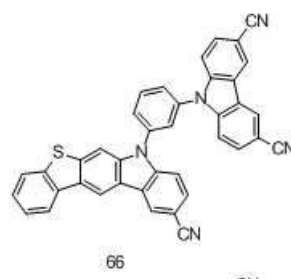
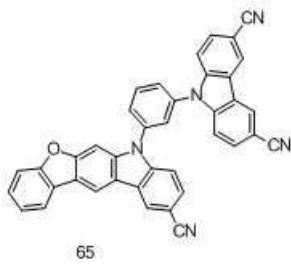
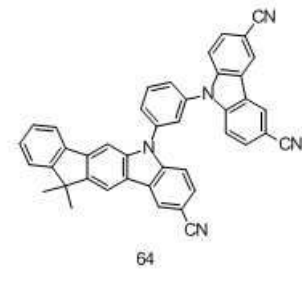
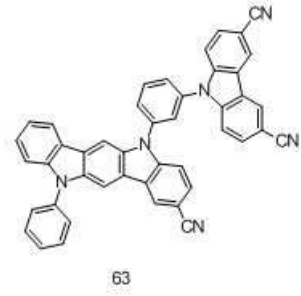
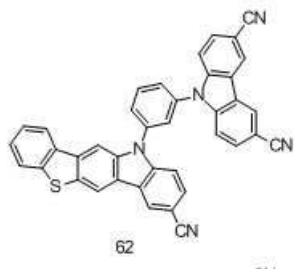
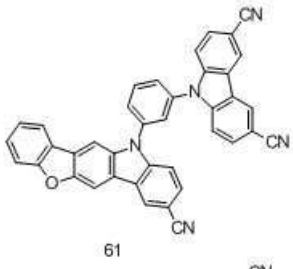
58

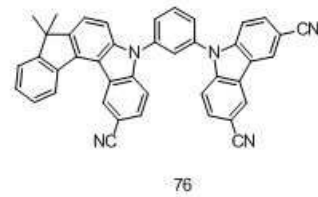
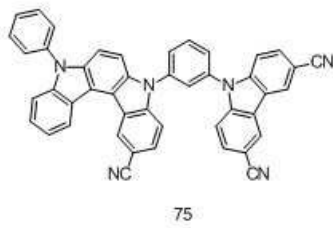
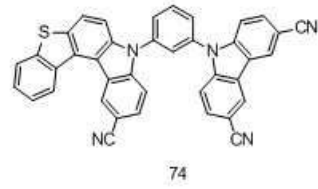
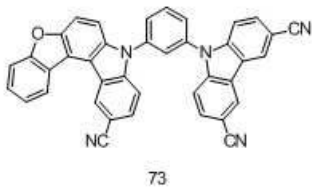
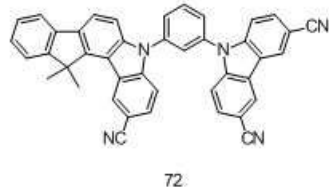
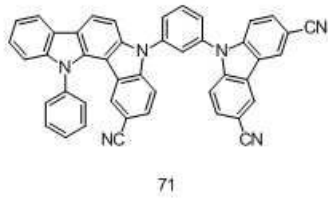
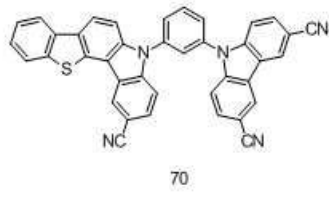
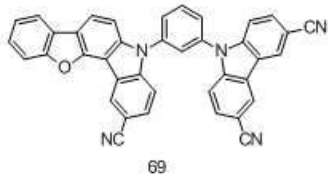


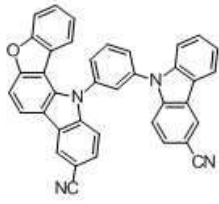
59



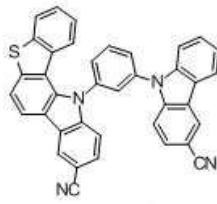
60



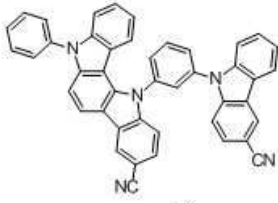




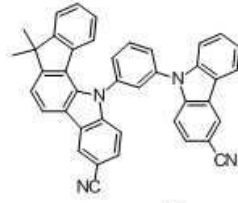
77



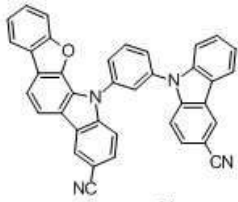
78



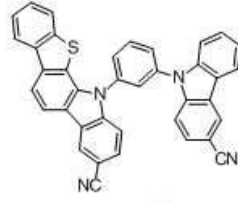
79



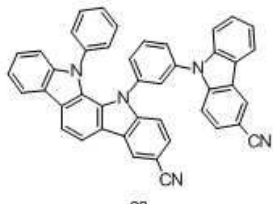
80



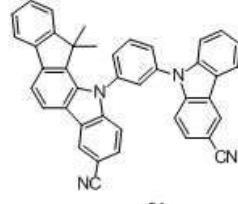
81



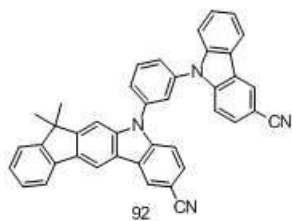
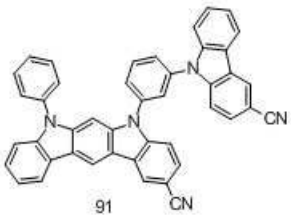
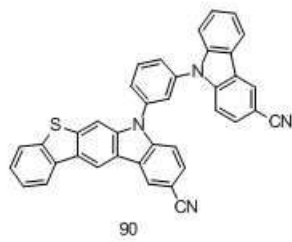
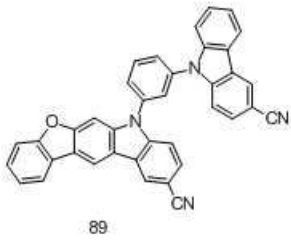
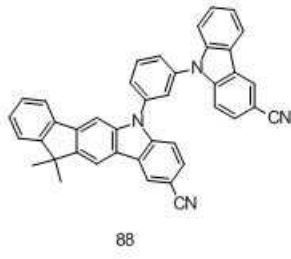
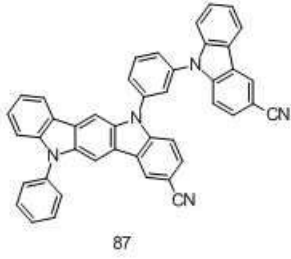
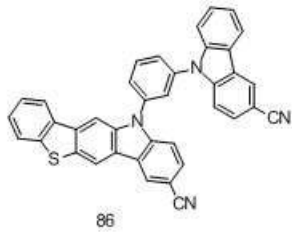
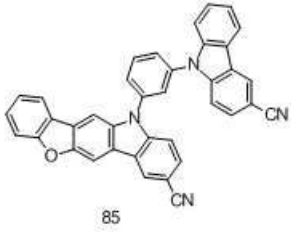
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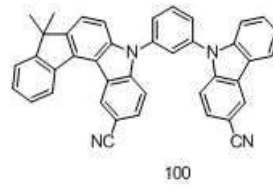
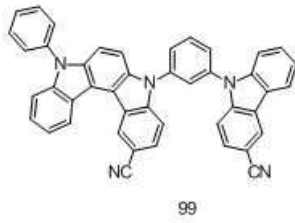
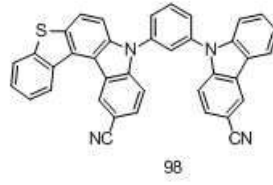
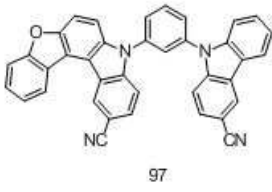
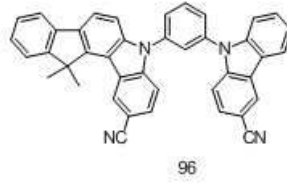
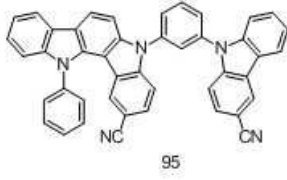
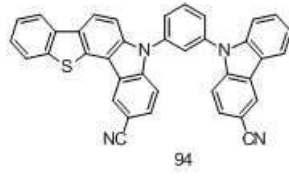
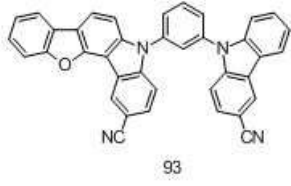
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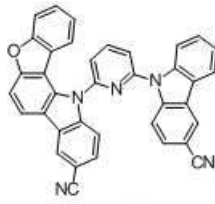


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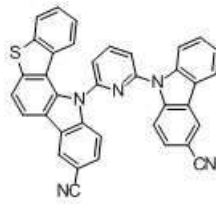




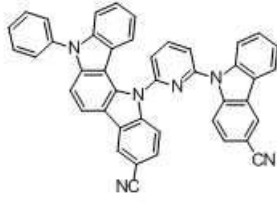




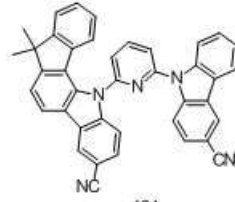
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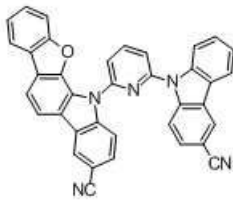
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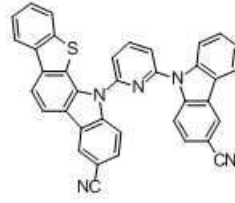
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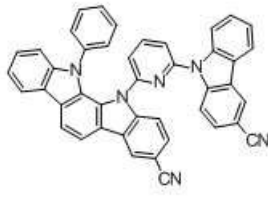
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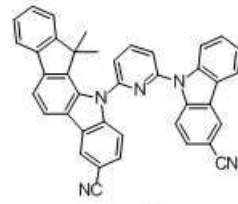
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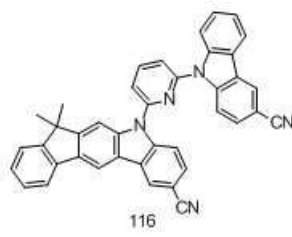
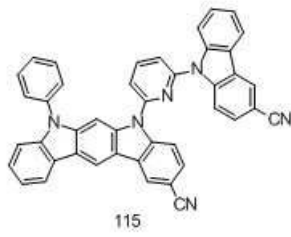
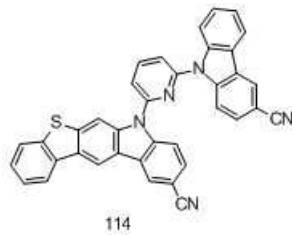
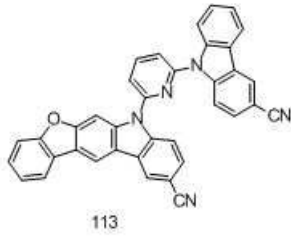
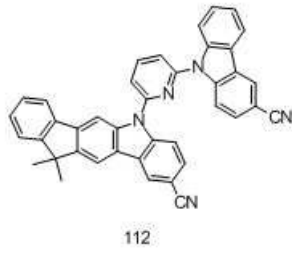
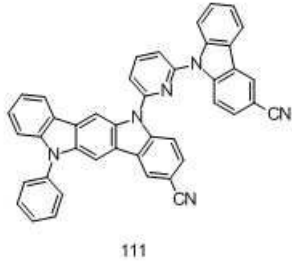
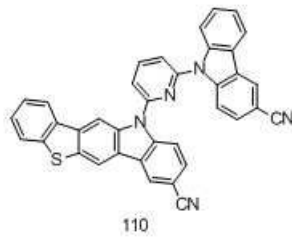
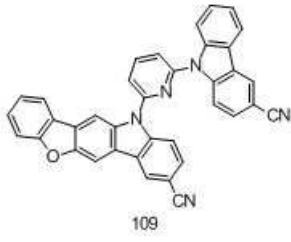
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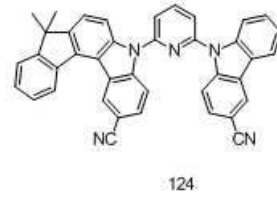
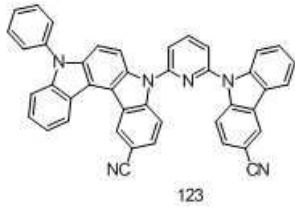
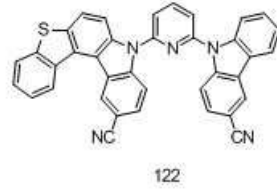
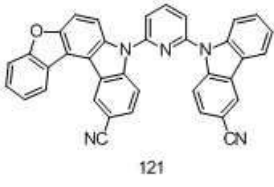
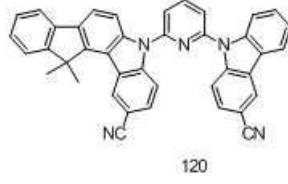
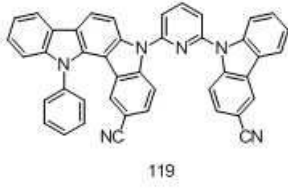
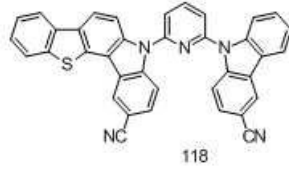
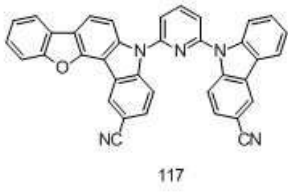


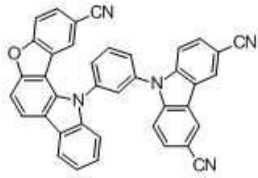
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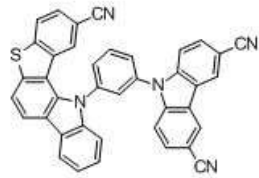
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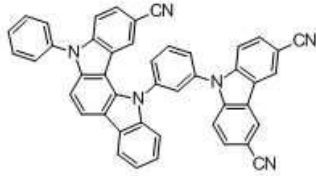




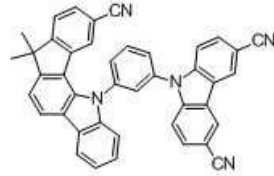
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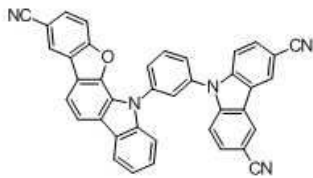
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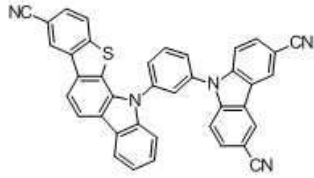
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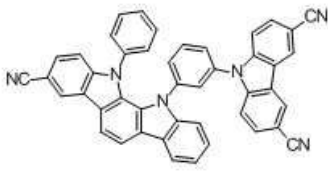
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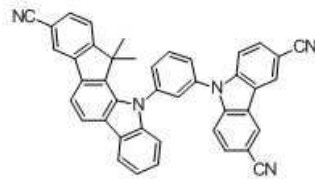
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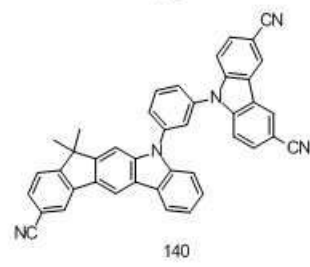
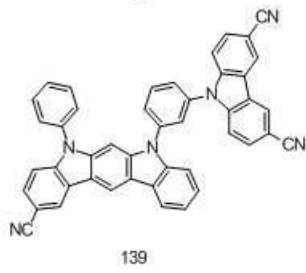
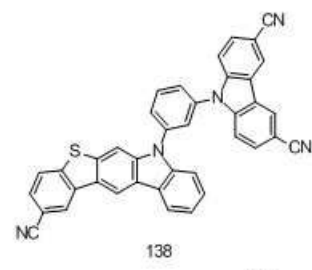
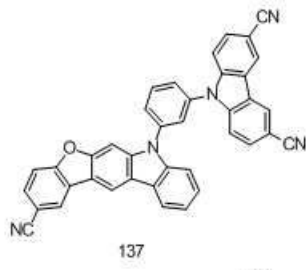
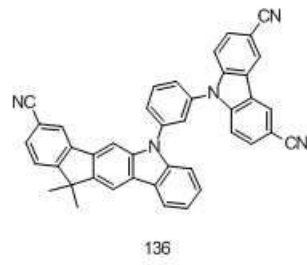
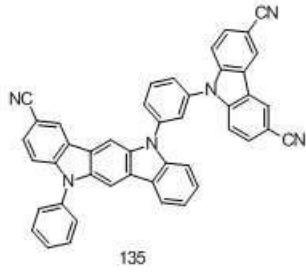
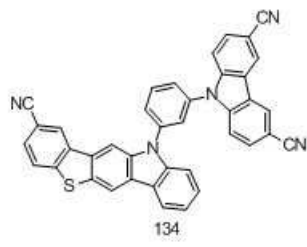
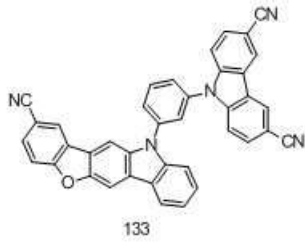
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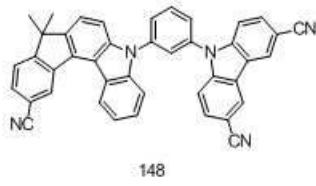
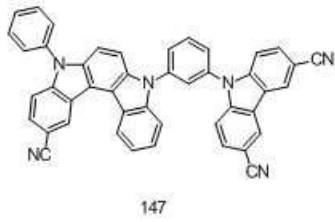
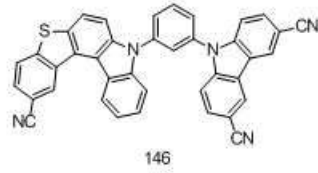
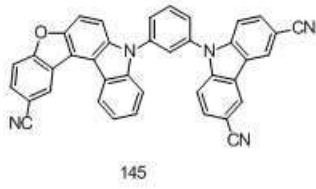
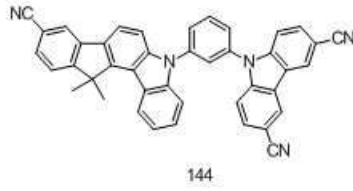
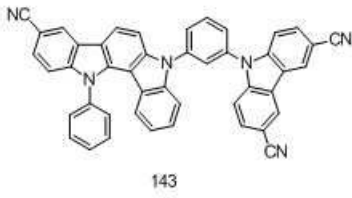
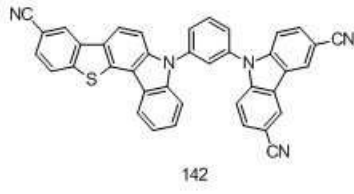
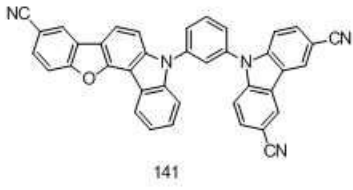


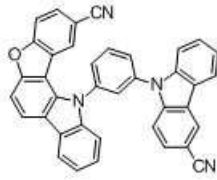
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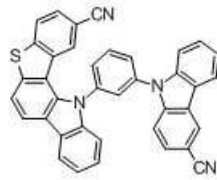
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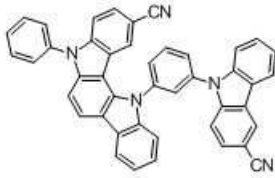




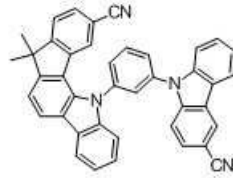
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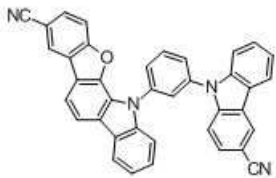
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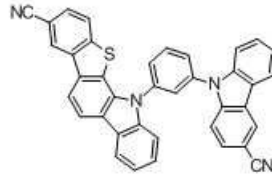
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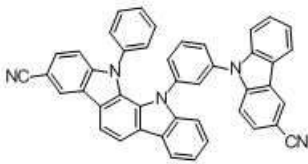
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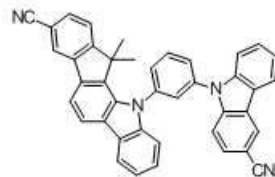
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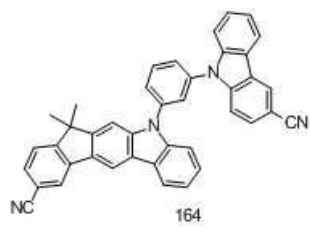
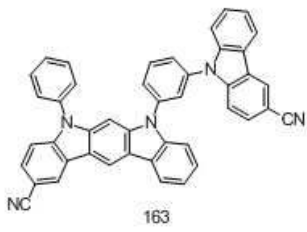
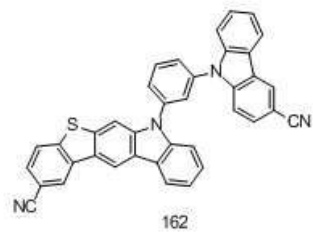
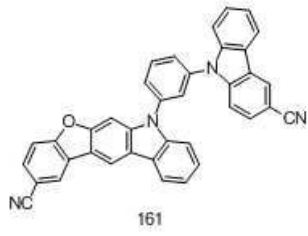
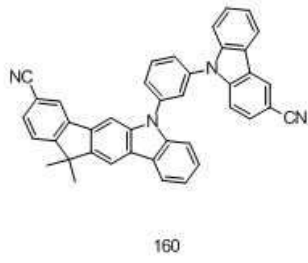
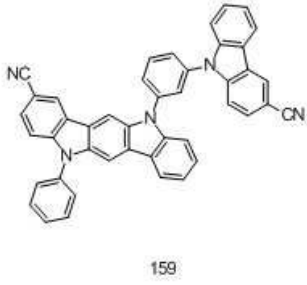
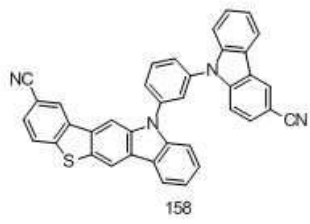
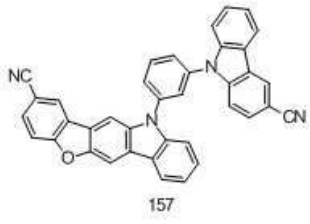


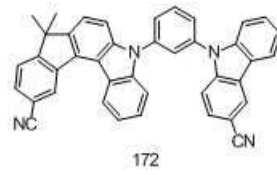
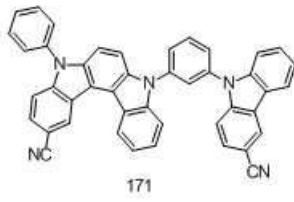
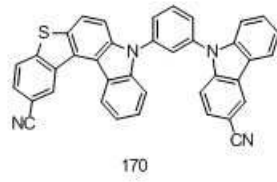
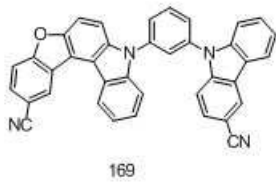
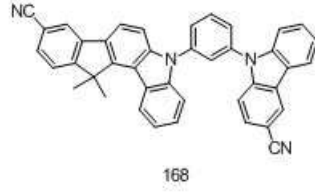
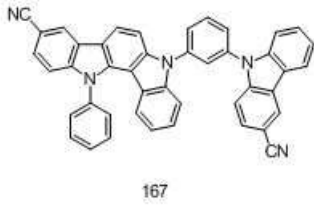
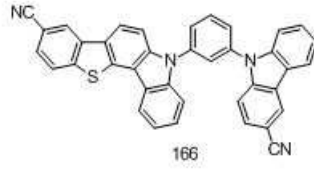
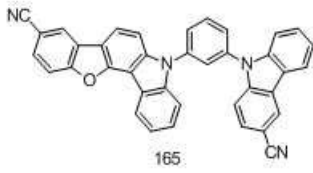
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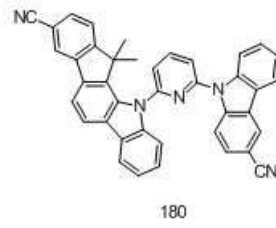
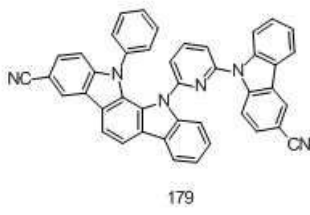
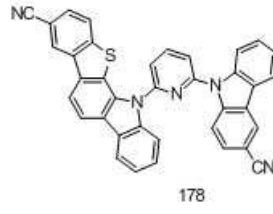
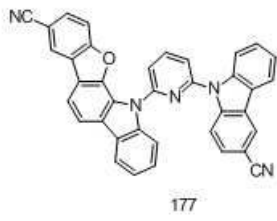
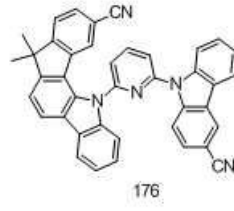
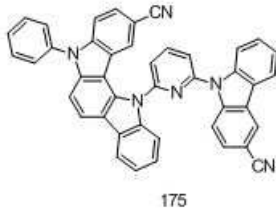
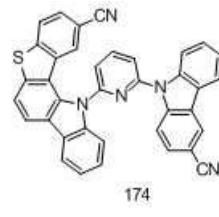
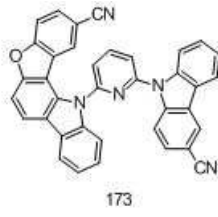


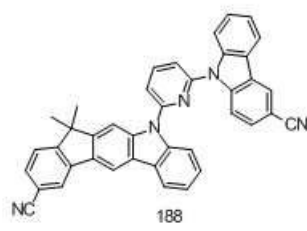
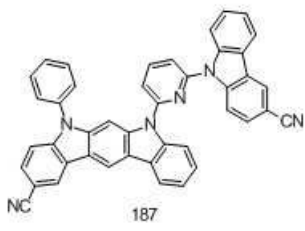
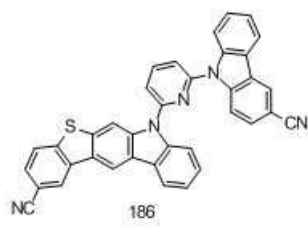
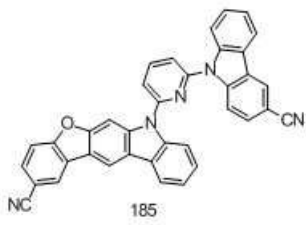
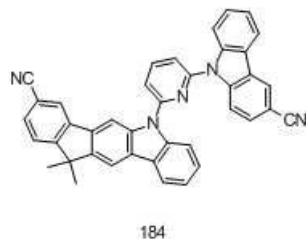
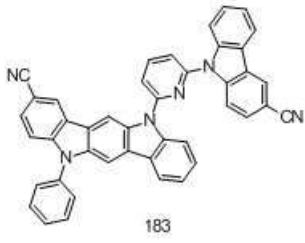
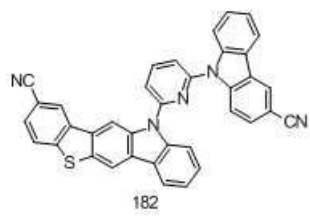
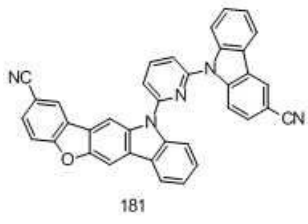
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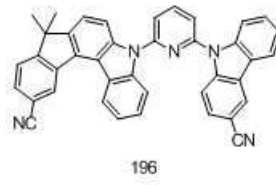
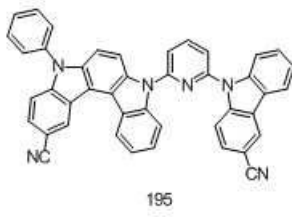
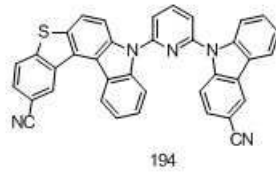
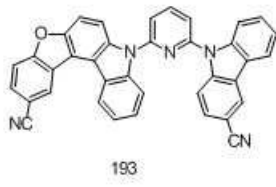
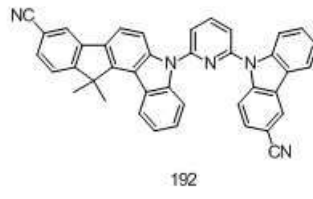
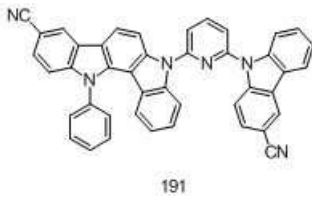
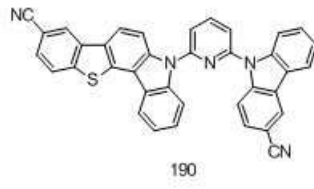
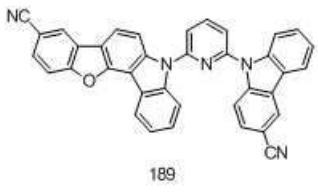


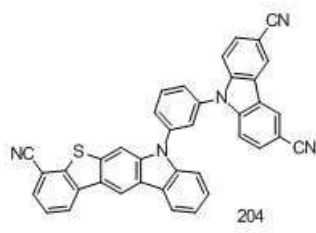
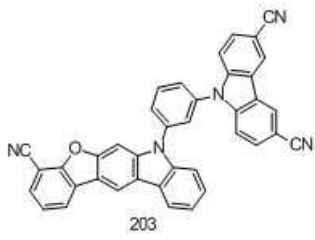
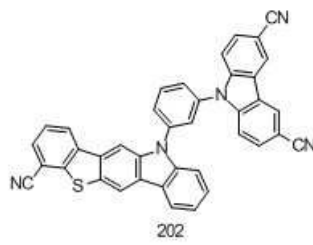
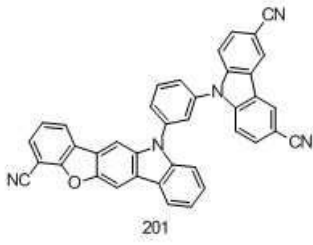
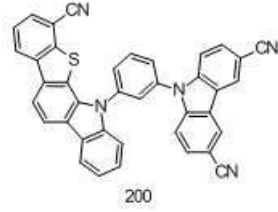
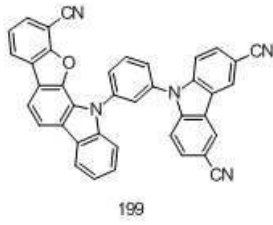
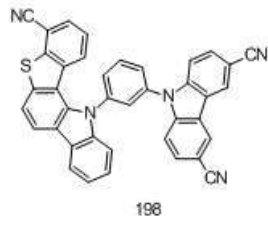
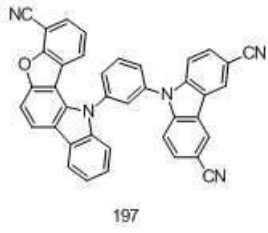


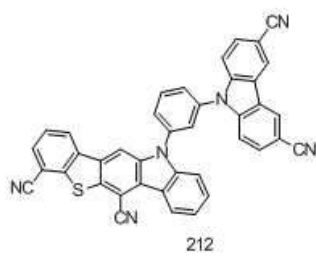
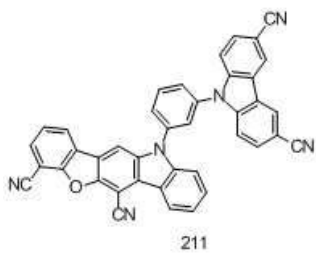
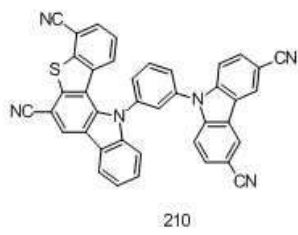
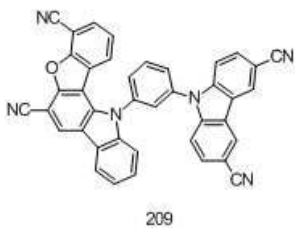
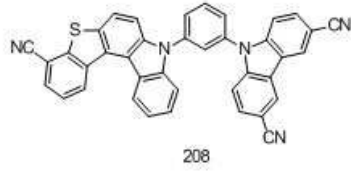
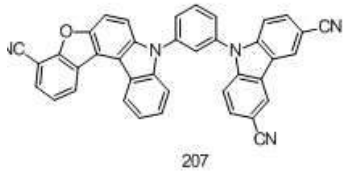
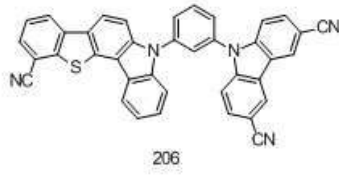
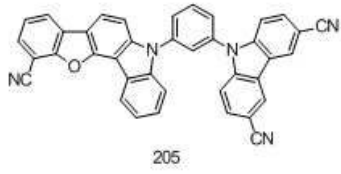


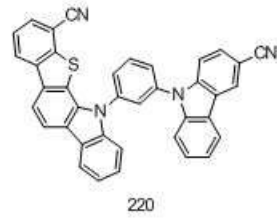
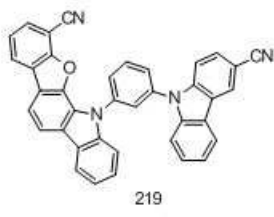
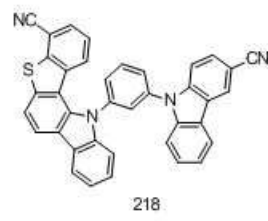
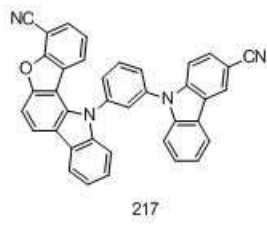
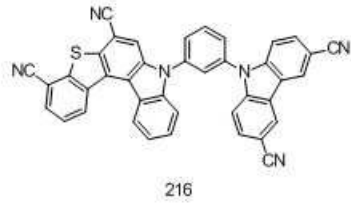
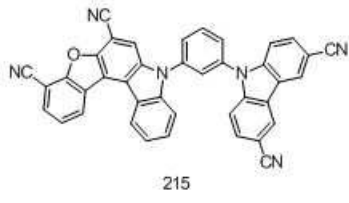
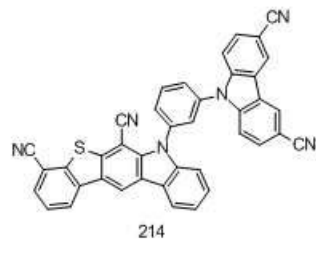
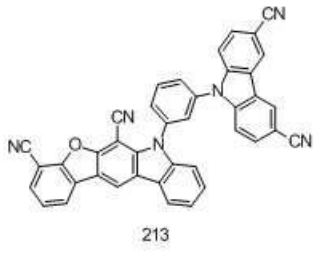




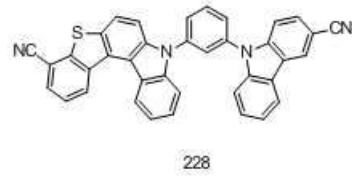
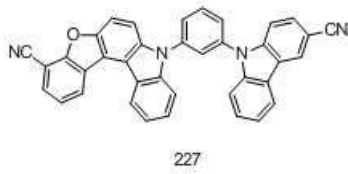
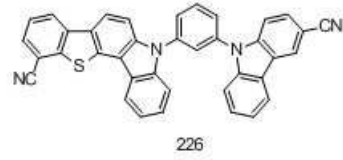
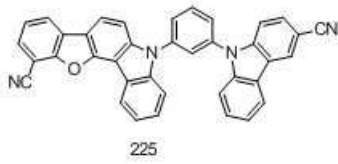
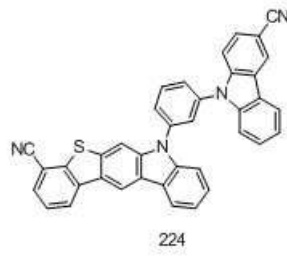
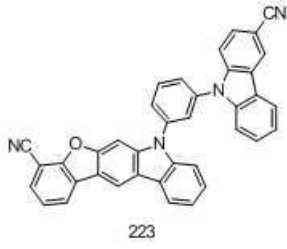
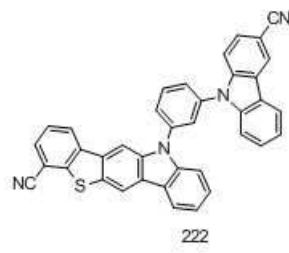
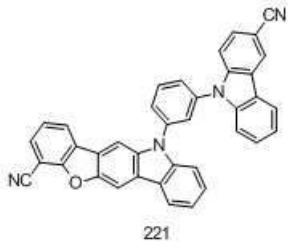


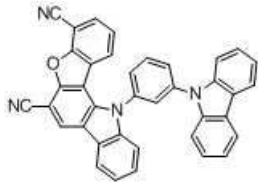




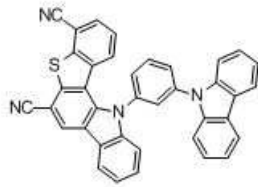




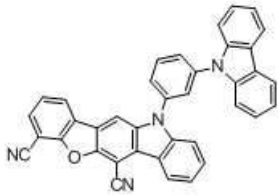




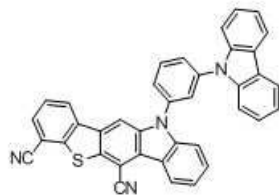
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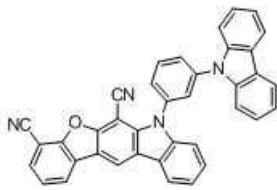
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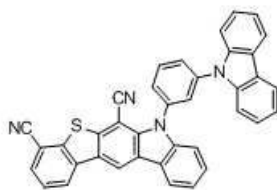
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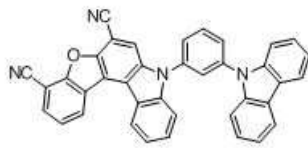
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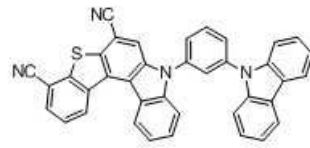
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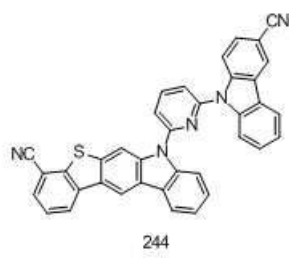
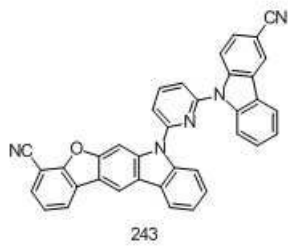
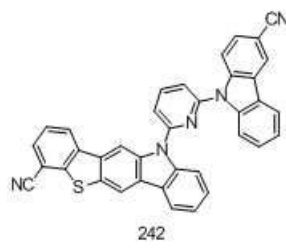
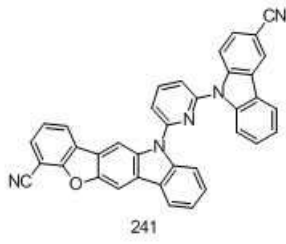
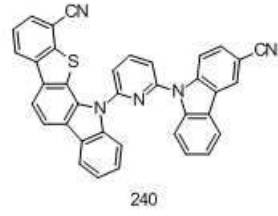
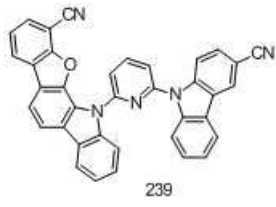
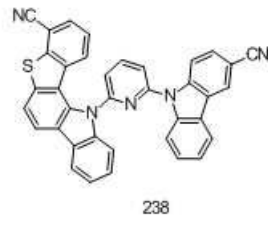
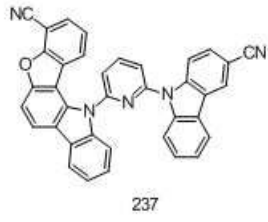
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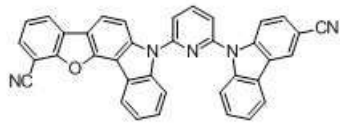


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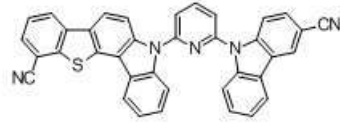


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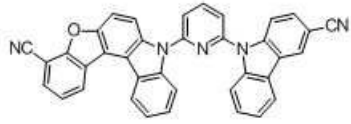




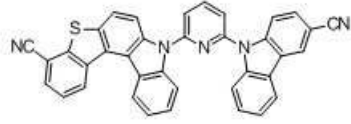
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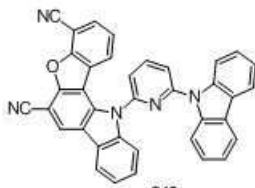
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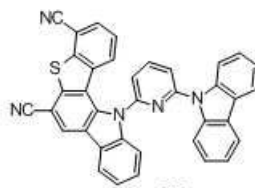
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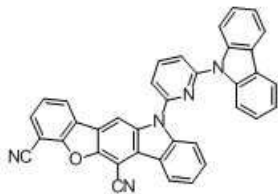
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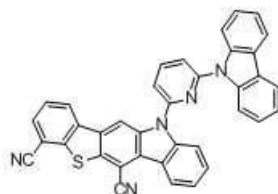
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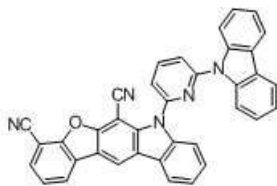
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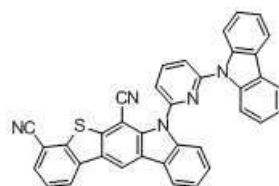
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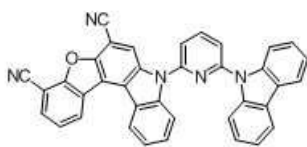
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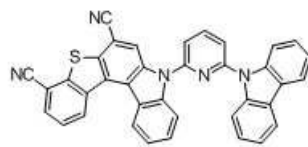
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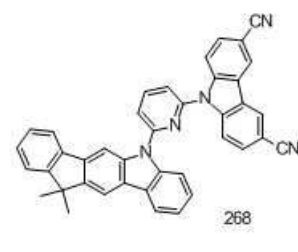
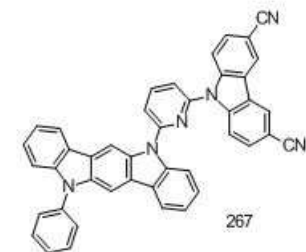
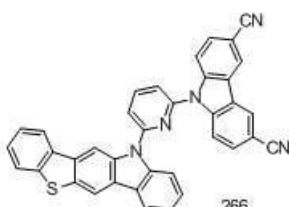
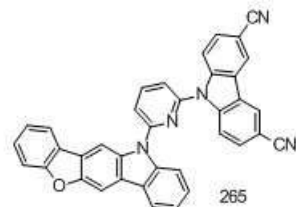
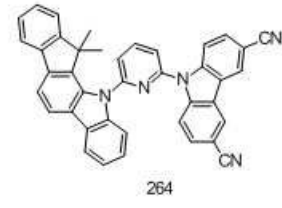
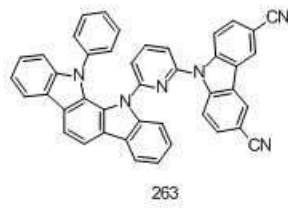
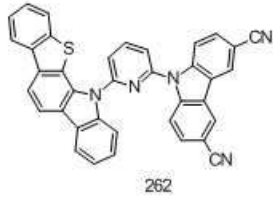
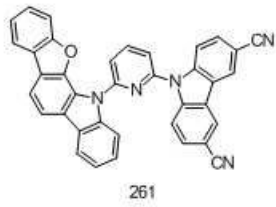
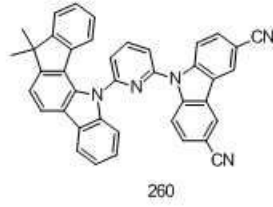
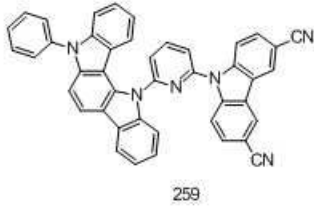
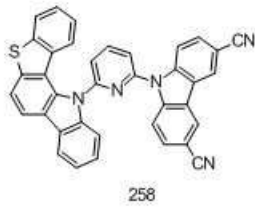
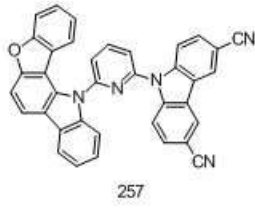
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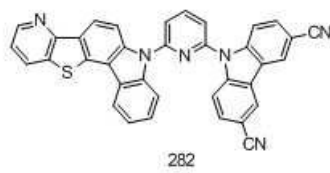
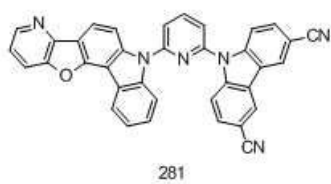
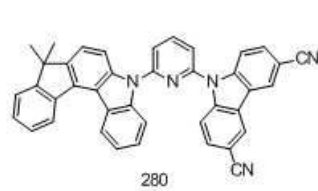
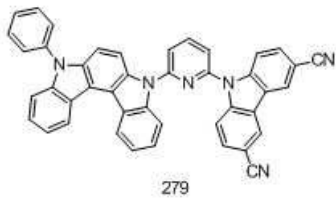
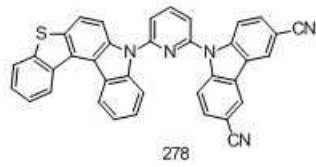
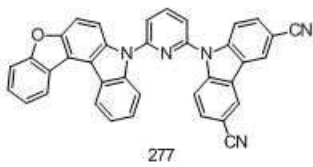
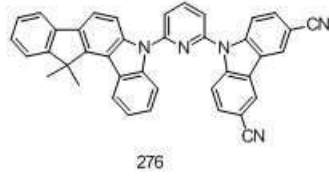
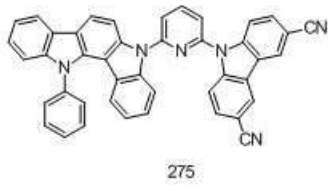
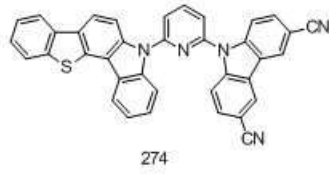
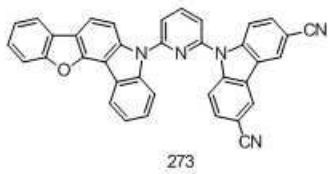
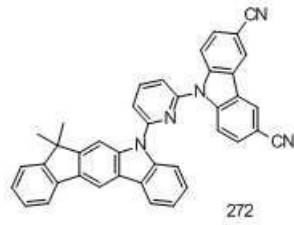
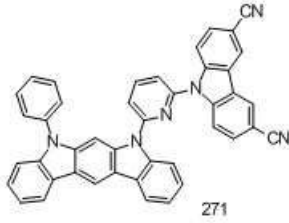
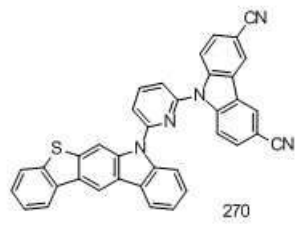
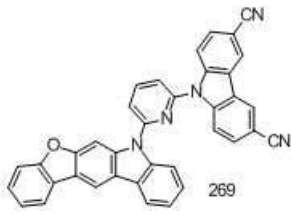


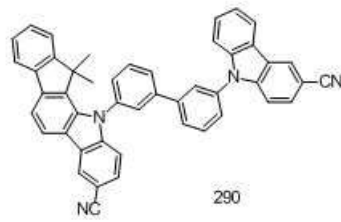
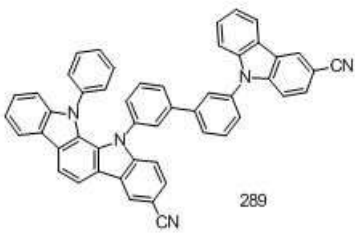
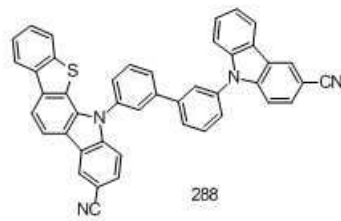
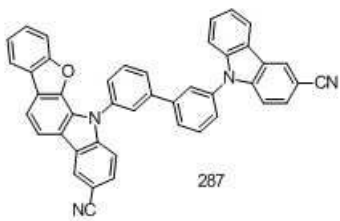
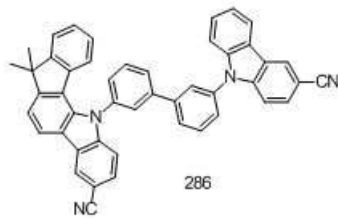
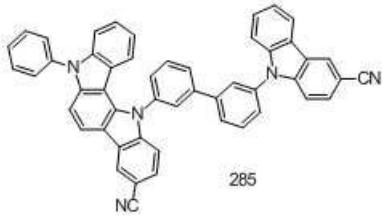
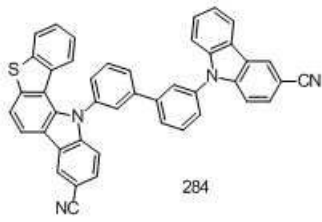
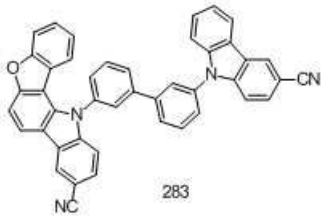
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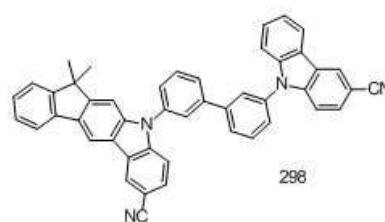
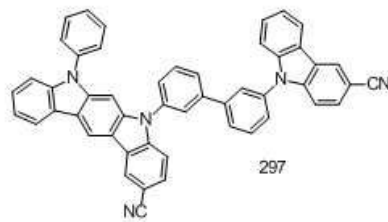
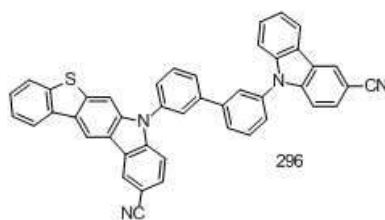
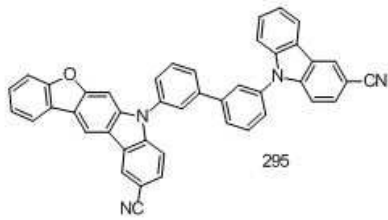
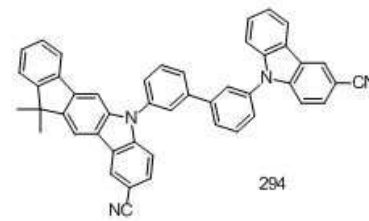
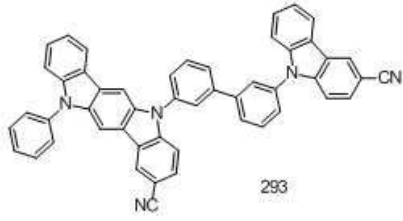
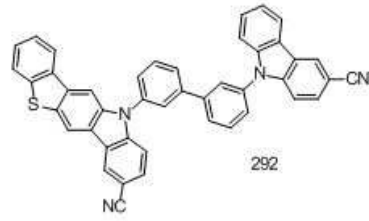
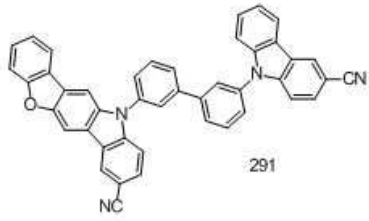


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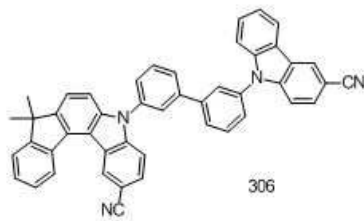
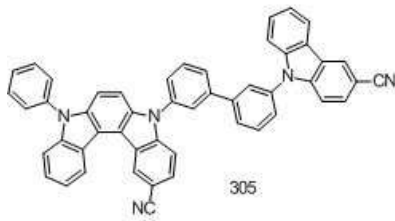
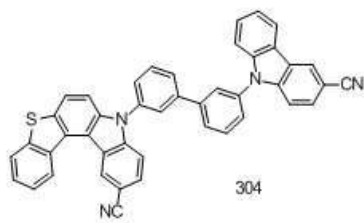
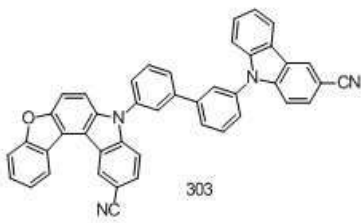
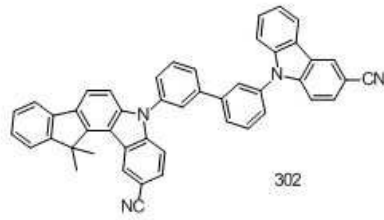
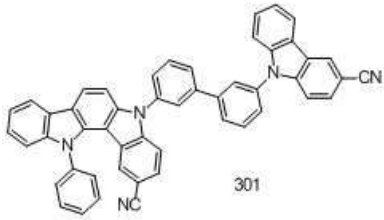
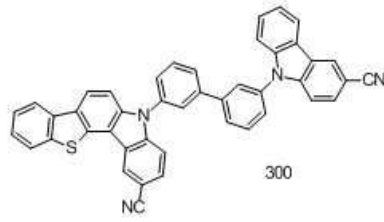
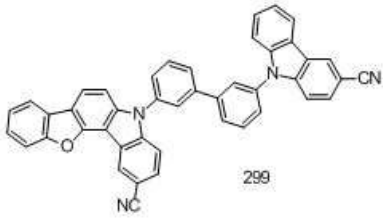


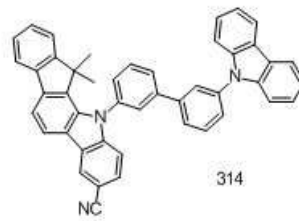
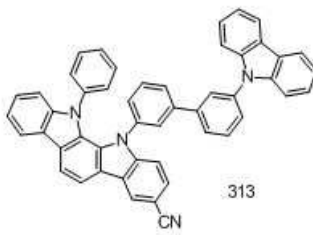
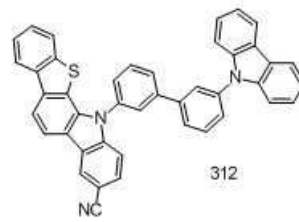
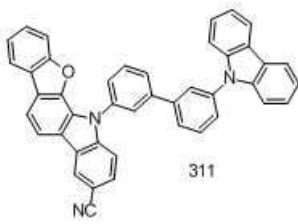
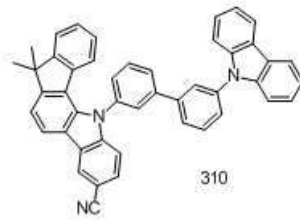
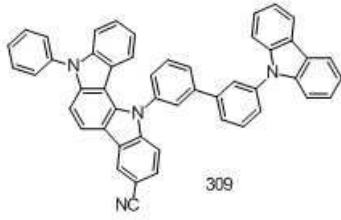
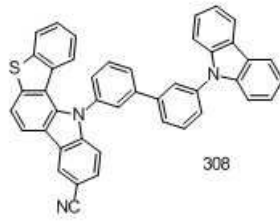
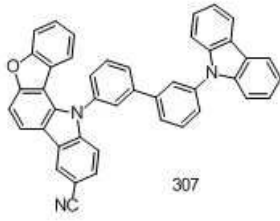


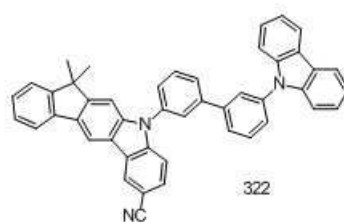
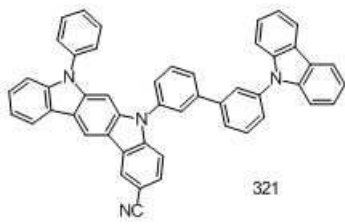
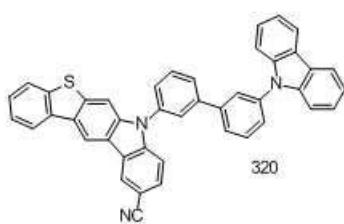
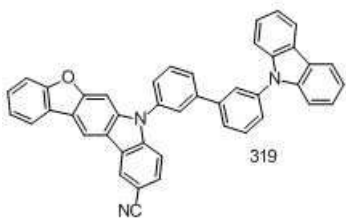
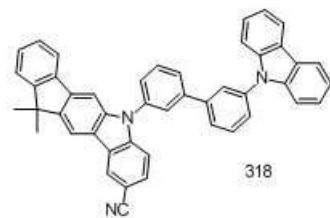
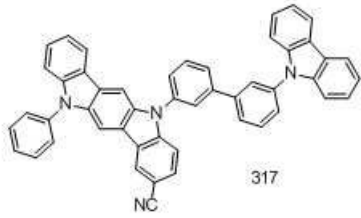
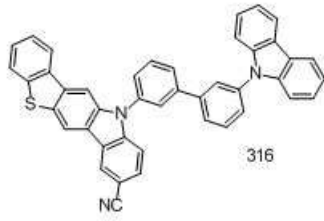
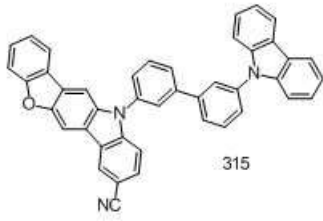


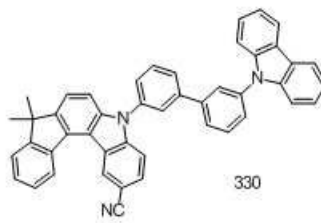
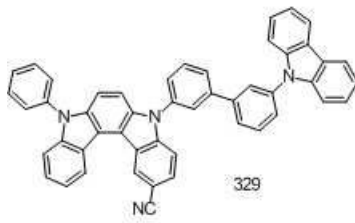
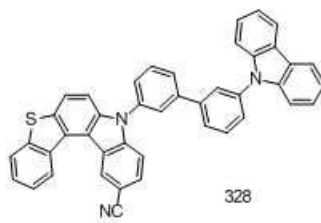
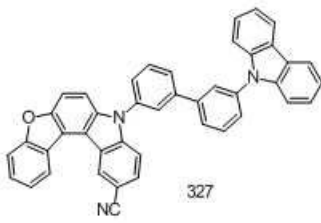
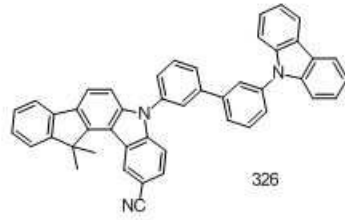
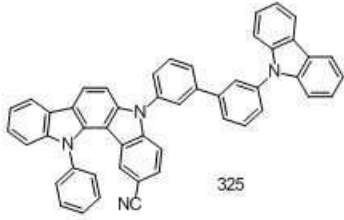
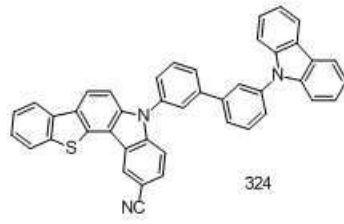
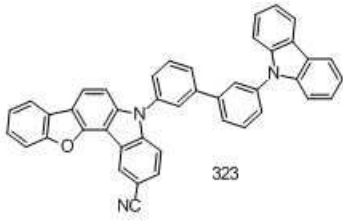


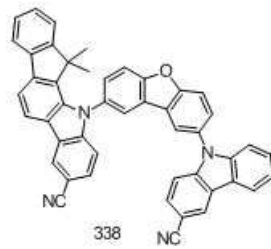
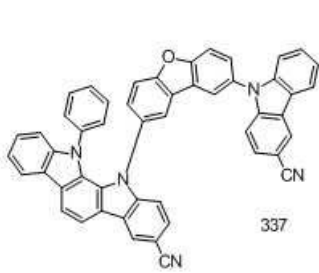
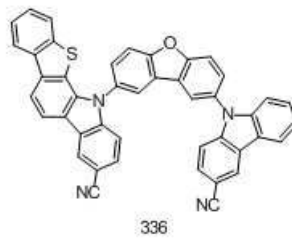
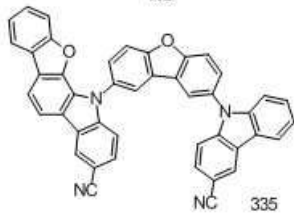
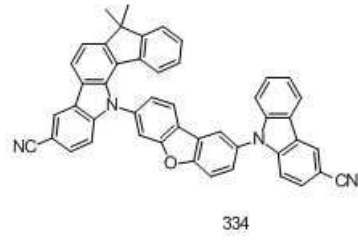
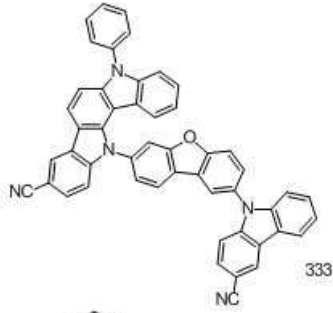
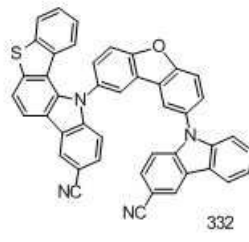
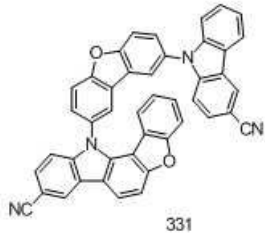


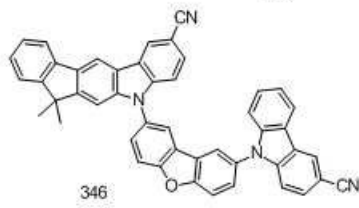
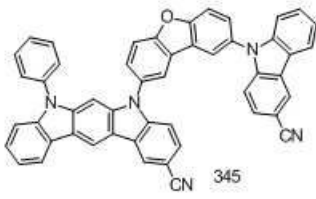
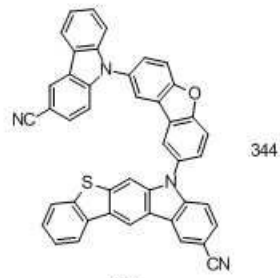
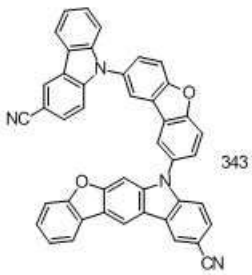
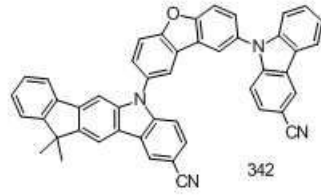
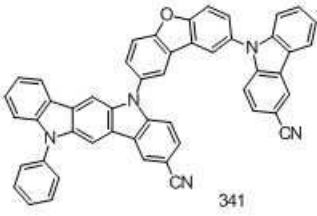
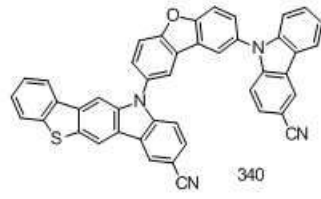
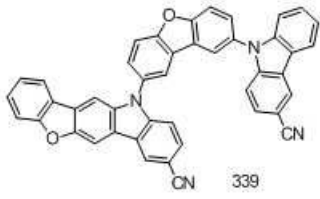


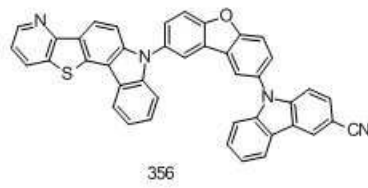
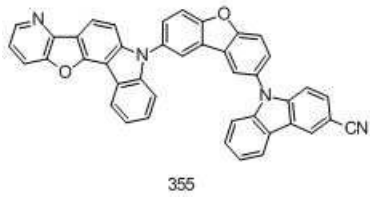
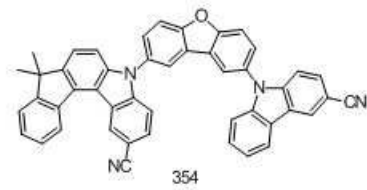
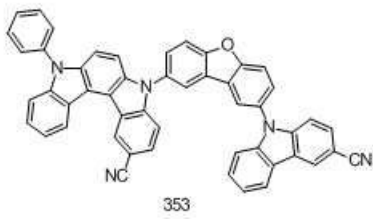
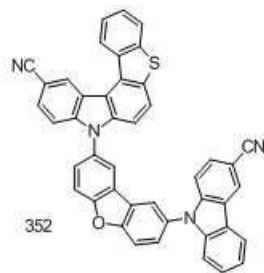
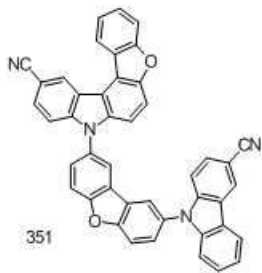
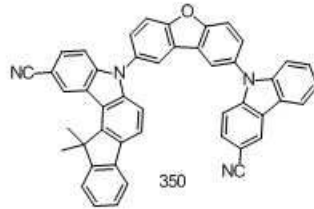
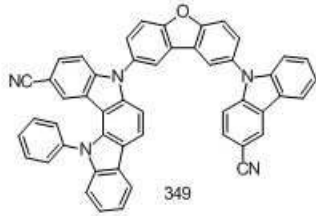
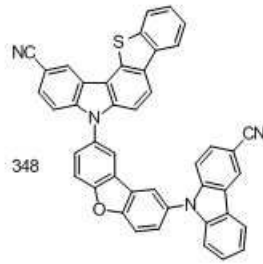
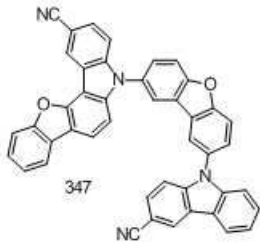


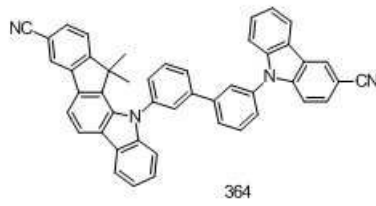
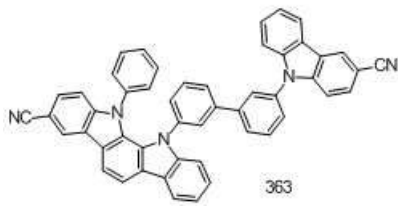
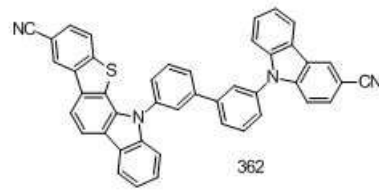
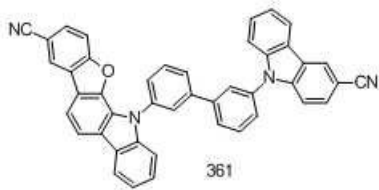
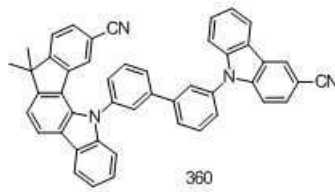
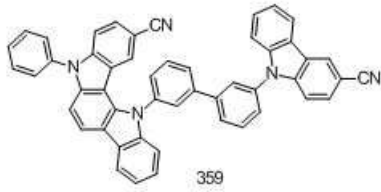
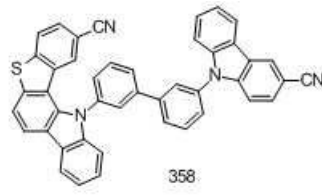
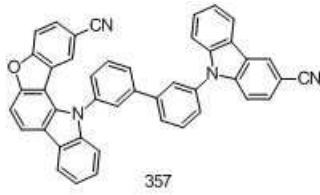




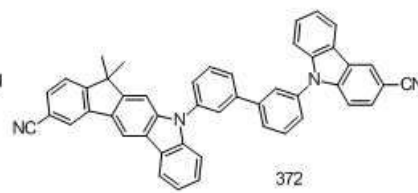
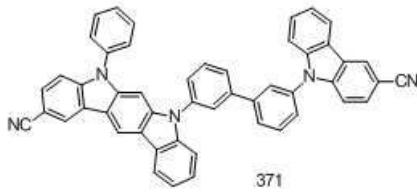
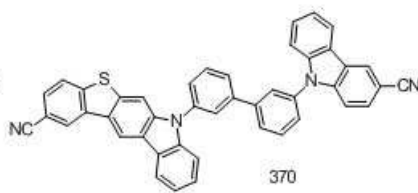
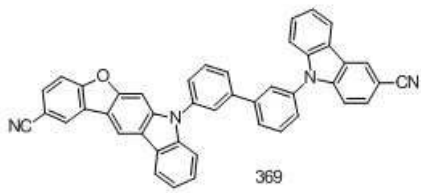
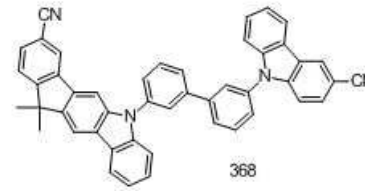
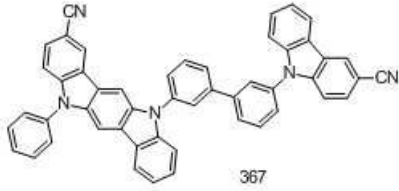
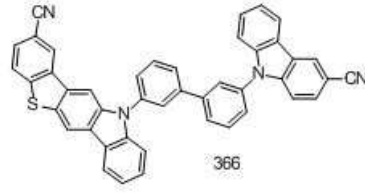
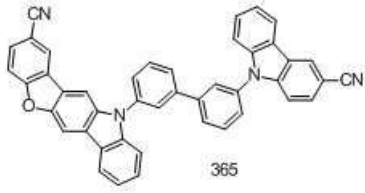


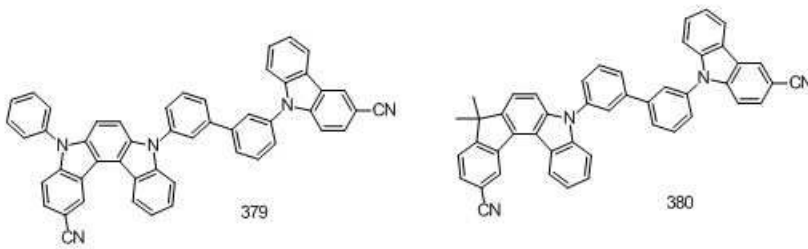
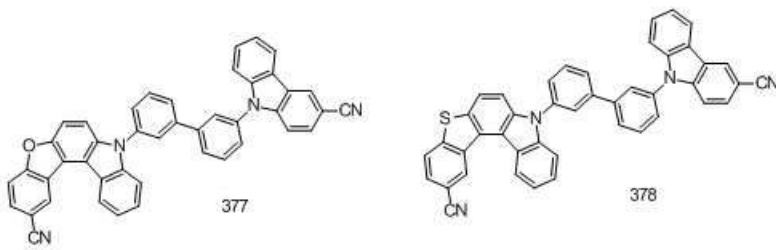
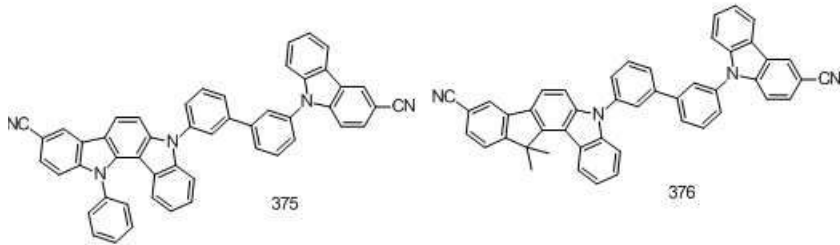
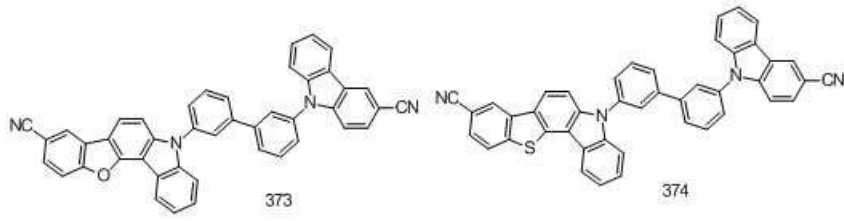


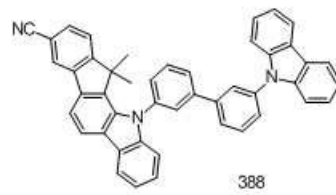
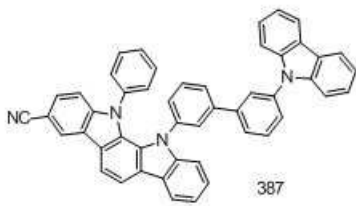
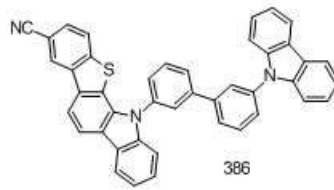
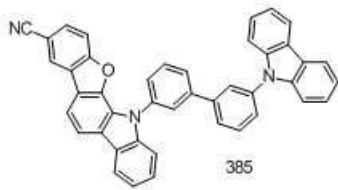
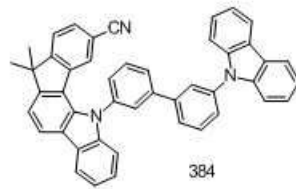
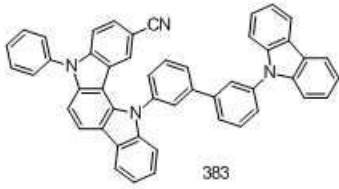
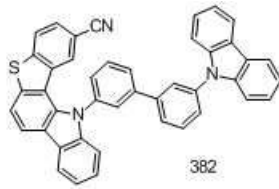
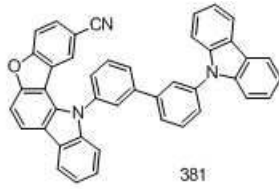


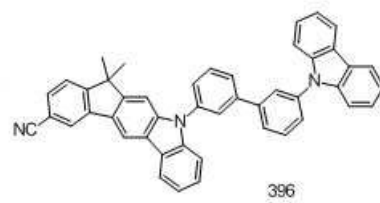
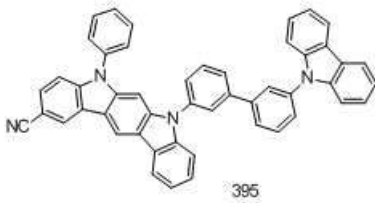
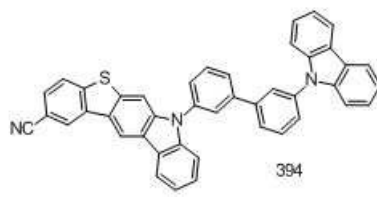
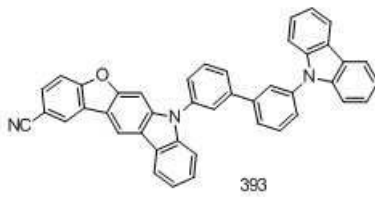
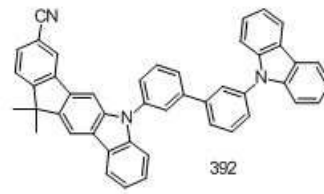
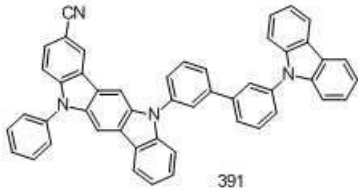
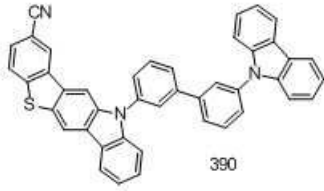
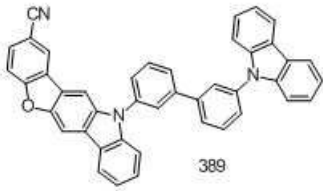


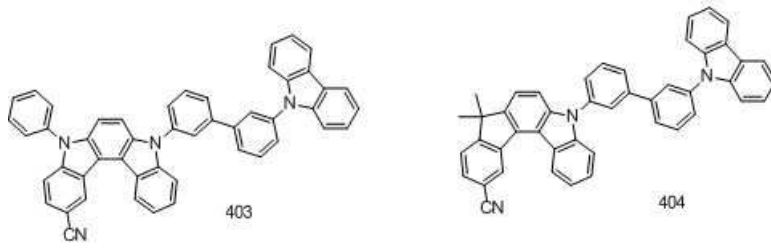
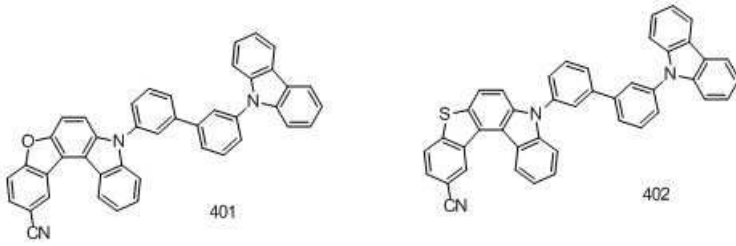
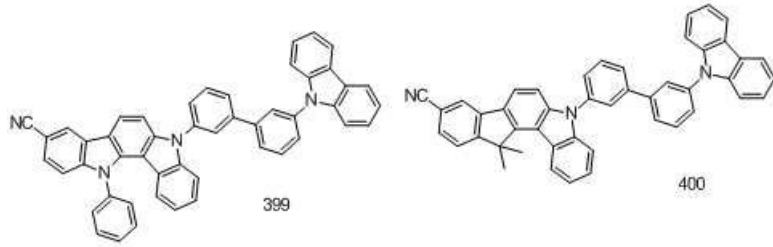
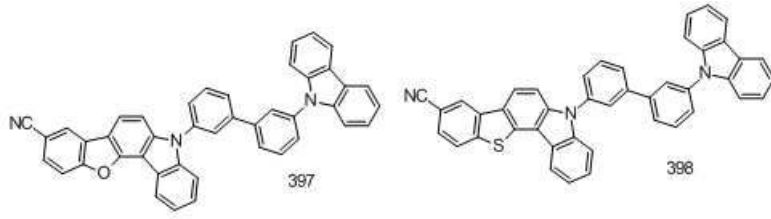


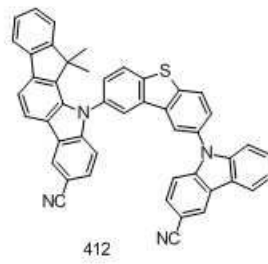
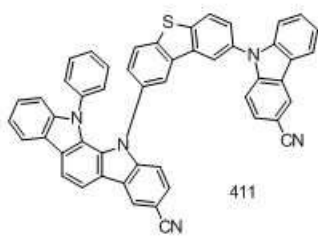
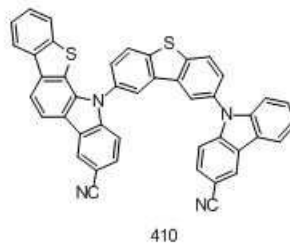
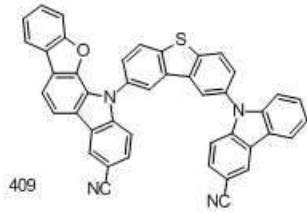
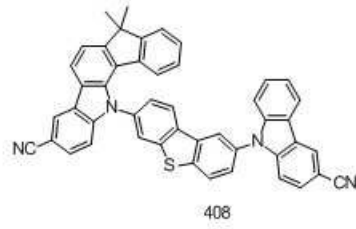
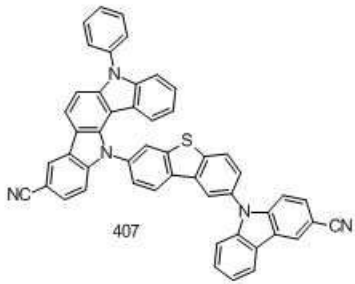
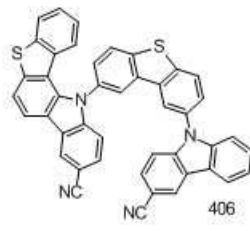
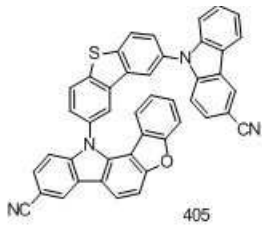


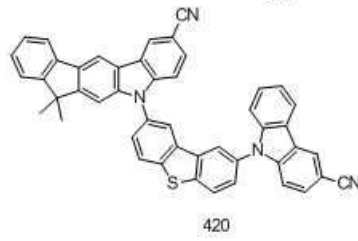
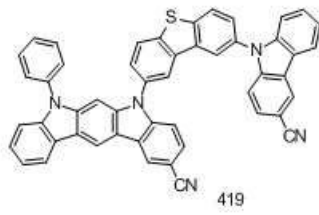
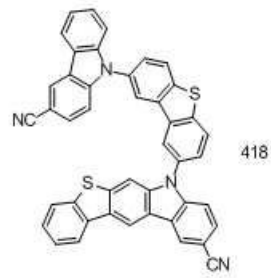
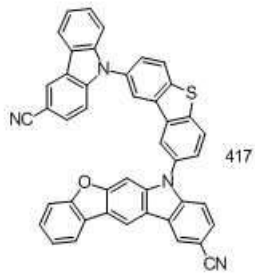
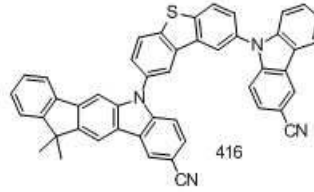
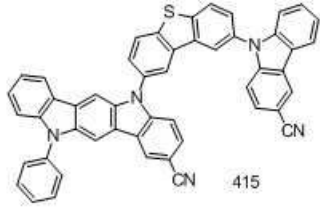
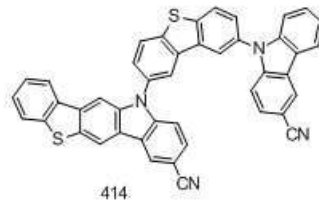
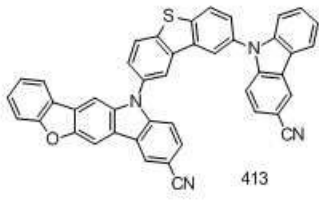


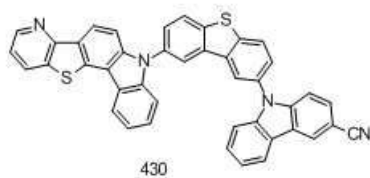
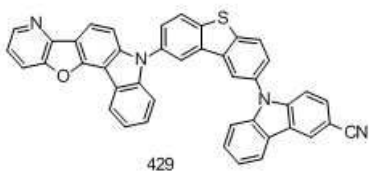
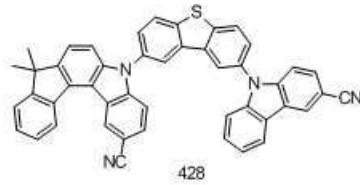
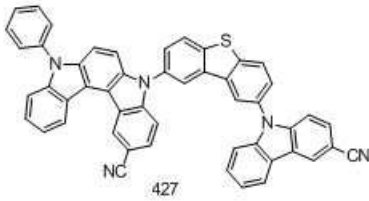
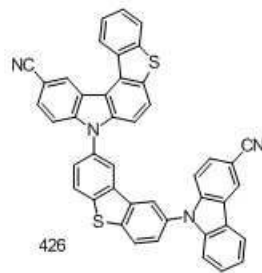
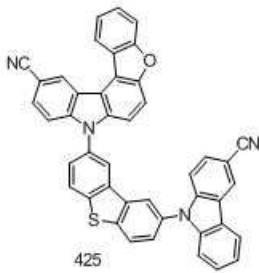
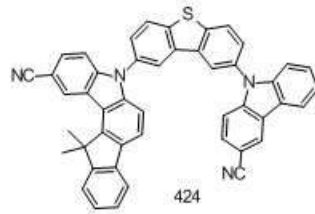
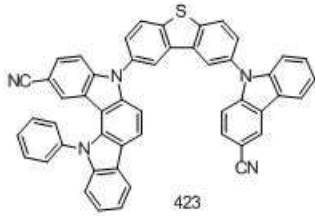
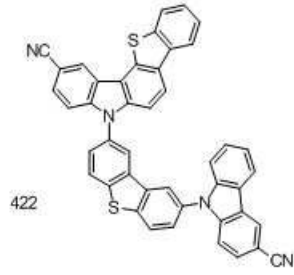
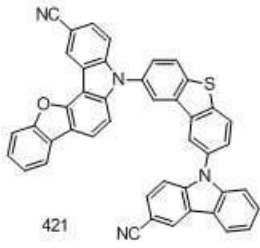




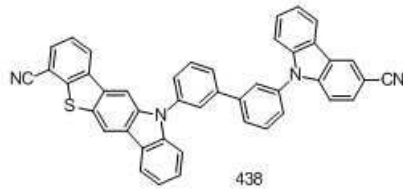
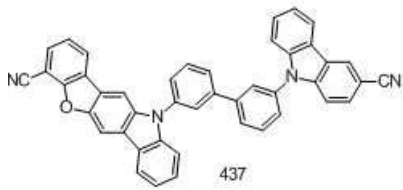
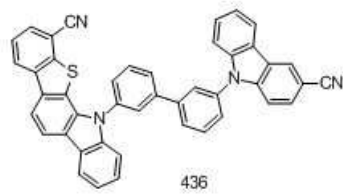
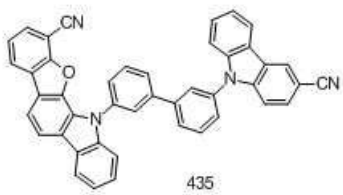
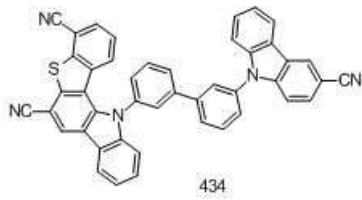
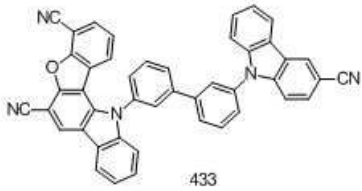
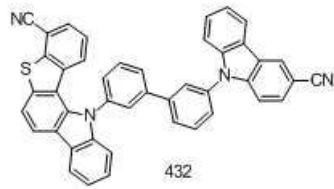
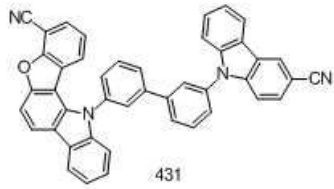


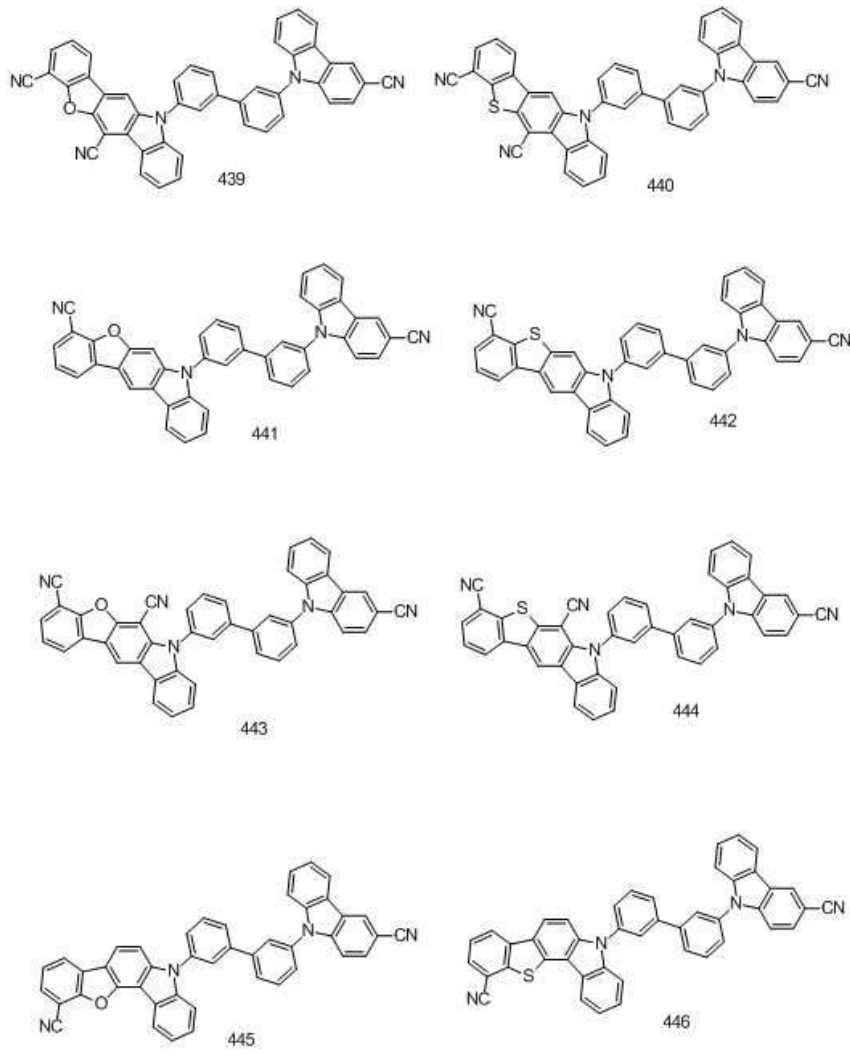


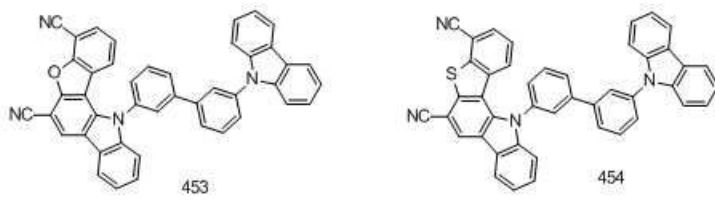
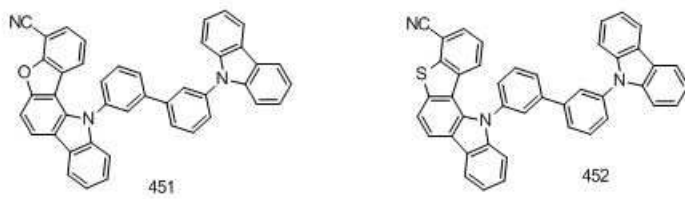
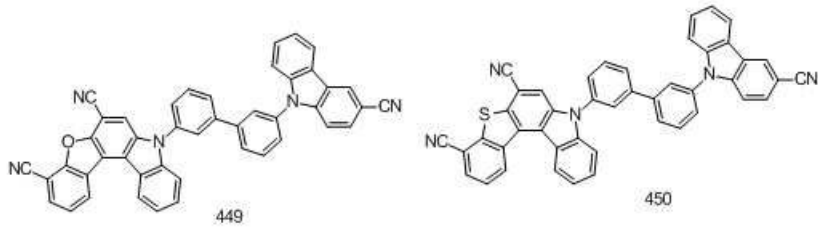
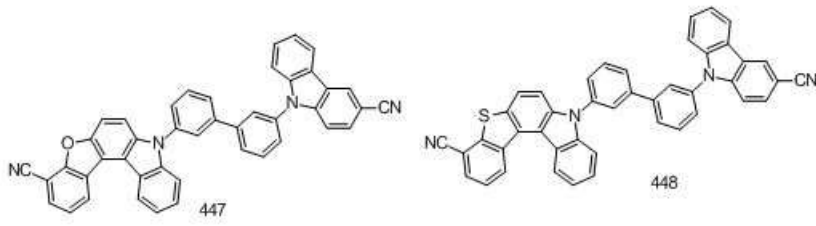


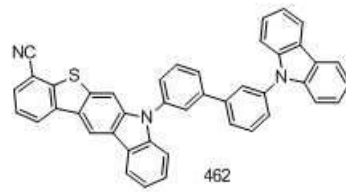
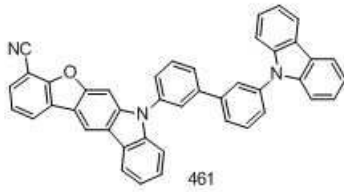
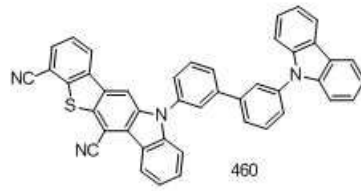
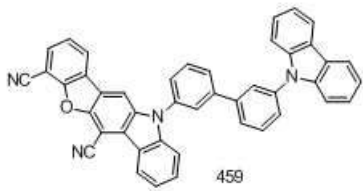
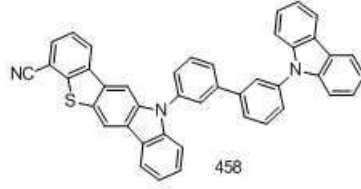
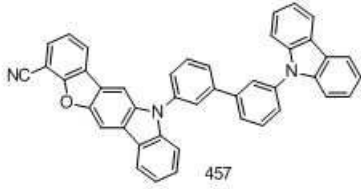
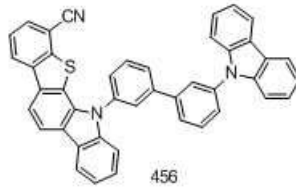
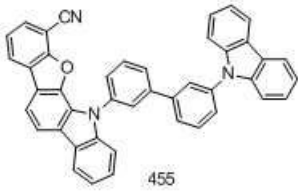


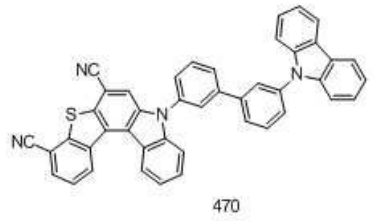
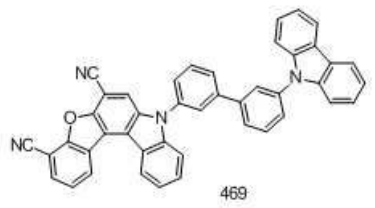
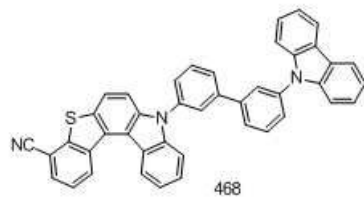
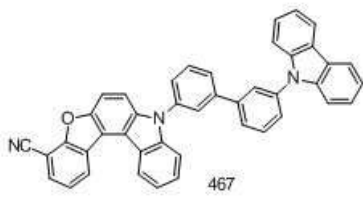
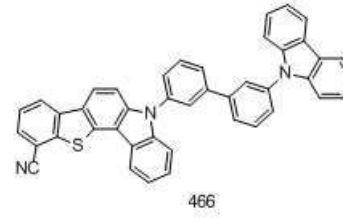
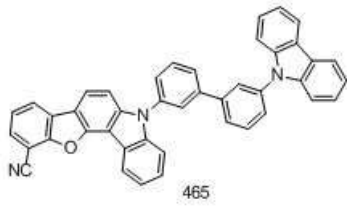
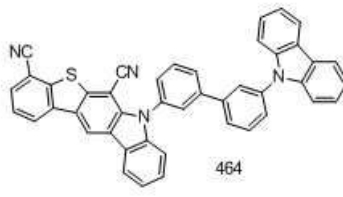
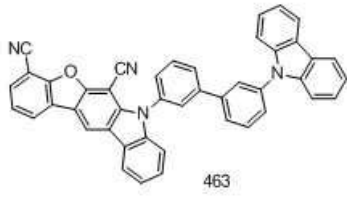


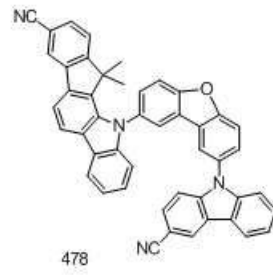
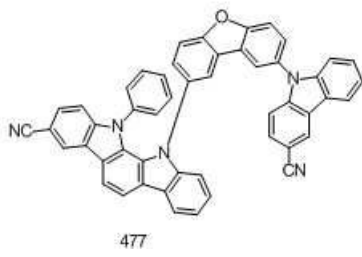
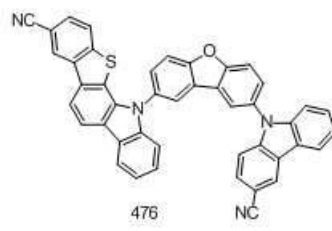
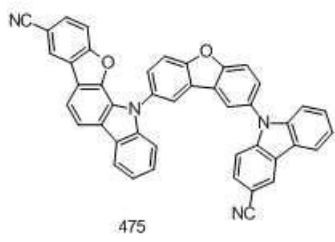
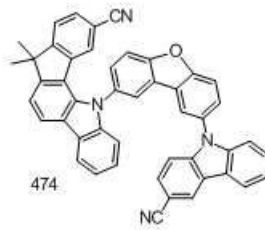
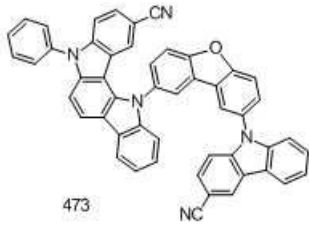
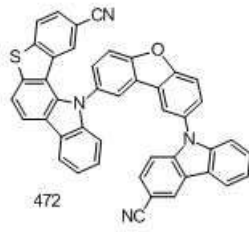
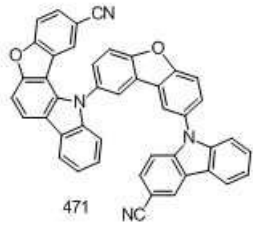


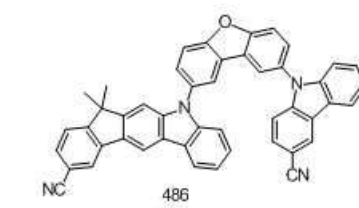
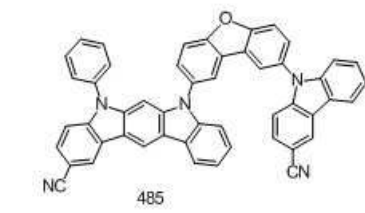
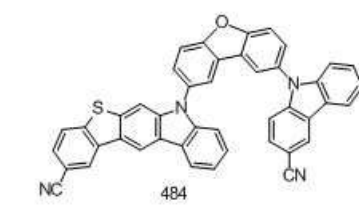
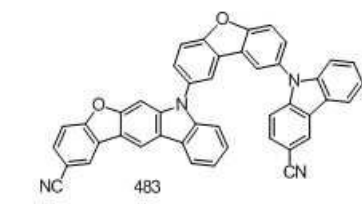
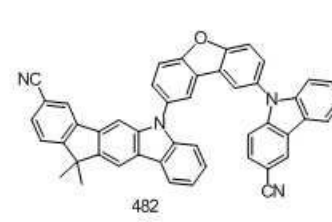
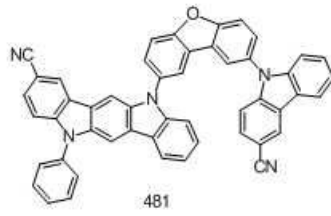
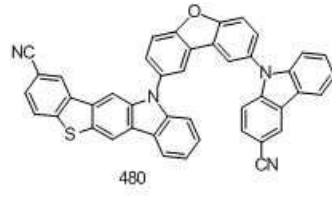
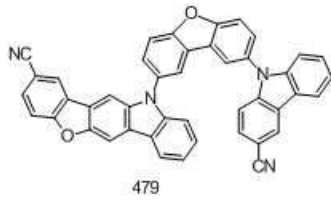


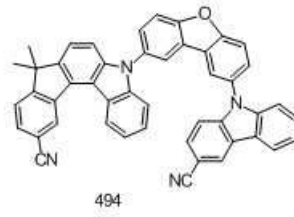
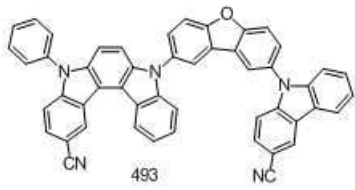
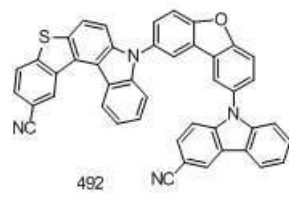
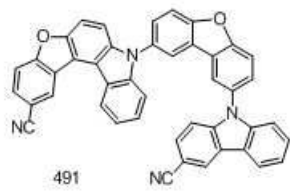
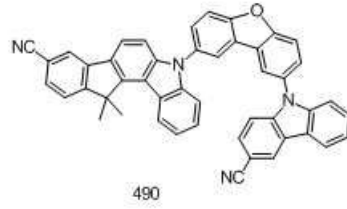
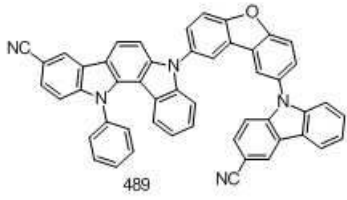
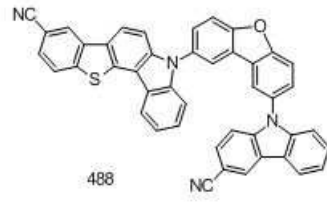
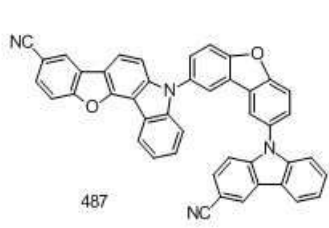




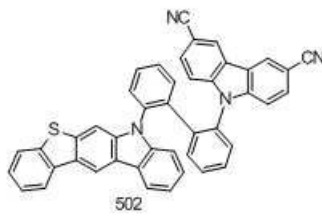
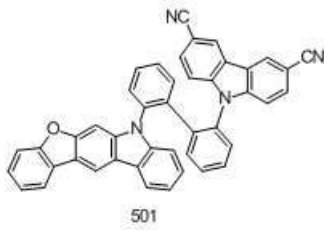
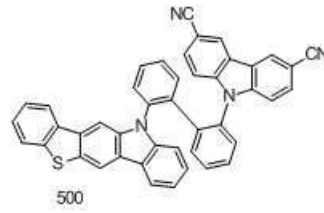
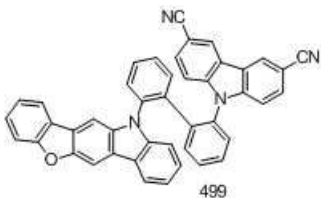
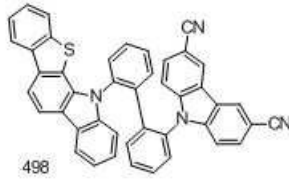
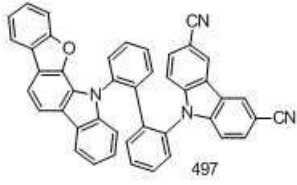
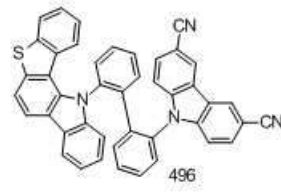
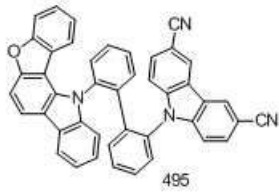


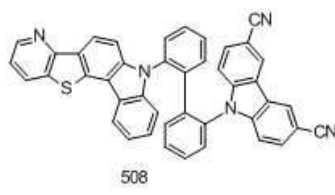
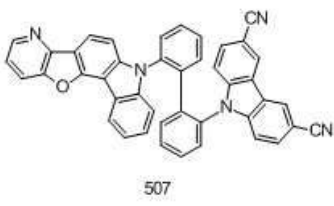
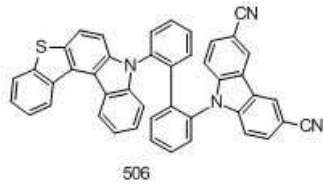
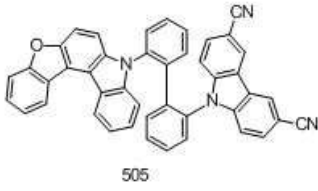
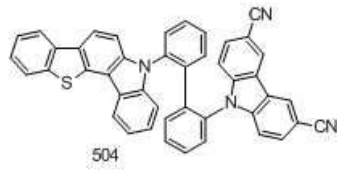
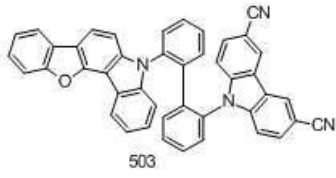


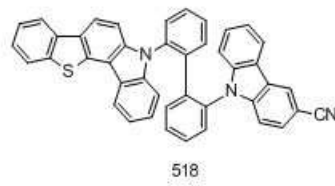
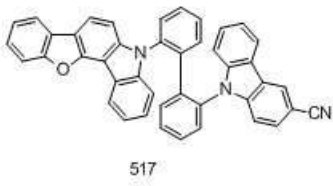
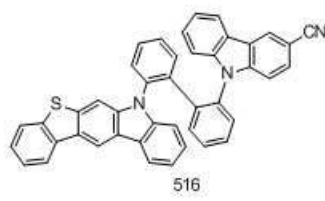
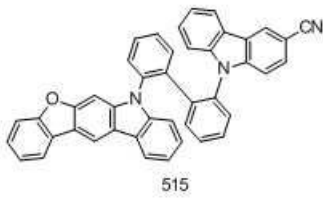
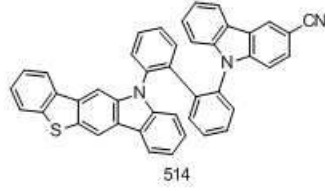
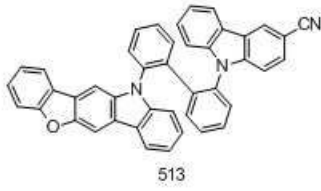
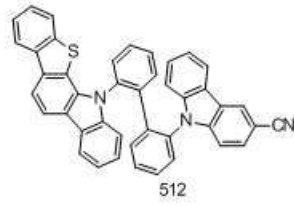
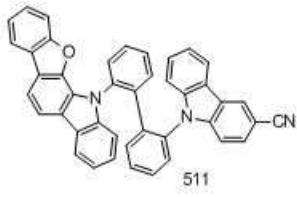


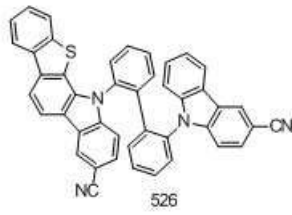
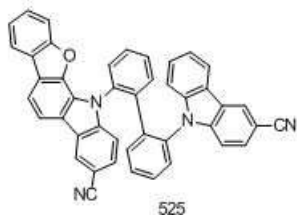
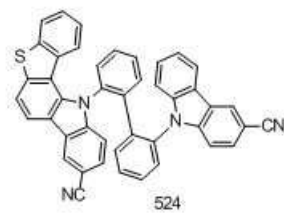
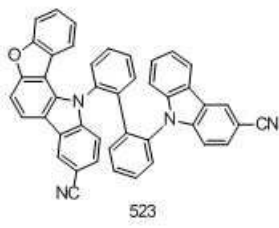
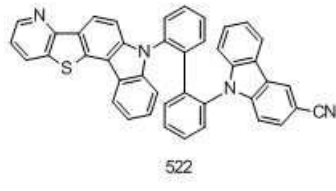
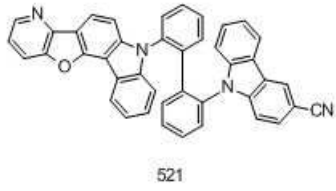
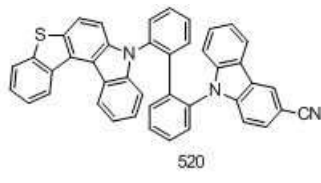
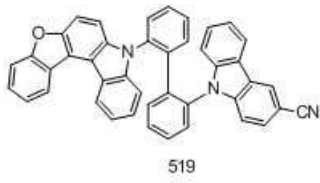


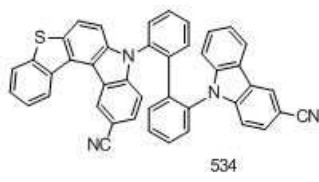
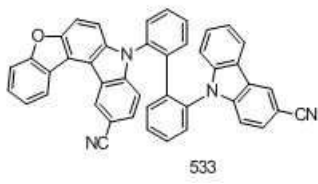
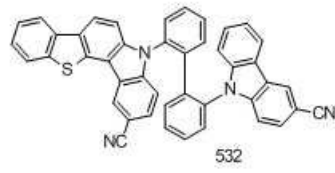
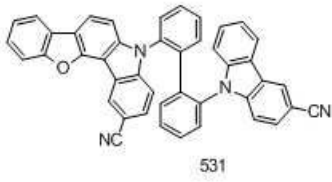
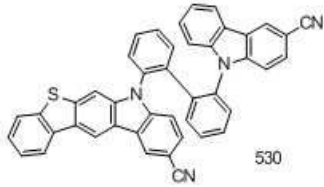
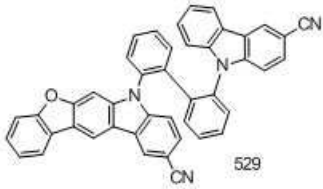
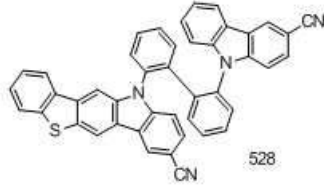
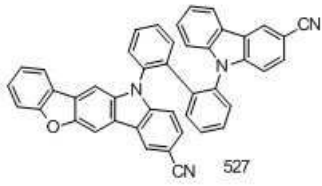


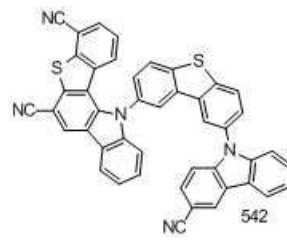
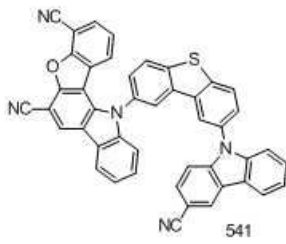
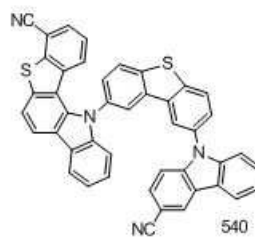
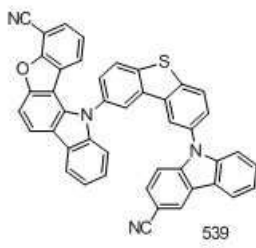
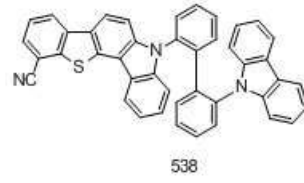
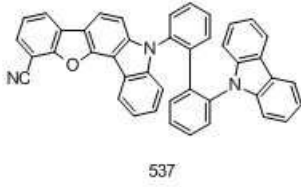
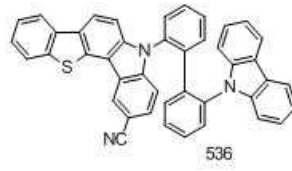
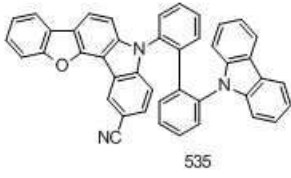


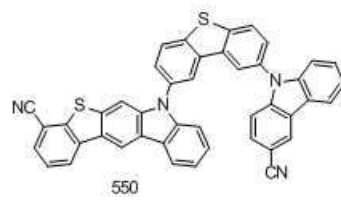
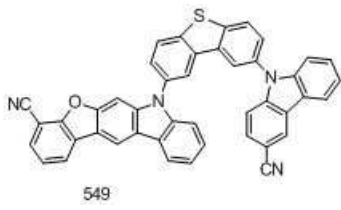
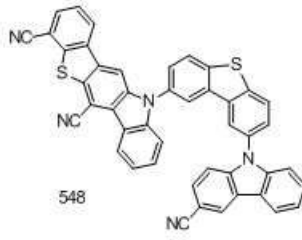
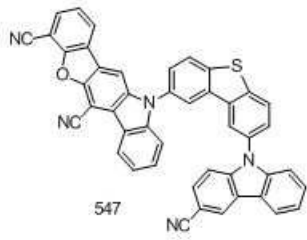
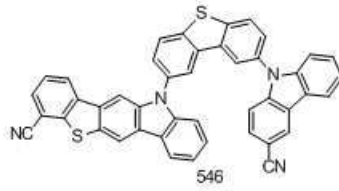
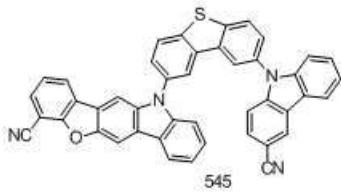
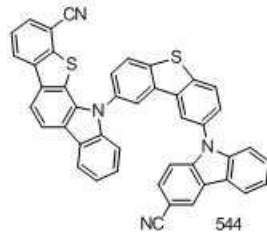
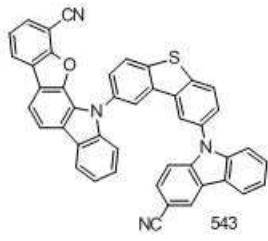


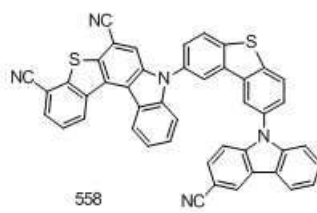
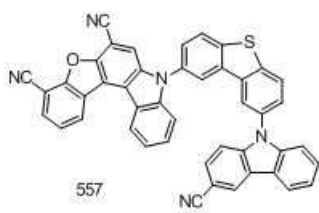
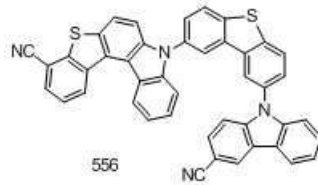
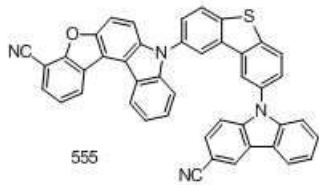
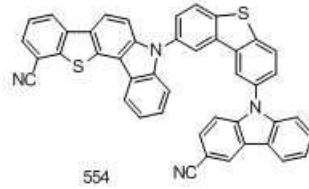
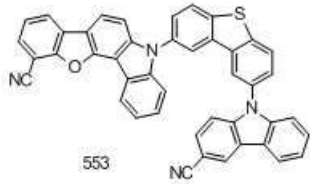
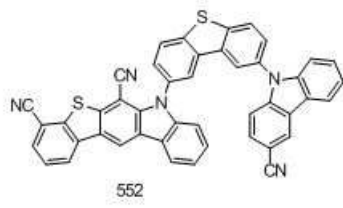
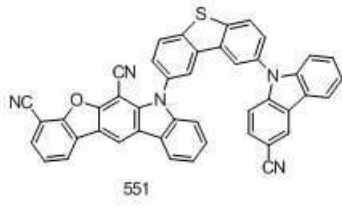




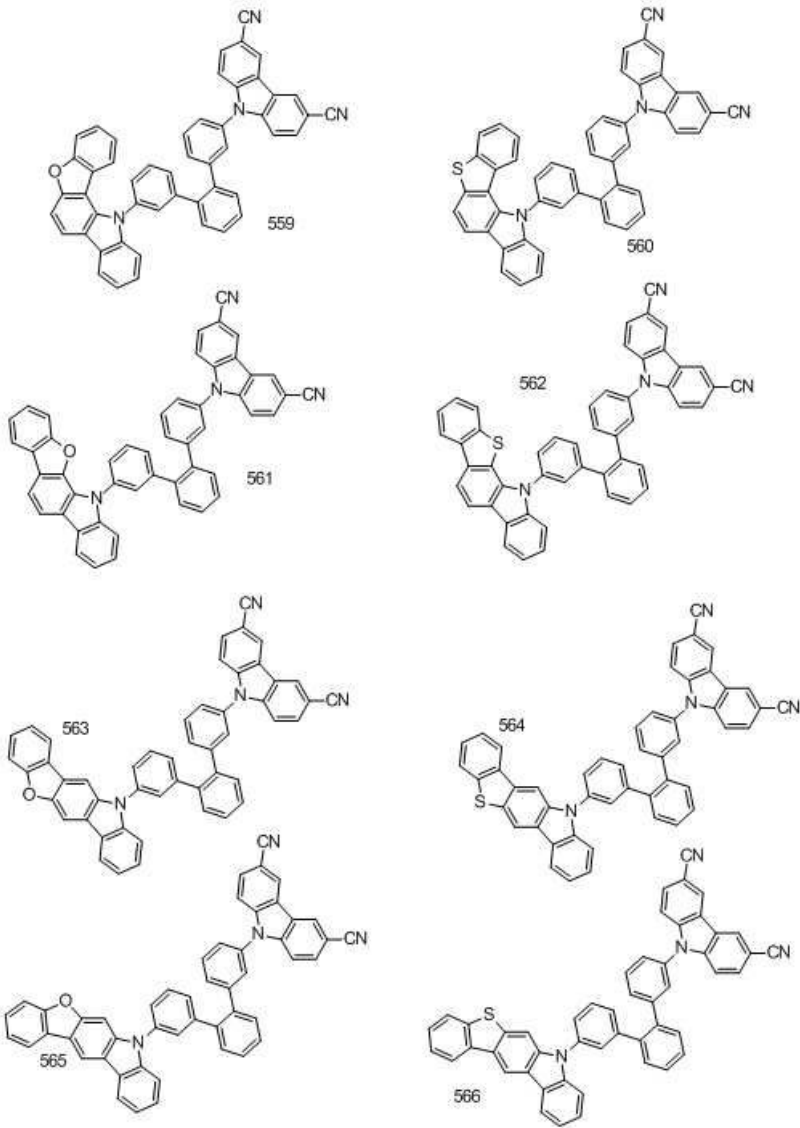


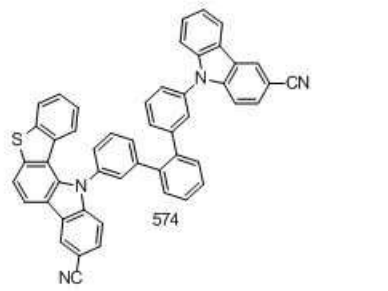
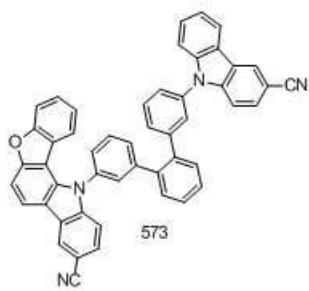
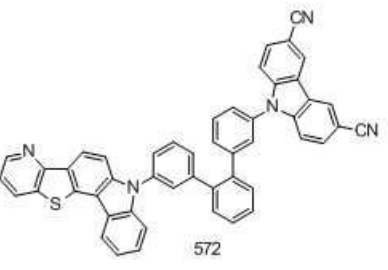
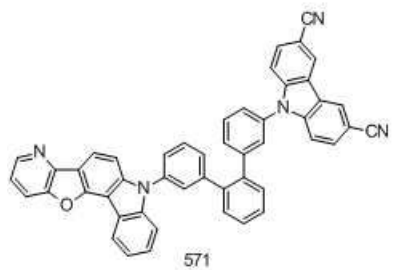
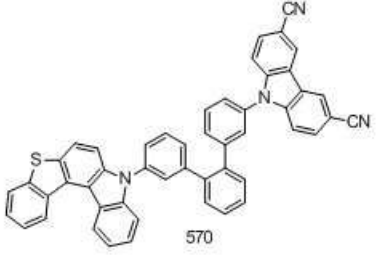
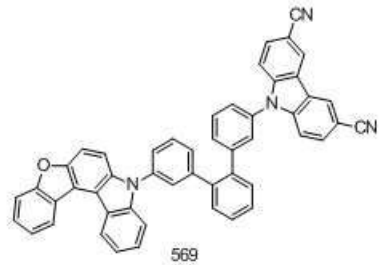
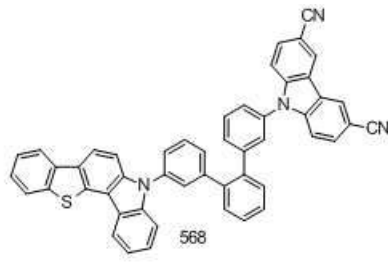
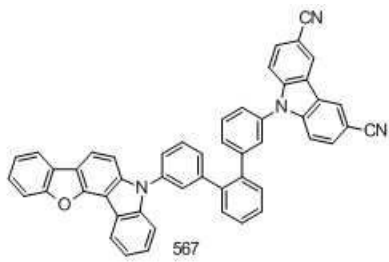


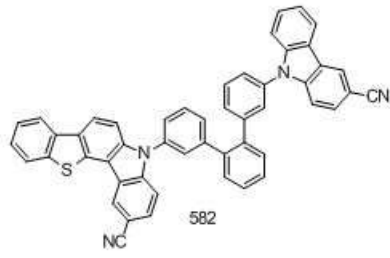
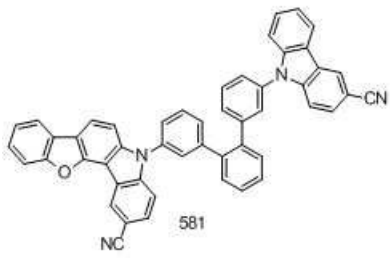
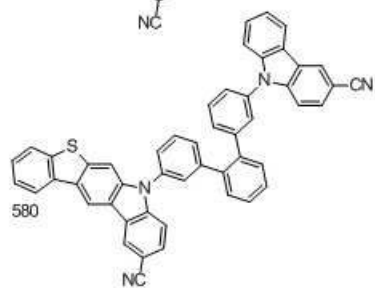
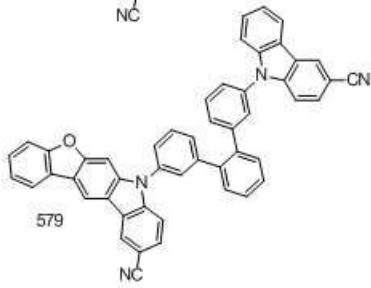
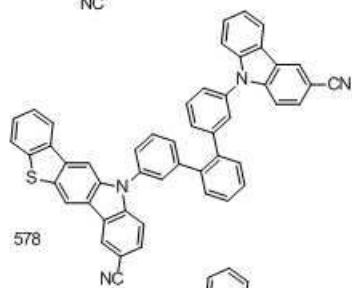
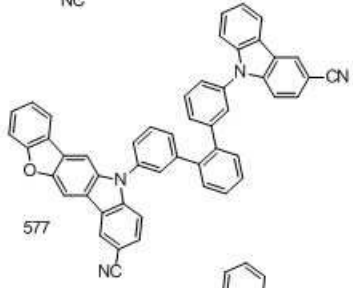
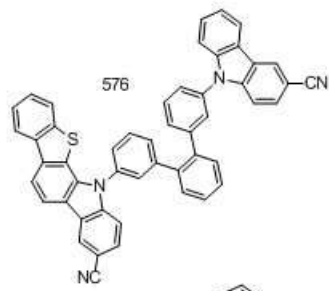
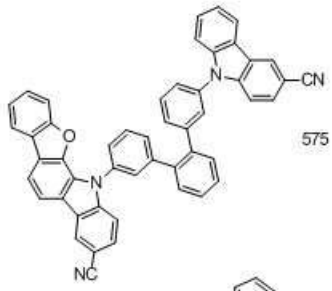


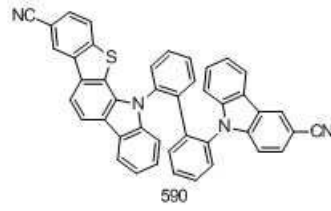
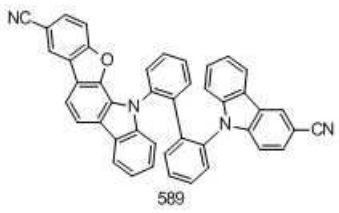
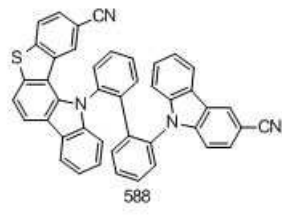
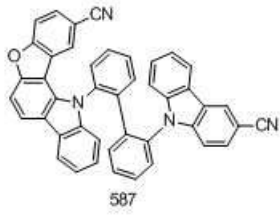
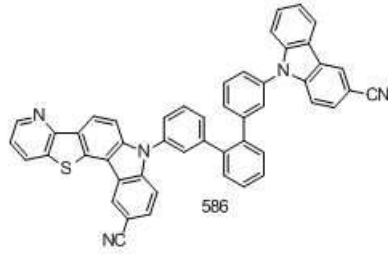
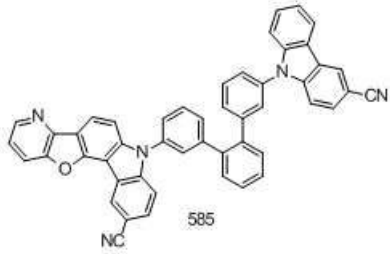
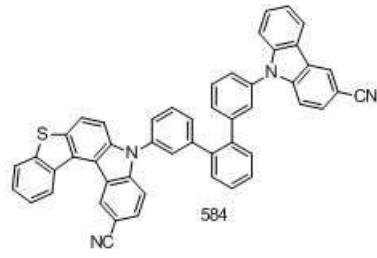
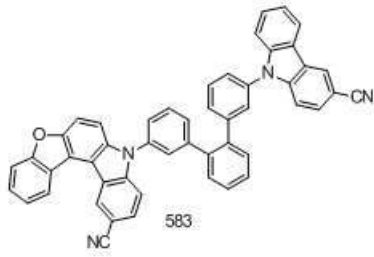


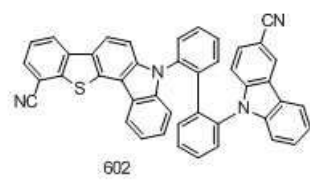
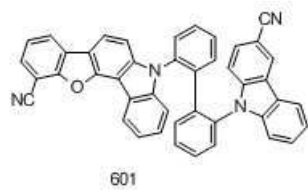
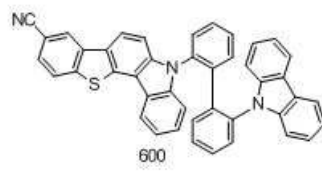
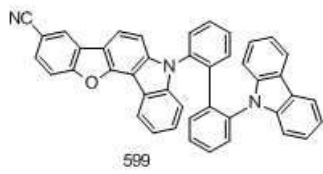
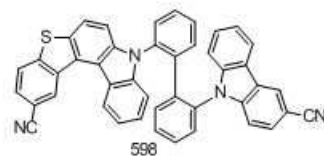
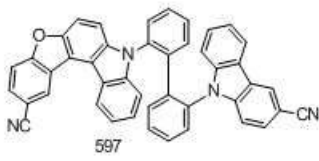
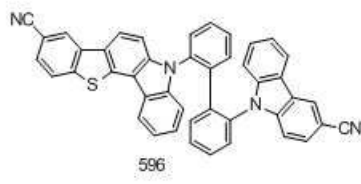
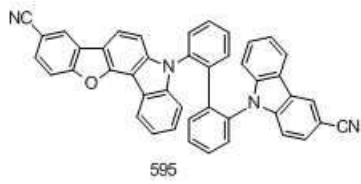
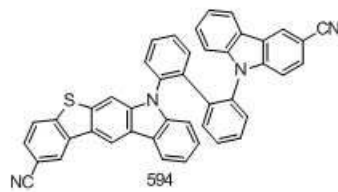
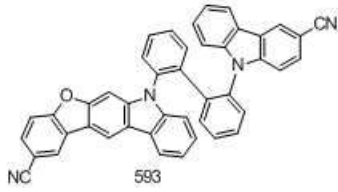
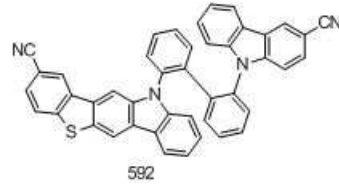
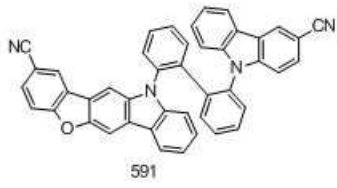


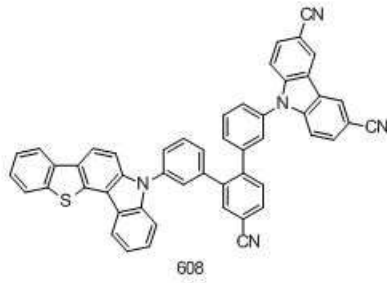
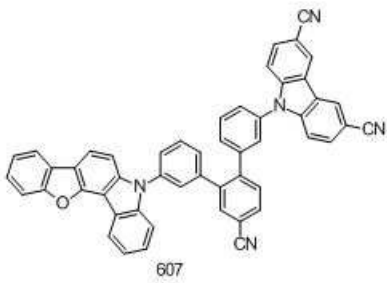
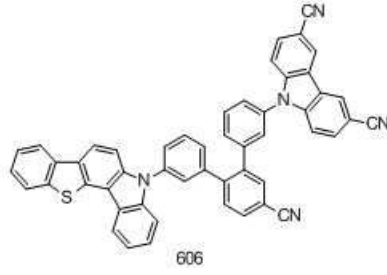
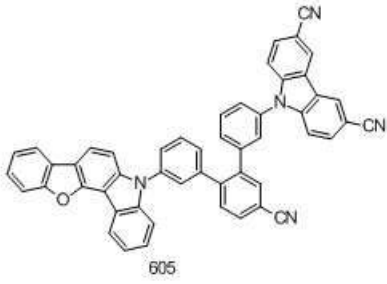
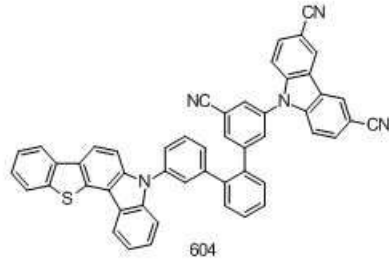
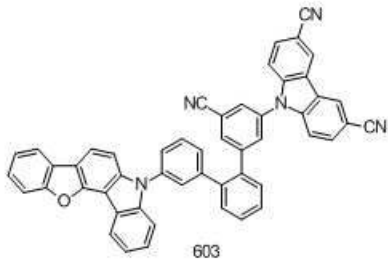


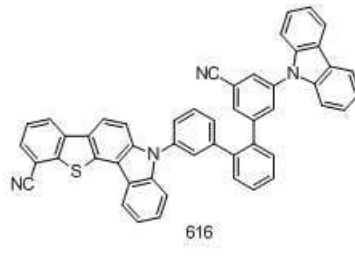
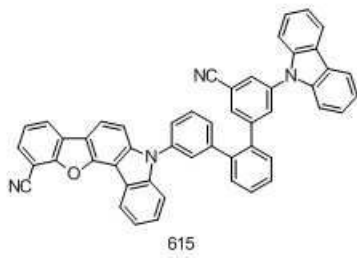
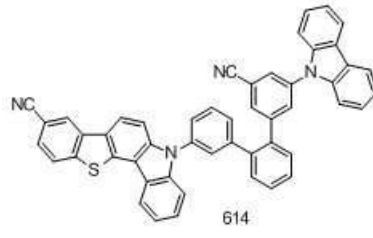
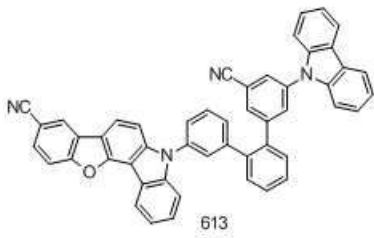
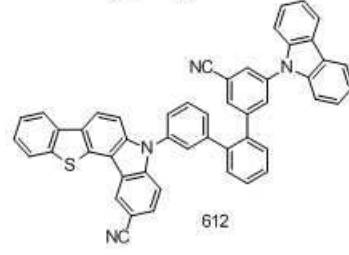
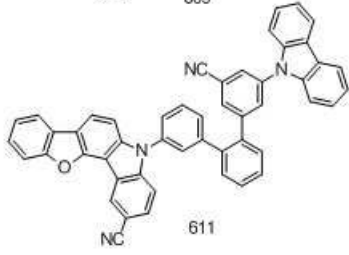
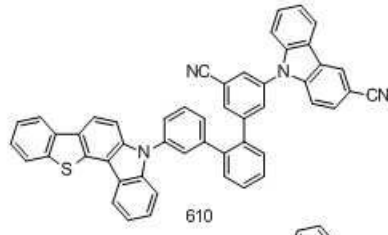
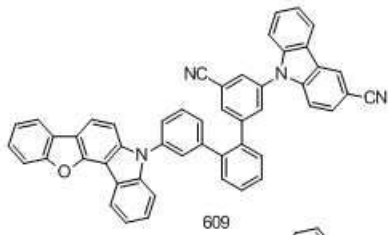


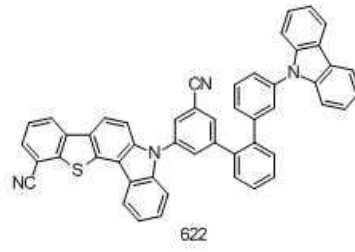
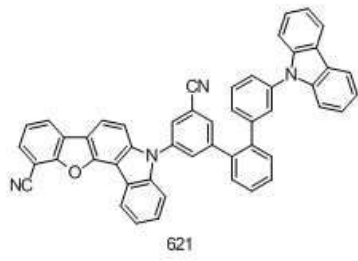
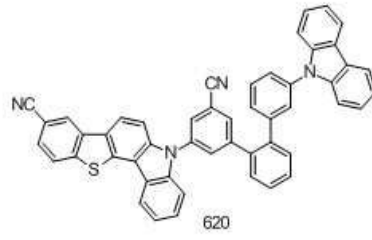
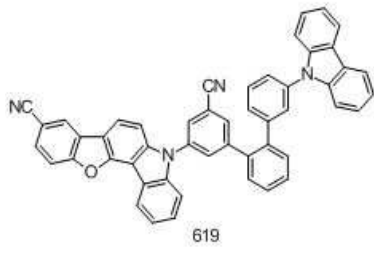
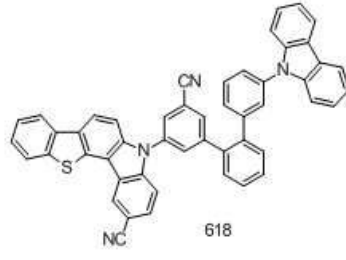
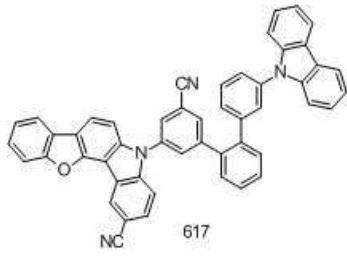




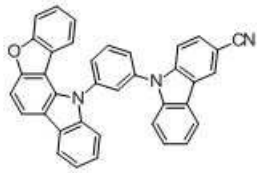




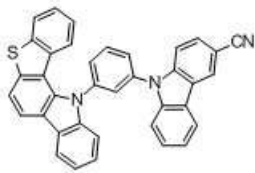




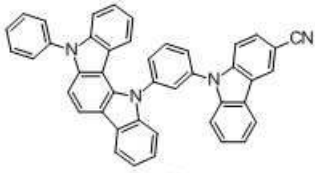




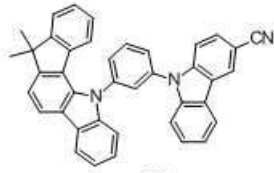
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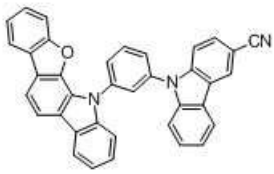
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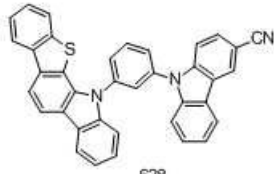
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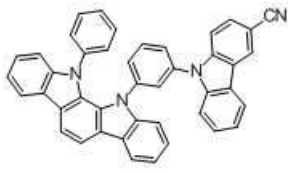
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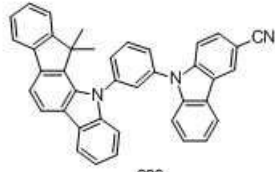
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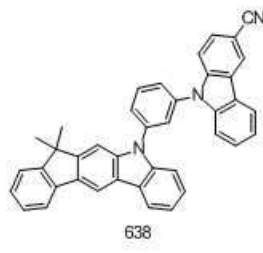
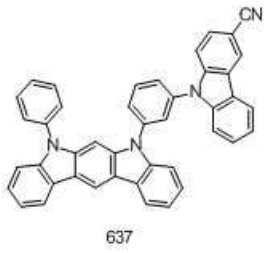
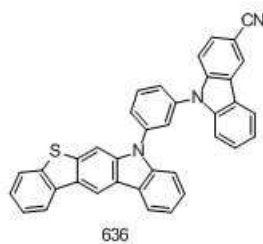
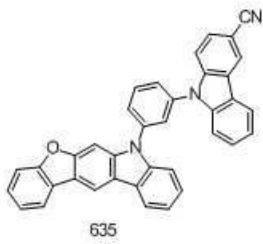
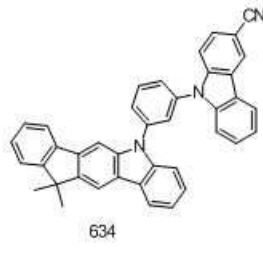
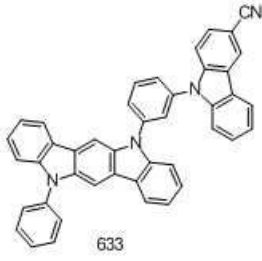
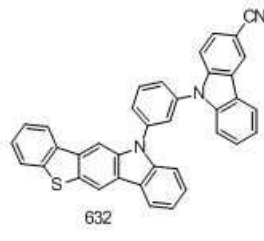
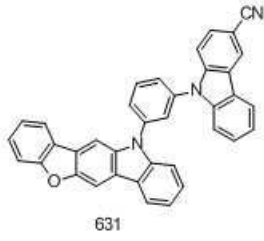
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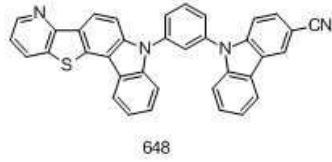
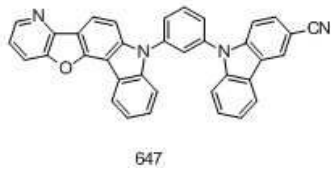
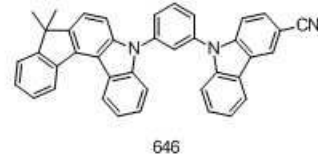
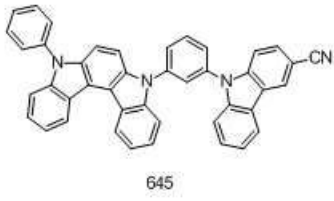
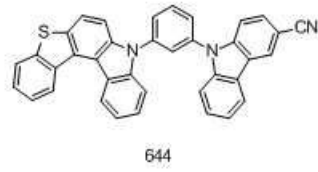
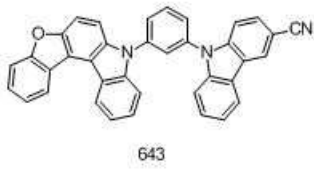
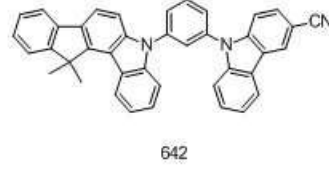
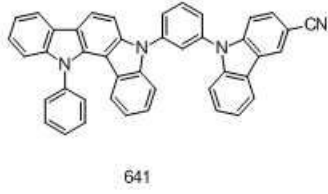
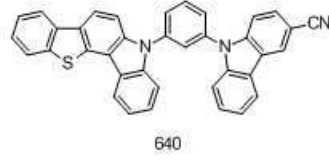
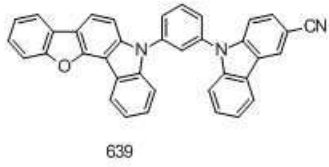


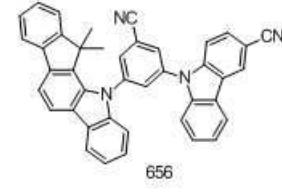
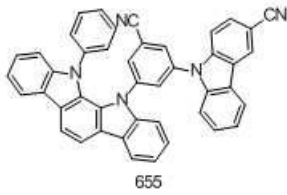
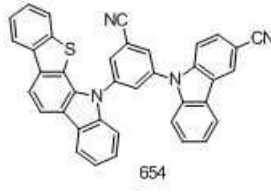
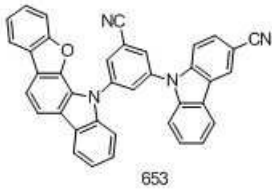
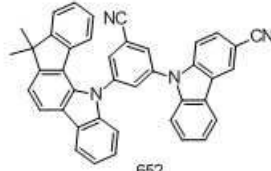
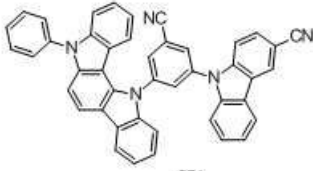
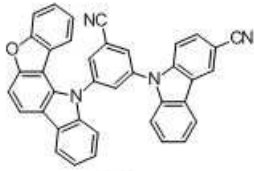
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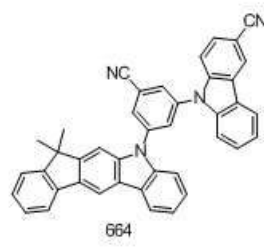
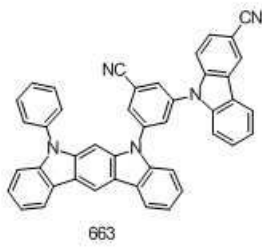
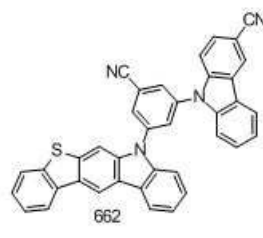
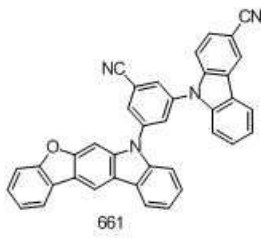
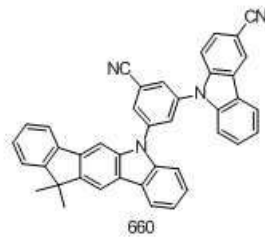
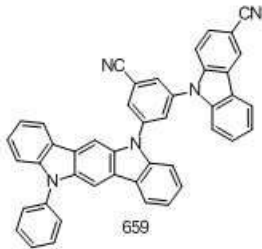
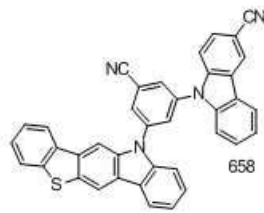
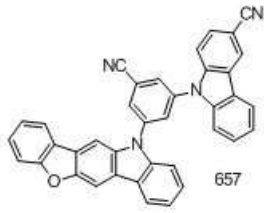


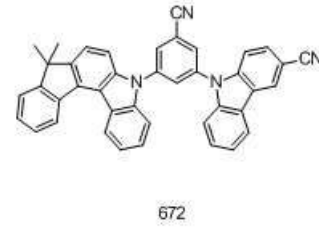
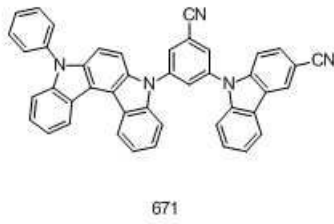
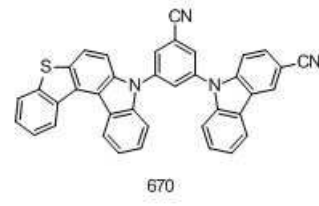
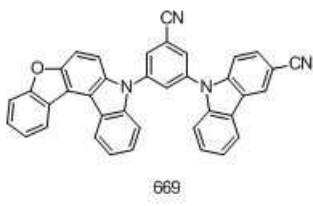
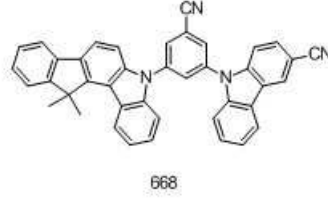
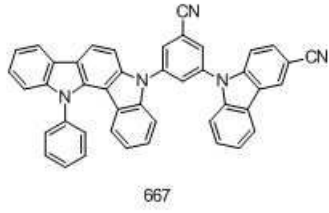
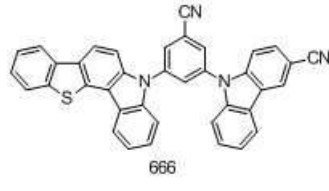
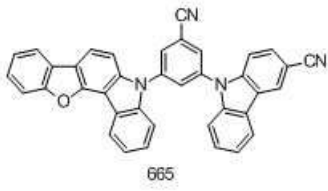
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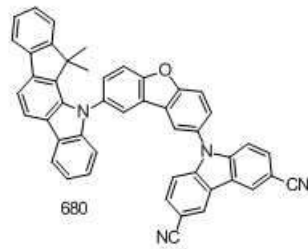
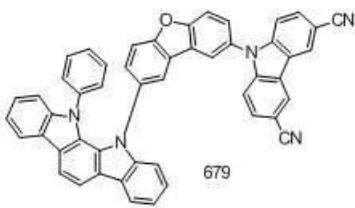
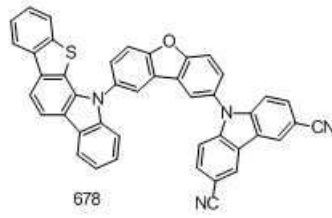
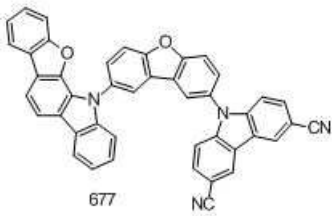
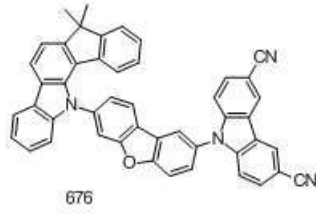
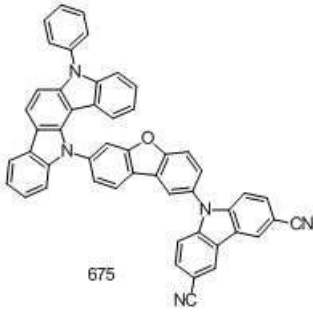
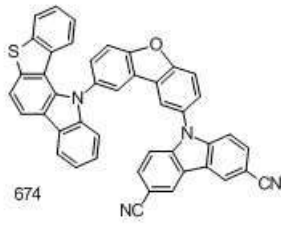
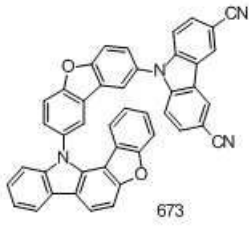


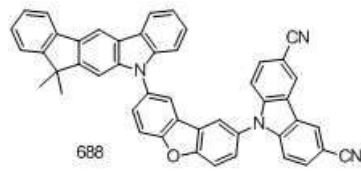
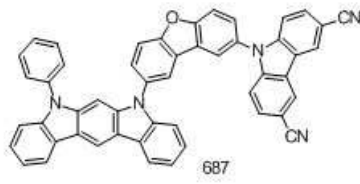
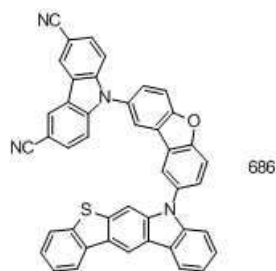
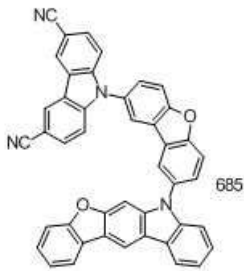
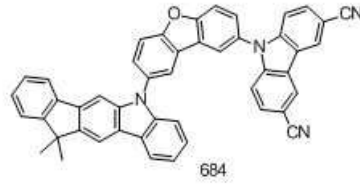
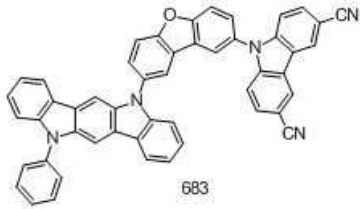
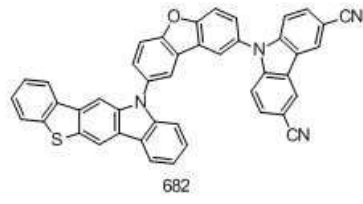
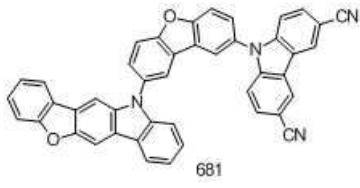




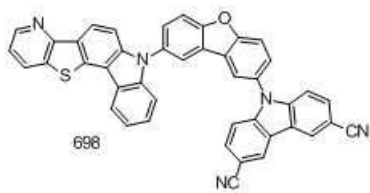
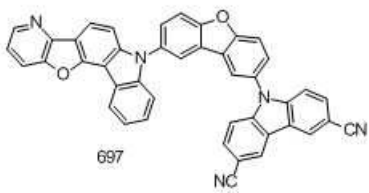
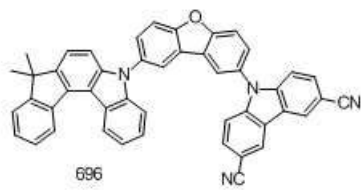
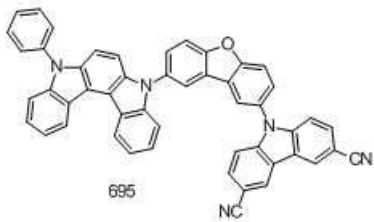
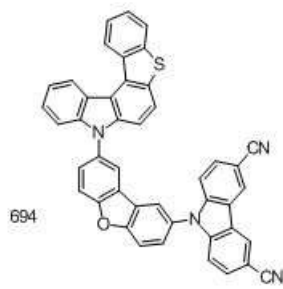
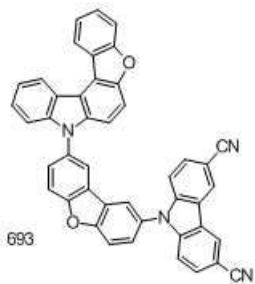
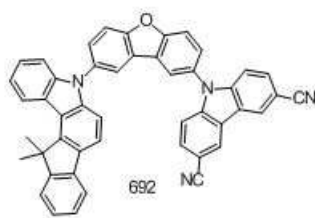
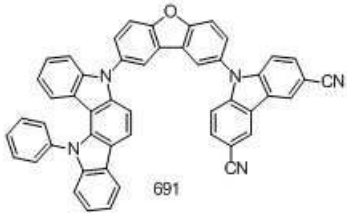
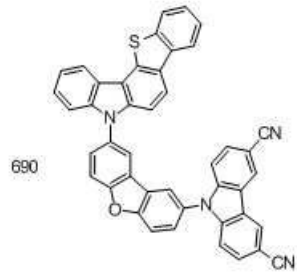
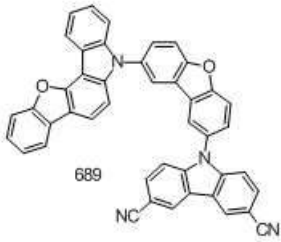


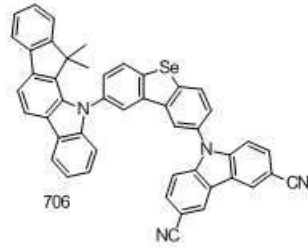
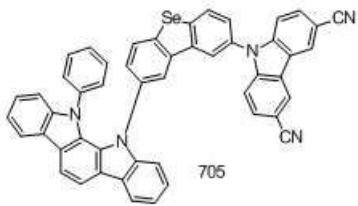
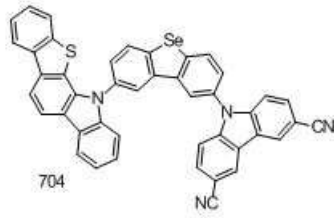
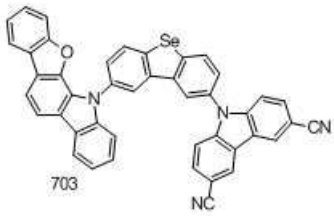
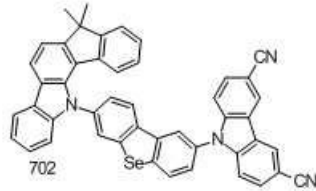
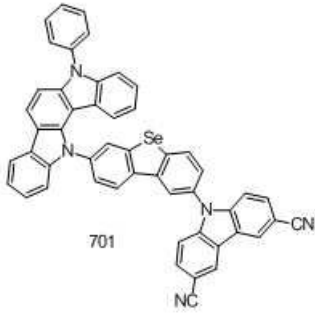
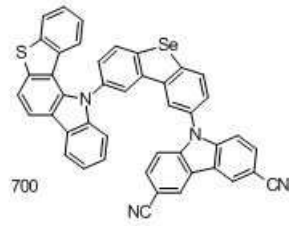
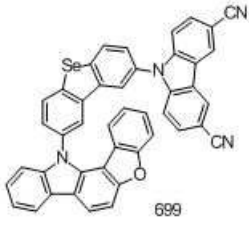


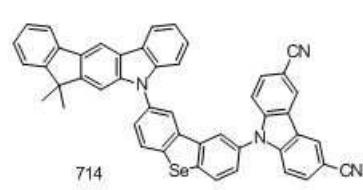
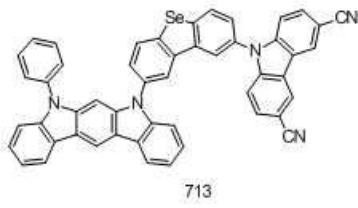
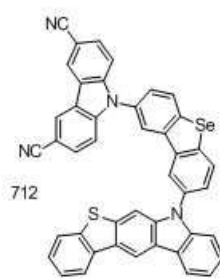
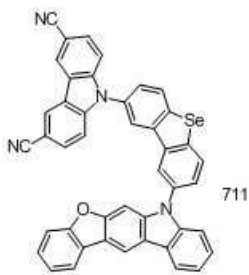
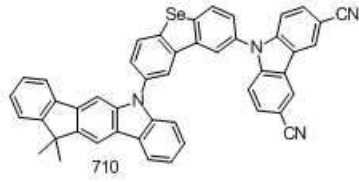
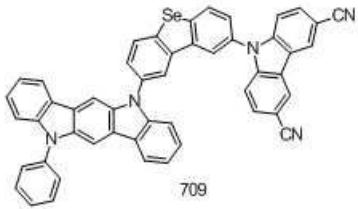
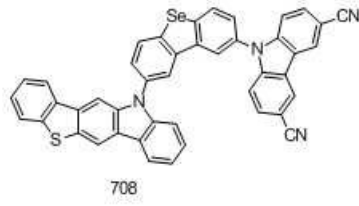
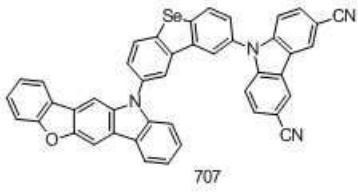


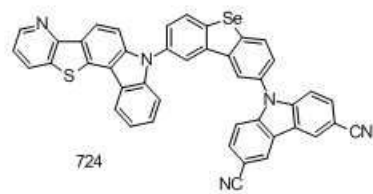
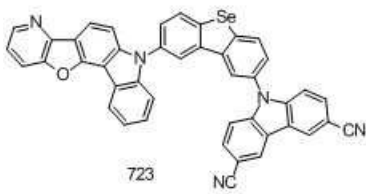
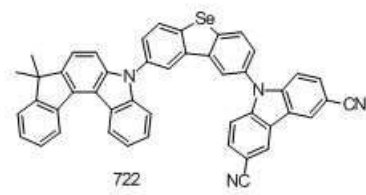
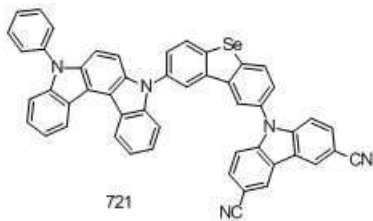
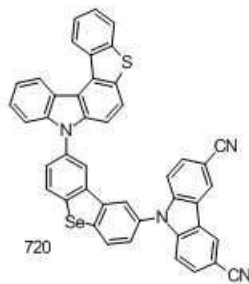
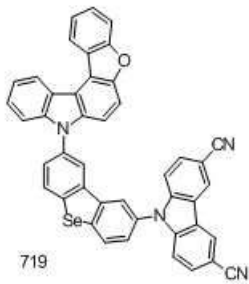
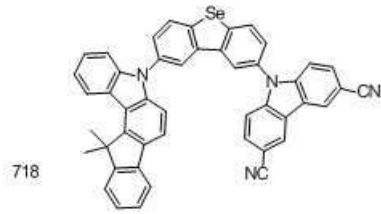
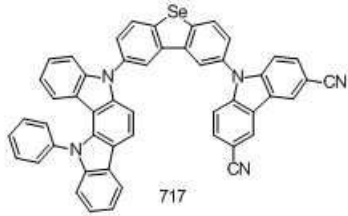
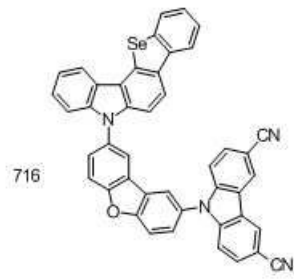
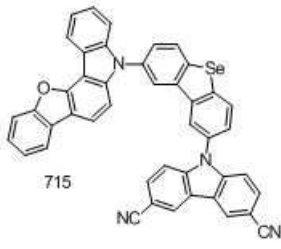


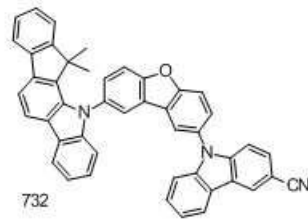
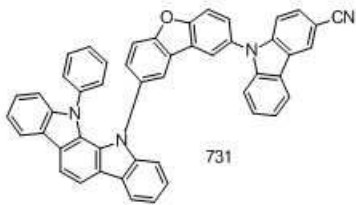
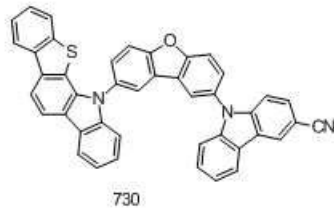
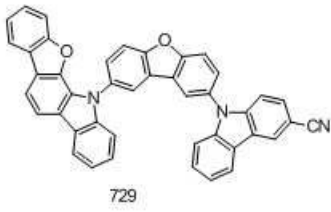
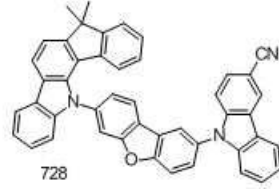
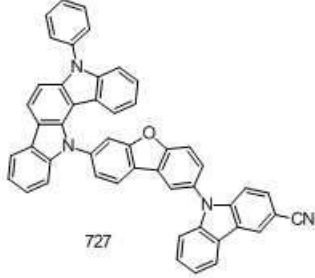
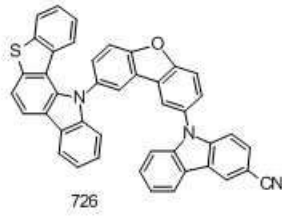
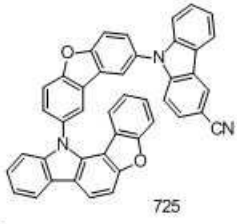


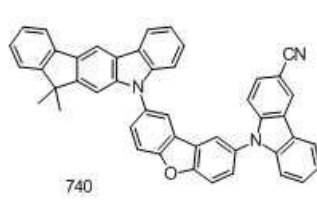
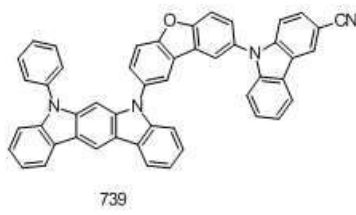
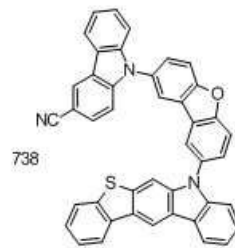
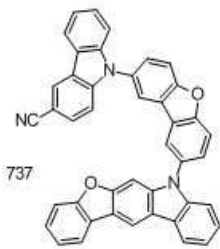
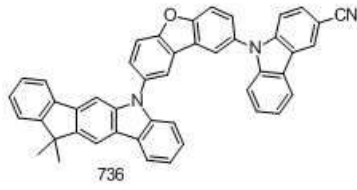
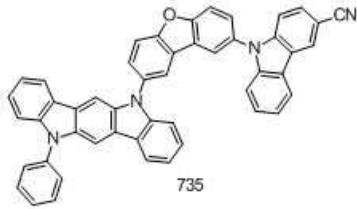
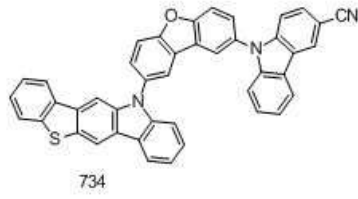
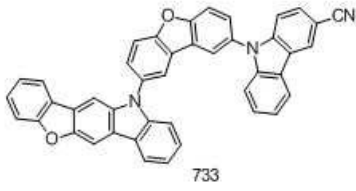


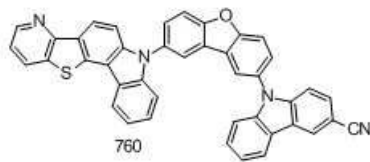
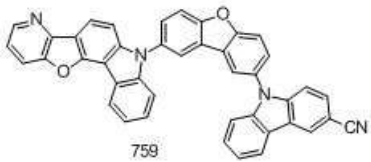
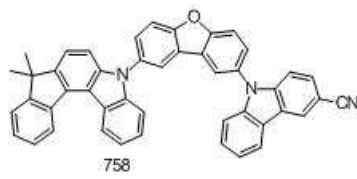
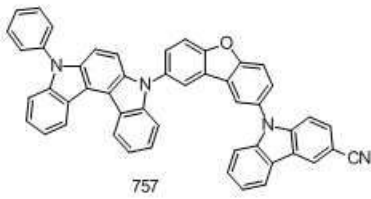
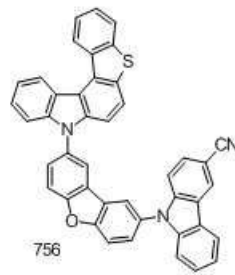
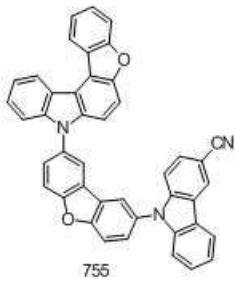
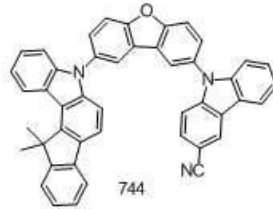
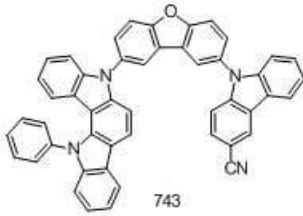
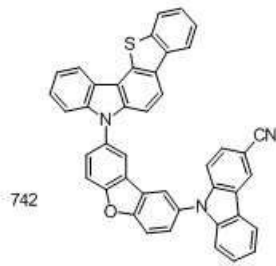
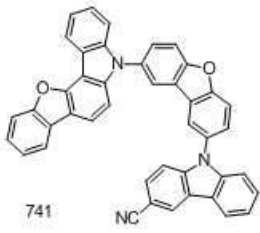


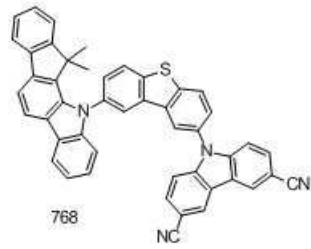
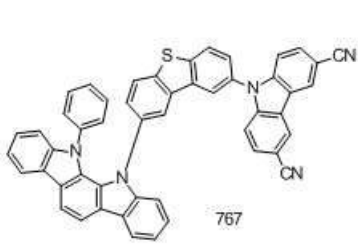
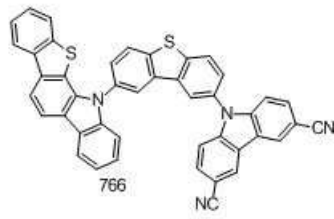
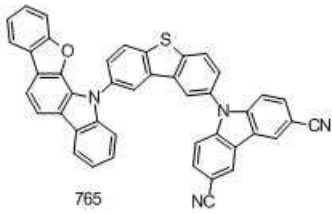
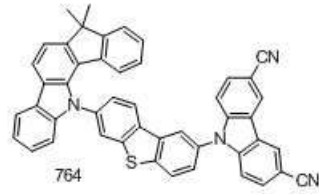
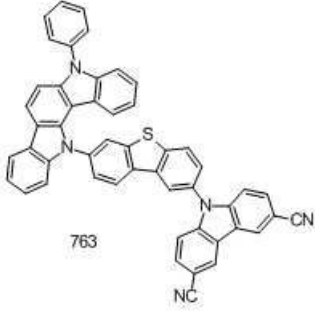
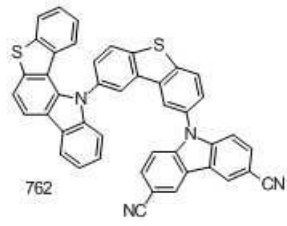
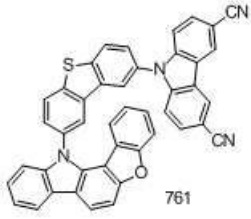




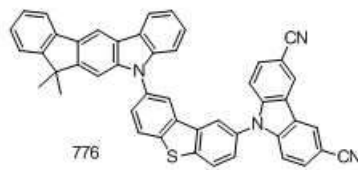
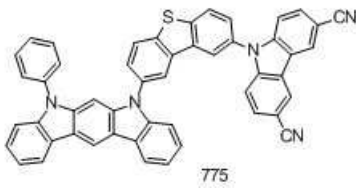
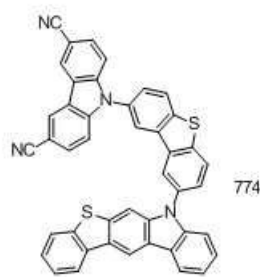
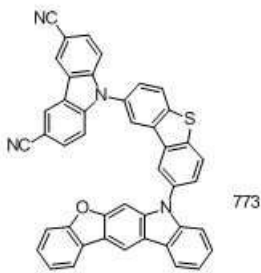
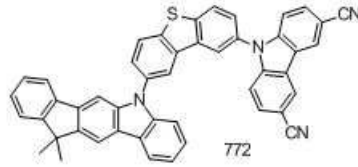
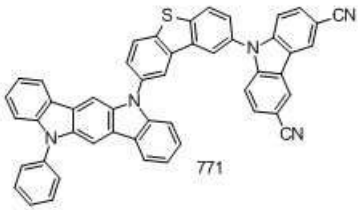
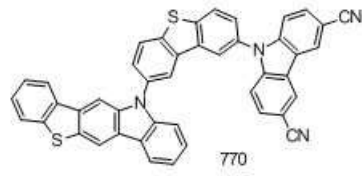
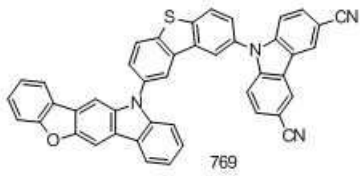


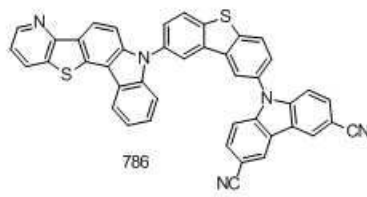
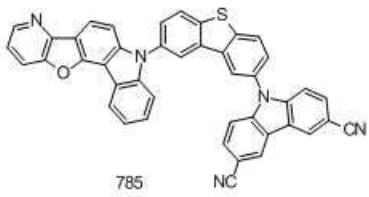
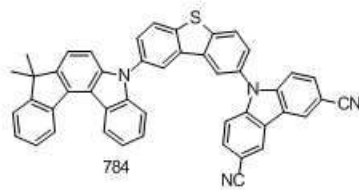
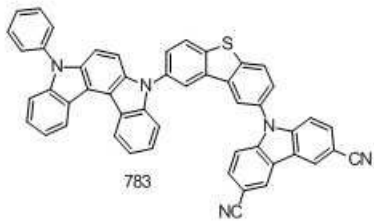
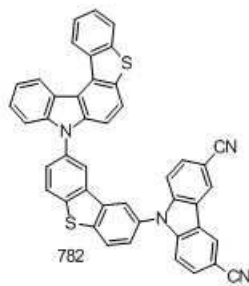
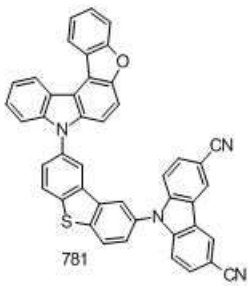
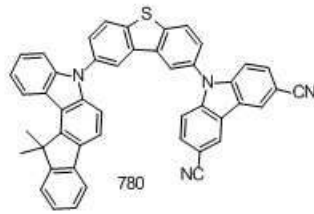
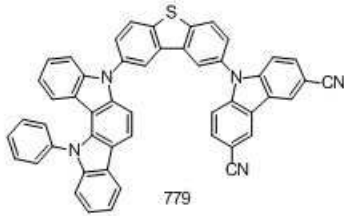
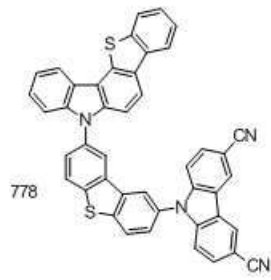
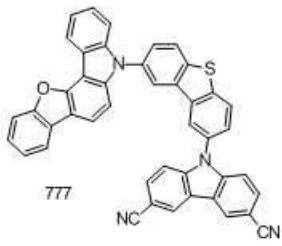


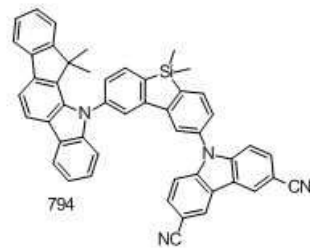
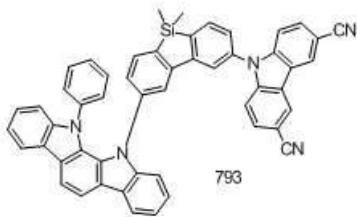
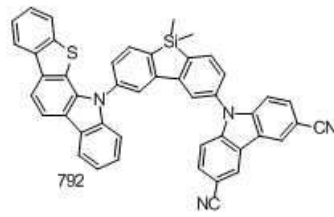
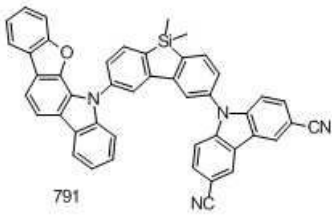
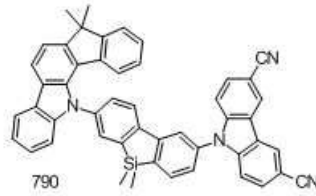
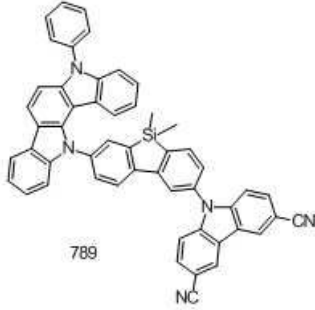
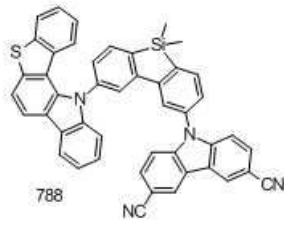
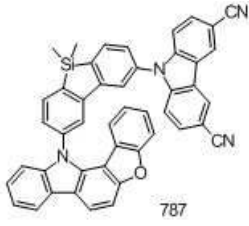


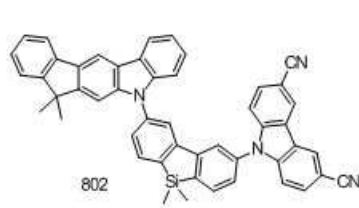
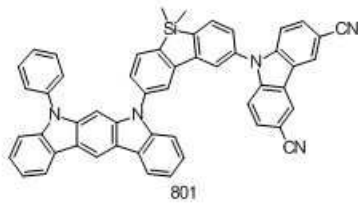
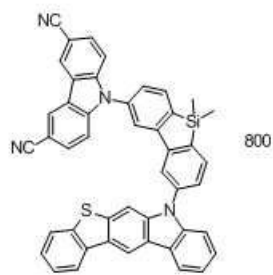
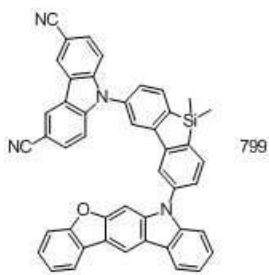
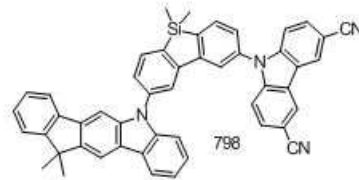
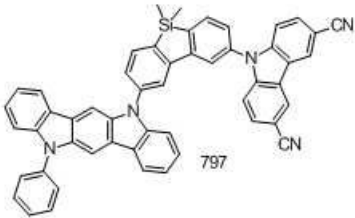
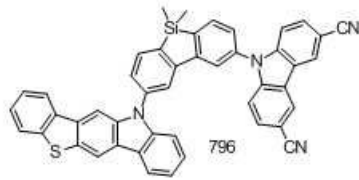
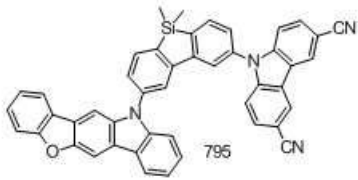


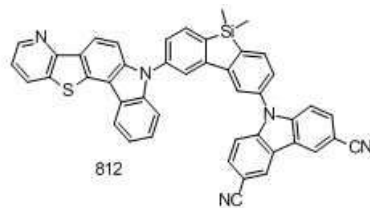
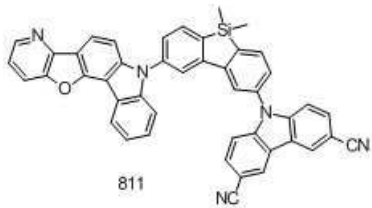
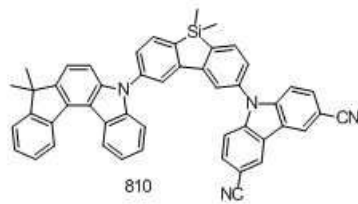
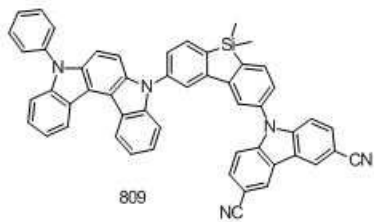
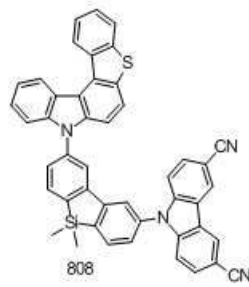
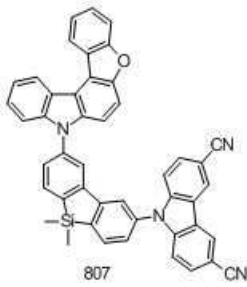
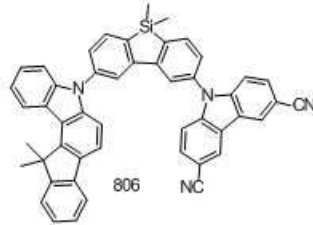
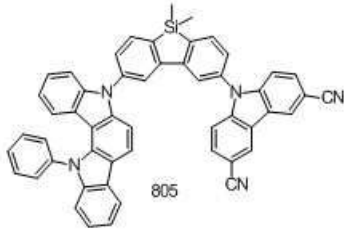
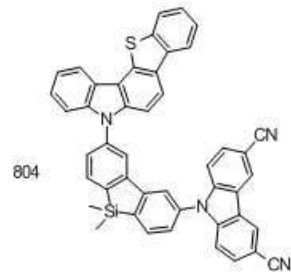
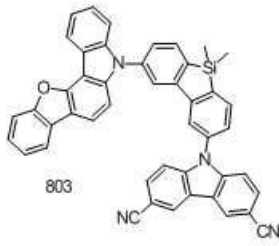


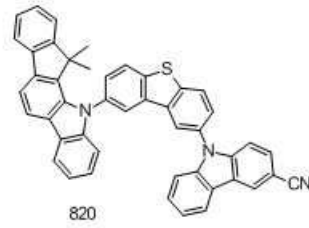
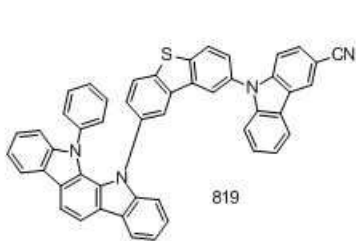
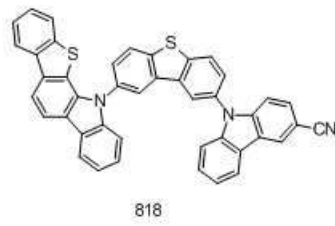
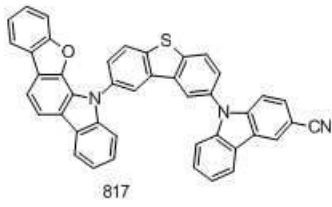
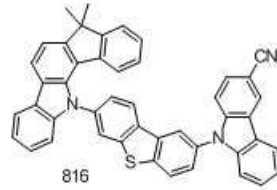
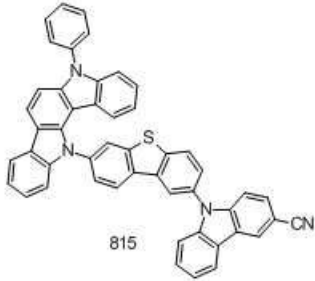
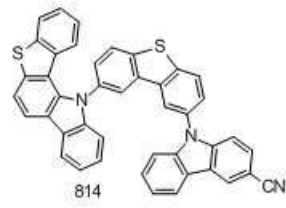


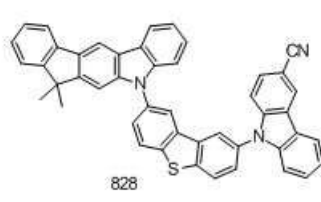
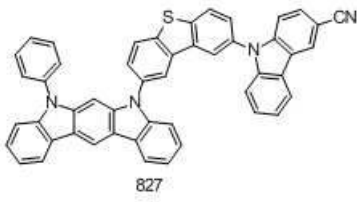
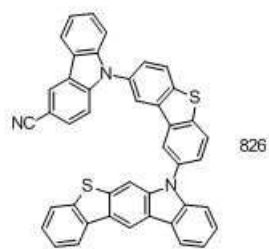
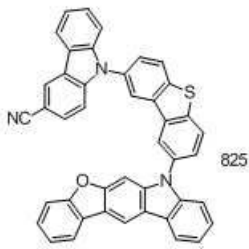
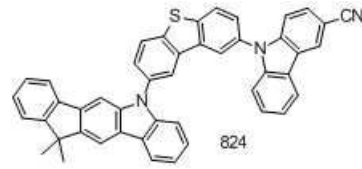
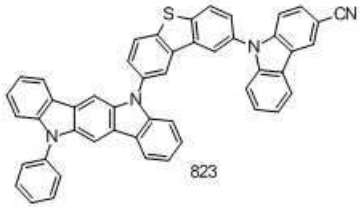
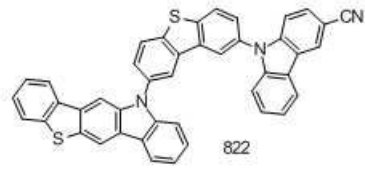
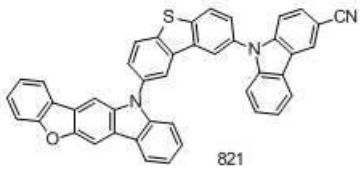


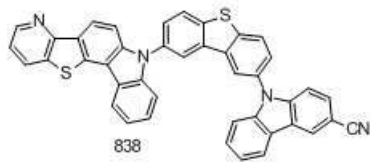
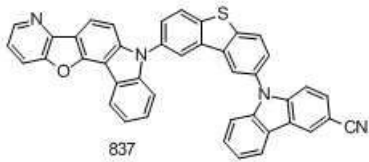
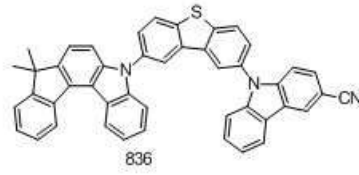
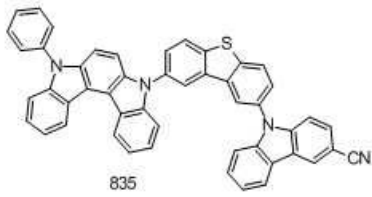
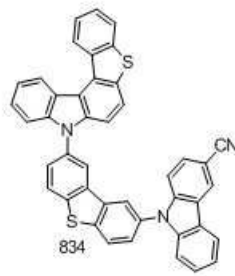
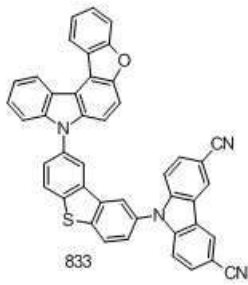
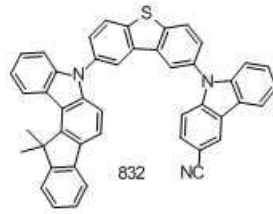
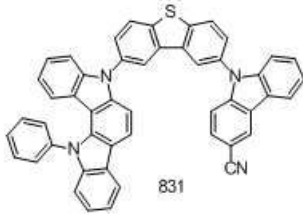
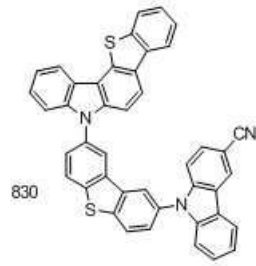
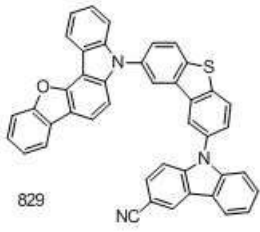




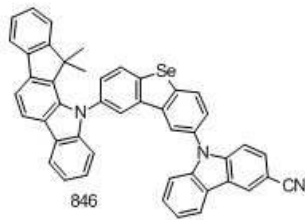
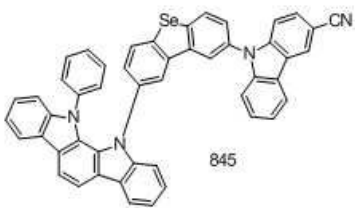
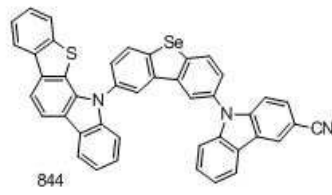
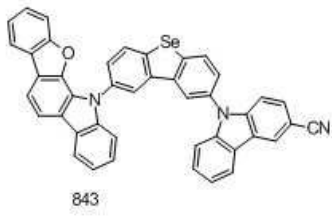
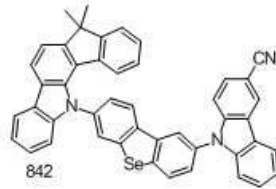
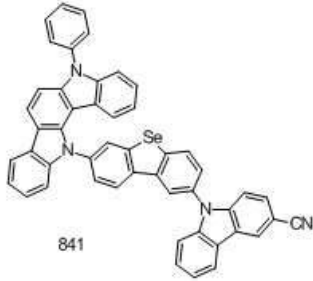
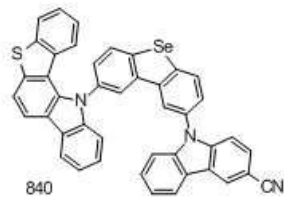
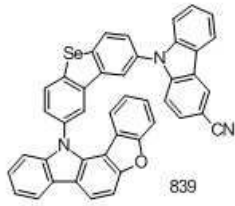


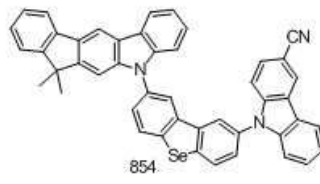
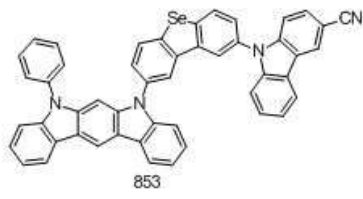
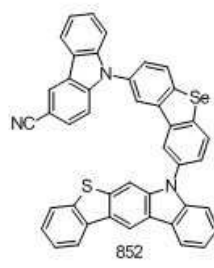
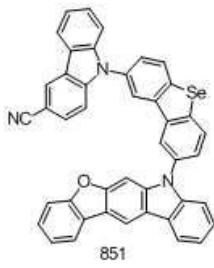
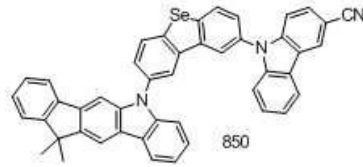
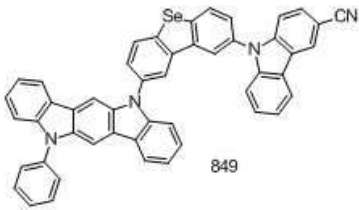
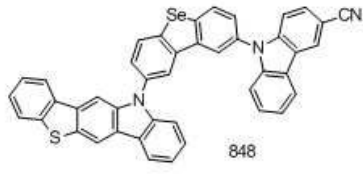
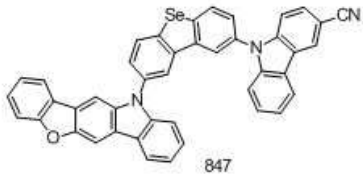


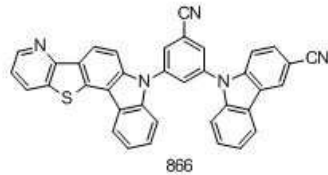
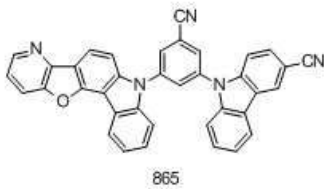
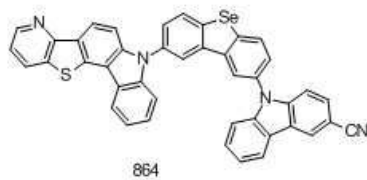
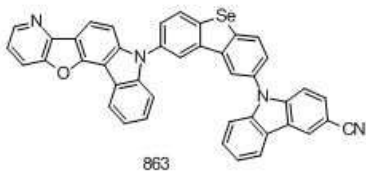
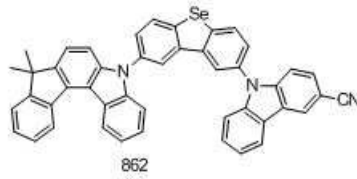
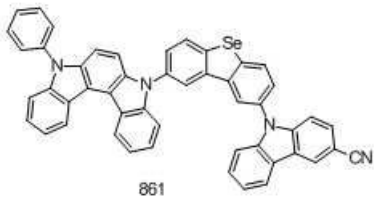
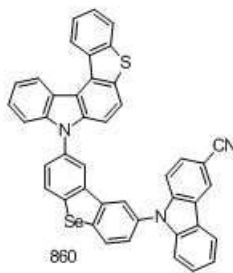
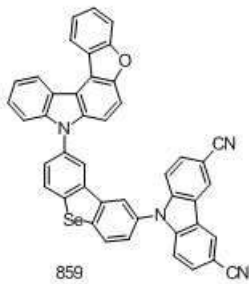
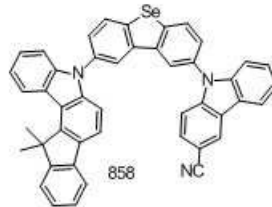
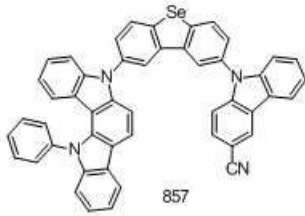
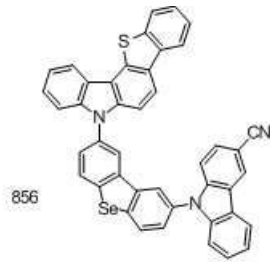
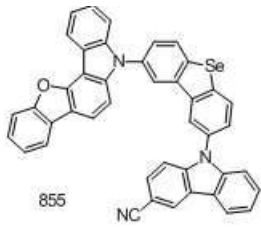


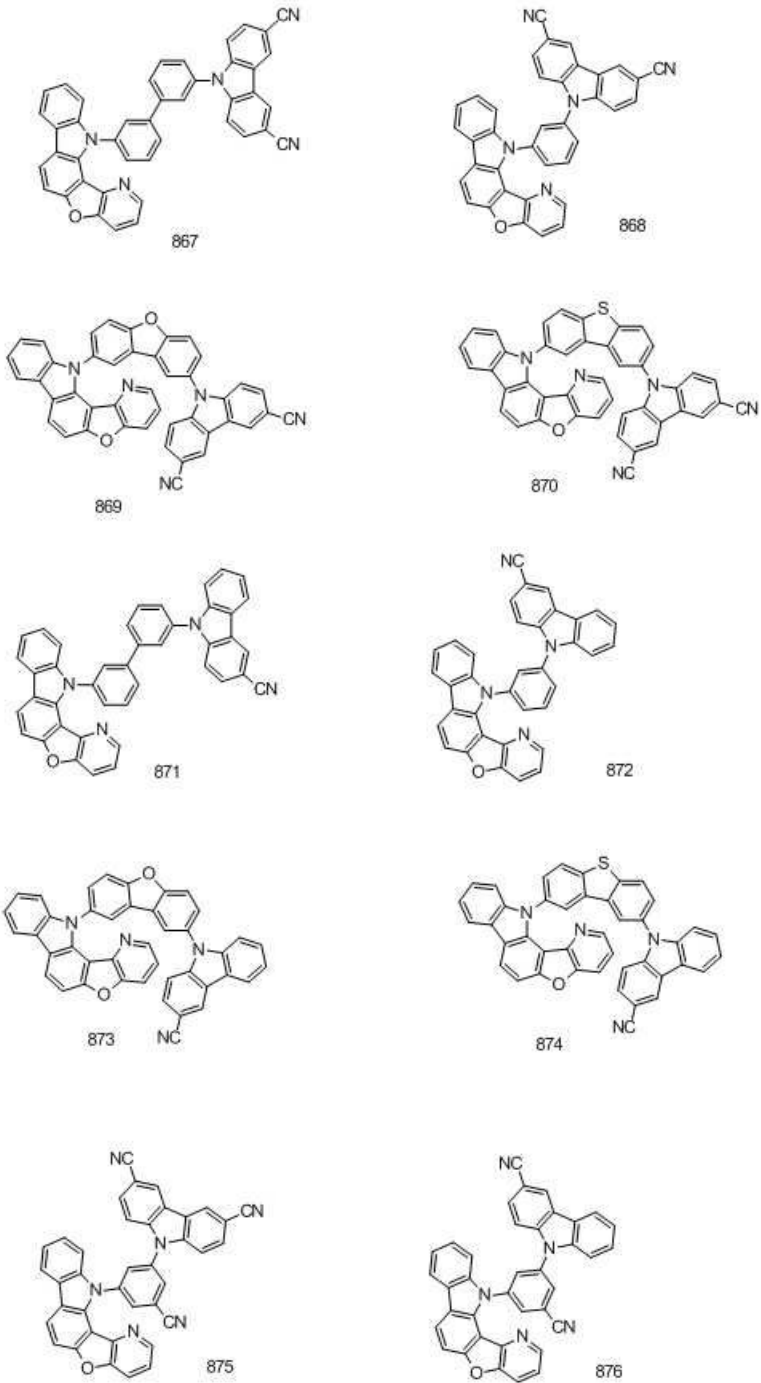












**청구항 15**

제1전극;

제2전극; 및

상기 제1전극과 상기 제2전극 사이에 개재되고 발광층을 포함한 유기층;

을 포함하고,

상기 유기층은, 제1항 내지 제14항 중 어느 한 항의 화학식 1로 표시되는 축합환 화합물을 1종 이상 포함한, 유기 발광 소자.

**청구항 16**

제15항에 있어서,

상기 제1전극은 애노드이고, 상기 제2전극은 캐소드이고,

상기 유기층은, 상기 제1전극과 상기 발광층 사이에 개재된 정공 수송 영역 및 상기 발광층과 상기 제2전극 사이에 개재된 전자 수송 영역을 포함하고,

상기 정공 수송 영역은, 정공 주입층, 정공 수송층 및 전자 저지층 중에서 선택된 적어도 하나를 포함하고,

상기 전자 수송 영역은, 정공 저지층, 전자 수송층 및 전자 주입층 중에서 선택된 적어도 하나를 포함하는, 유기 발광 소자.

**청구항 17**

제15항에 있어서,

상기 화학식 1로 표시되는 축합환 화합물이 상기 발광층에 포함되어 있는, 유기 발광 소자.

**청구항 18**

제15항에 있어서,

상기 발광층은 호스트 및 도펀트를 포함하고,

상기 호스트는 상기 화학식 1로 표시되는 축합환 화합물을 포함하고,

상기 호스트의 함량은 상기 도펀트의 함량보다 큰, 유기 발광 소자.

**청구항 19**

제18항에 있어서,

상기 발광층이 청색광을 방출하는, 유기 발광 소자.

**청구항 20**

제16항에 있어서,

상기 전자 수송 영역은 상기 정공 저지층을 포함하고, 상기 정공 저지층에 상기 화학식 1로 표시되는 축합환 화합물이 포함되어 있는, 유기 발광 소자.

**발명의 설명**

**기술 분야**

[0001] 축합환 화합물 및 이를 포함한 유기 발광 소자가 제시된다.

**배경 기술**

[0002] 유기 발광 소자(organic light emitting device)는 자발광형 소자로서, 종래의 전자 소자에 비하여, 시야각이 넓고 콘트라스트가 우수할 뿐만 아니라, 응답시간이 빠르며, 휘도, 구동전압 및 응답속도 특성이 우수하고 다색화가 가능하다.

[0003] 일예에 따르면, 유기 발광 소자는, 애노드, 캐소드 및 상기 애노드와 캐소드 사이에 개재되고 발광층을 포함한 유기층 포함할 수 있다. 상기 애노드와 발광층 사이에는 정공 수송 영역이 구비될 수 있고, 상기 발광층과 캐소드 사이에는 전자 수송 영역이 구비될 수 있다. 상기 애노드로부터 주입된 정공은 정공 수송 영역을 경유하여 발광층으로 이동하고, 캐소드로부터 주입된 전자는 전자 수송 영역을 경유하여 발광층으로 이동한다. 상기 정공 및 전자와 같은 캐리어들은 발광층에서 재결합하여 엑시톤(exciton)을 생성한다. 이 엑시톤이 여기 상태에서 기저상태로 변하면서 광이 생성된다.

**발명의 내용**

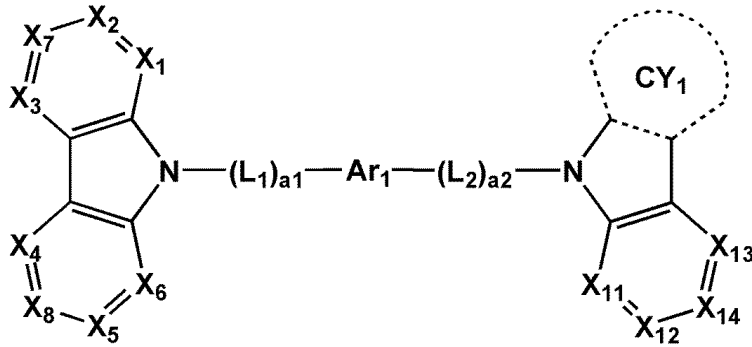
**해결하려는 과제**

[0004] 신규 축합환 화합물 및 이를 채용한 유기 발광 소자를 제공하는 것이다.

**과제의 해결 수단**

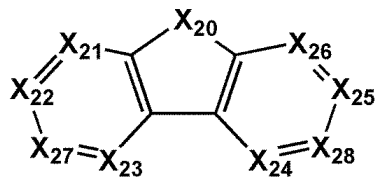
[0005] 일 측면에 따르면, 하기 화학식 1로 표시되는 축합환 화합물이 제공된다:

[0006] <화학식 1>



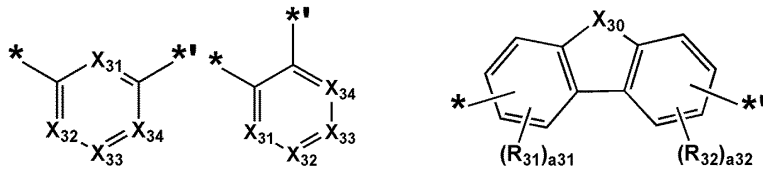
[0007]

[0008] <화학식 2>



[0009]

[0010] <화학식 3A> <화학식 3B><화학식 3C>



[0011]

[0012] 상기 화학식 1, 2 및 화학식 3A 내지 3C 중,

[0013] X<sub>1</sub>은 N 또는 C(R<sub>1</sub>)이고, X<sub>2</sub>는 N 또는 C(R<sub>2</sub>)이고, X<sub>3</sub>은 N 또는 C(R<sub>3</sub>)이고, X<sub>4</sub>는 N 또는 C(R<sub>4</sub>)이고, X<sub>5</sub>는 N 또는 C(R<sub>5</sub>)이고, X<sub>6</sub>은 N 또는 C(R<sub>6</sub>)이고, X<sub>7</sub>은 N 또는 C(R<sub>7</sub>)이고, X<sub>8</sub>은 N 또는 C(R<sub>8</sub>)이고,

[0014] X<sub>11</sub>은 N 또는 C(R<sub>11</sub>)이고, X<sub>12</sub>는 N 또는 C(R<sub>12</sub>)이고, X<sub>13</sub>은 N 또는 C(R<sub>13</sub>)이고, X<sub>14</sub>는 N 또는 C(R<sub>14</sub>)이고,

[0015] CY<sub>1</sub>은 상기 화학식 2로 표시되고,

[0016] X<sub>20</sub>은 O, S, N(R<sub>20</sub>) 및 C(R<sub>20</sub>)(R<sub>29</sub>) 중에서 선택되고,

[0017] X<sub>21</sub>은 N 또는 C(R<sub>21</sub>)이고, X<sub>22</sub>는 N 또는 C(R<sub>22</sub>)이고, X<sub>23</sub>은 N 또는 C(R<sub>23</sub>)이고, X<sub>24</sub>는 N 또는 C(R<sub>24</sub>)이고, X<sub>25</sub>는 N 또는 C(R<sub>25</sub>)이고, X<sub>26</sub>는 N 또는 C(R<sub>26</sub>)이고, X<sub>27</sub>은 N 또는 C(R<sub>27</sub>)이고, X<sub>28</sub>은 N 또는 C(R<sub>28</sub>)이고,

[0018] CY<sub>1</sub>은 X<sub>21</sub> 및 X<sub>22</sub>, X<sub>22</sub> 및 X<sub>27</sub>, X<sub>27</sub> 및 X<sub>23</sub>, X<sub>24</sub> 및 X<sub>28</sub>, X<sub>28</sub> 및 X<sub>25</sub> 또는 X<sub>25</sub> 및 X<sub>26</sub>를 통해 N을 고리 구성 원자로 포함하는 이웃한 5각 고리와 융합되어 있고,

[0019] R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기(CN), 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치

환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알킬닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 및 -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) 중에서 선택되고,

- [0020] X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub> 및 X<sub>21</sub> 내지 X<sub>28</sub> 중 적어도 하나는 C(CN)이고,
- [0021] Ar<sub>1</sub>은 상기 화학식 3A 내지 3C 중 하나로 표시되고,
- [0022] X<sub>30</sub>은 O, S, N(R<sub>30</sub>), C(R<sub>30</sub>)(R<sub>35</sub>), Si(R<sub>30</sub>)(R<sub>35</sub>), Se 및 P(=O)(R<sub>30</sub>) 중에서 선택되고,
- [0023] X<sub>31</sub>은 N 또는 C(R<sub>31</sub>)이고, X<sub>32</sub>는 N 또는 C(R<sub>32</sub>)이고, X<sub>33</sub>은 N 또는 C(R<sub>33</sub>)이고, X<sub>34</sub>는 N 또는 C(R<sub>34</sub>)이고,
- [0024] R<sub>30</sub> 내지 R<sub>35</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, C<sub>1</sub>-C<sub>4</sub>알킬기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,
- [0025] a<sub>31</sub> 및 a<sub>32</sub>는 서로 독립적으로, 0 내지 3의 정수 중에서 선택되고, a<sub>31</sub>이 2 이상일 경우 2 이상의 R<sub>31</sub>은 서로 동일하거나 상이하고, a<sub>32</sub>가 2 이상일 경우 2 이상의 R<sub>32</sub>는 서로 동일하거나 상이하고,
- [0026] L<sub>1</sub> 및 L<sub>2</sub>는 서로 독립적으로,
- [0027] 페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조푸라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기; 및
- [0028] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>) 중 적어도 하나로 치환된, 페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조푸라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기;
- [0029] 중에서 선택되고,
- [0030] a<sub>1</sub> 및 a<sub>2</sub>는 서로 독립적으로, 0 내지 5의 정수 중에서 선택되고, a<sub>1</sub>이 2 이상일 경우 2 이상의 L<sub>1</sub>은 서로 동일하거나 상이하고, a<sub>2</sub>가 2 이상일 경우 2 이상의 L<sub>2</sub>는 서로 동일하거나 상이하고,
- [0031] 단, Ar<sub>1</sub>이 화학식 3A 또는 3B로 표시되고, a<sub>1</sub> 및 a<sub>2</sub>의 합이 1이고, L<sub>1</sub> 또는 L<sub>2</sub>가 페닐렌기일 경우, 상기 화학식 1 중 \*(L<sub>1</sub>)<sub>a1</sub>-Ar<sub>1</sub>-(L<sub>2</sub>)<sub>a2</sub>-\*로 표시되는 그룹은 치환기로서 시아노기(CN)를 비포함하고,
- [0032] \* 및 \*'은 각각 서로 이웃한 원자와의 결합 사이트이고,
- [0033] 상기 치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환된 C<sub>2</sub>-C<sub>60</sub>알킬닐기, 치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환된 1가 비-방향족 축합다환 그룹 및 치환된 1가 비-방향족 헤테로축합다환 그룹 중 적어도 하나의 치환기는, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>2</sub>-C<sub>60</sub>알케닐기, C<sub>2</sub>-C<sub>60</sub>알킬닐기, C<sub>1</sub>-C<sub>60</sub>알콕시기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>6</sub>-C<sub>60</sub>아릴옥시기, C<sub>6</sub>-C<sub>60</sub>아릴티오기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중에서 선택되고,
- [0034] 상기 Q<sub>1</sub> 내지 Q<sub>3</sub>, Q<sub>11</sub> 내지 Q<sub>13</sub>, Q<sub>21</sub> 내지 Q<sub>23</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>1</sub>-C<sub>60</sub>알콕시

기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹 중에서 선택된다.

**발명의 효과**

[0035] 상기 축합환 화합물은 우수한 전기적 특성 및 열적 안정성을 갖는 바, 상기 축합환 화합물을 채용한 유기 발광 소자는 고효율 및 장수명 특성을 가질 수 있다.

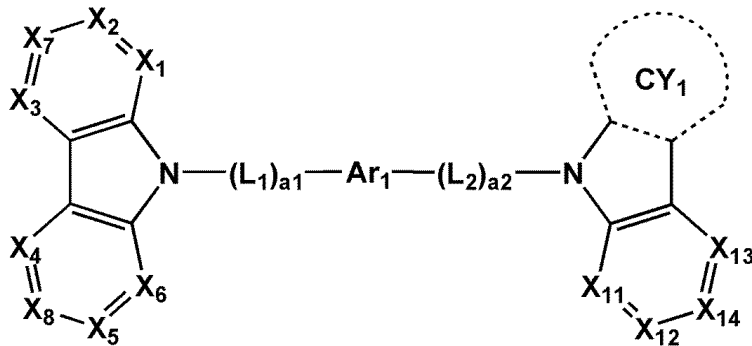
**도면의 간단한 설명**

[0036] 도 1은 일 구현예를 따르는 유기 발광 소자를 개략적으로 나타낸 단면도이다.

**발명을 실시하기 위한 구체적인 내용**

[0037] 상기 축합환 화합물은 하기 화학식 1로 표시된다:

[0038] <화학식 1>



[0039] 상기 화학식 1 중, X<sub>1</sub>은 N 또는 C(R<sub>1</sub>)이고, X<sub>2</sub>는 N 또는 C(R<sub>2</sub>)이고, X<sub>3</sub>은 N 또는 C(R<sub>3</sub>)이고, X<sub>4</sub>는 N 또는 C(R<sub>4</sub>)이고, X<sub>5</sub>는 N 또는 C(R<sub>5</sub>)이고, X<sub>6</sub>은 N 또는 C(R<sub>6</sub>)이고, X<sub>7</sub>은 N 또는 C(R<sub>7</sub>)이고, X<sub>8</sub>은 N 또는 C(R<sub>8</sub>)이고,

[0041] X<sub>11</sub>은 N 또는 C(R<sub>11</sub>)이고, X<sub>12</sub>는 N 또는 C(R<sub>12</sub>)이고, X<sub>13</sub>은 N 또는 C(R<sub>13</sub>)이고, X<sub>14</sub>는 N 또는 C(R<sub>14</sub>)일 수 있다. R<sub>1</sub> 내지 R<sub>9</sub> 및 R<sub>11</sub> 내지 R<sub>14</sub>에 대한 설명은 후술하는 바를 참조한다.

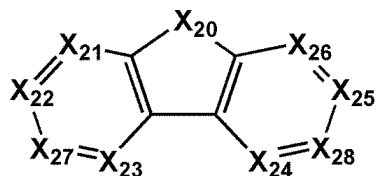
[0042] 예를 들어, 상기 화학식 1 중, X<sub>7</sub>은 C(R<sub>7</sub>)이고, X<sub>8</sub>은 C(R<sub>8</sub>)이고, X<sub>14</sub>는 C(R<sub>14</sub>)일 수 있다.

[0043] 다른 예로서, 상기 화학식 1 중, X<sub>1</sub> 내지 X<sub>6</sub> 및 X<sub>11</sub> 내지 X<sub>13</sub>은 모두 N이 아닐 수 있다.

[0044] 또 다른 예로서, 상기 화학식 1 중, X<sub>1</sub> 내지 X<sub>6</sub> 및 X<sub>11</sub> 내지 X<sub>13</sub> 중 1개는 N이고, 나머지는 N이 아닐 수 있다.

[0045] 상기 화학식 1 중, CY<sub>1</sub>은 하기 화학식 2로 표시될 수 있다:

[0046] <화학식 2>



[0047] 상기 화학식 2 중, X<sub>20</sub>은 O, S, N(R<sub>20</sub>) 및 C(R<sub>20</sub>)(R<sub>29</sub>) 중에서 선택될 수 있다.

[0049] X<sub>21</sub>은 N 또는 C(R<sub>21</sub>)이고, X<sub>22</sub>는 N 또는 C(R<sub>22</sub>)이고, X<sub>23</sub>은 N 또는 C(R<sub>23</sub>)이고, X<sub>24</sub>는 N 또는 C(R<sub>24</sub>)이고, X<sub>25</sub>는 N 또는 C(R<sub>25</sub>)이고, X<sub>26</sub>는 N 또는 C(R<sub>26</sub>)이고, X<sub>27</sub>은 N 또는 C(R<sub>27</sub>)이고, X<sub>28</sub>은 N 또는 C(R<sub>28</sub>)일 수 있다. 상기 R<sub>20</sub> 내지



R<sub>29</sub>에 대한 설명은 후술하는 바를 참조한다.

- [0050] CY<sub>1</sub>은 X<sub>21</sub> 및 X<sub>22</sub>, X<sub>22</sub> 및 X<sub>27</sub>, X<sub>27</sub> 및 X<sub>23</sub>, X<sub>24</sub> 및 X<sub>28</sub>, X<sub>28</sub> 및 X<sub>25</sub> 또는 X<sub>25</sub> 및 X<sub>26</sub>를 통해 N을 고리 구성 원자로 포함하는 이웃한 5각 고리와 융합되어 있다.
- [0051] 예를 들어, 상기 화학식 2 중, X<sub>27</sub>이 C(R<sub>27</sub>)이거나 X<sub>28</sub>이 C(R<sub>28</sub>)일 수 있다.
- [0052] 다른 예로서, 상기 화학식 2 중, X<sub>21</sub> 내지 X<sub>26</sub>은 모두 N이 아닐 수 있다.
- [0053] 또 다른 예로서, 상기 화학식 2 중, X<sub>21</sub> 내지 X<sub>26</sub> 중 1개는 N이고, 나머지는 N이 아닐 수 있다.
- [0054] 상기 화학식 1 및 2 중, R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기(CN), 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알키닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아틸기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아틸옥시기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아틸티오기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아틸기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹 및 -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) 중에서 선택될 수 있다. 상기 Q<sub>1</sub> 내지 Q<sub>3</sub>에 대한 설명은 후술하는 바를 참조한다.
- [0055] 예를 들어, 상기 화학식 1 및 2 중,
- [0056] R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로,
- [0057] 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>20</sub>알킬기 및 C<sub>1</sub>-C<sub>20</sub>알콕시기;
- [0058] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 중 적어도 하나로 치환된, C<sub>1</sub>-C<sub>20</sub>알킬기 및 C<sub>1</sub>-C<sub>20</sub>알콕시기;
- [0059] 시클로펜틸기, 시클로헥실기, 시클로헵테닐기, 시클로헥세닐기, 시클로헵테닐기, 페닐기, 펜탈레닐기, 인테닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-플루오레닐기, 페날레닐기, 페난트레닐기, 안트라세닐기, 플루오란트레닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페틸레닐기, 펜타페닐기, 헥사세닐기, 피롤일기, 이미다졸일기, 피라졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴놀살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조옥사졸일기, 벤조이미다졸일기, 푸라닐기, 벤조푸라닐기, 티오펜일기, 벤조티오펜일기, 티아졸일기, 이소티아졸일기, 벤조티아졸일기, 이소옥사졸일기, 옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조푸라닐기, 디벤조티오펜일기, 이미다조피리디미디닐기 및 이미다조피리디닐기;
- [0060] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>20</sub>알킬기, C<sub>2</sub>-C<sub>20</sub>알케닐기, C<sub>2</sub>-C<sub>20</sub>알키닐기, C<sub>1</sub>-C<sub>20</sub>알콕시기, 페닐기, 나프틸기, 안트라세닐기, 파이레닐기, 페난쓰레닐기, 플루오레닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 프탈라지닐기, 퀴놀살리닐기, 시놀리닐기, 퀴나졸리닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 시클로펜틸기, 시클로헥실기, 시클로헵테닐기, 시클로헥세닐기, 시클로헵테닐기, 페닐기, 펜탈레닐기, 인테닐기, 나프틸기, 아줄레닐기, 헵탈레닐기, 인다세닐기, 아세나프틸기, 플루오레닐기, 스파이로-플루오레닐기, 페날레닐기, 페난

트레닐기, 안트라세닐기, 플루오란트레닐기, 트리페닐레닐기, 파이레닐기, 크라이세닐기, 나프타세닐기, 피세닐기, 페틸레닐기, 펜타페닐기, 헥사세닐기, 피롤일기, 이미다졸일기, 피라졸일기, 피리디닐기, 피라지닐기, 피리미디닐기, 피리다지닐기, 이소인돌일기, 인돌일기, 인다졸일기, 푸리닐기, 퀴놀리닐기, 이소퀴놀리닐기, 벤조퀴놀리닐기, 프탈라지닐기, 나프티리디닐기, 퀴녹살리닐기, 퀴나졸리닐기, 시놀리닐기, 페난트리디닐기, 아크리디닐기, 페난트롤리닐기, 페나지닐기, 벤조옥사졸일기, 벤조이미다졸일기, 푸라닐기, 벤조푸라닐기, 티오펜일기, 벤조티오펜일기, 티아졸일기, 이소티아졸일기, 벤조티아졸일기, 이소옥사졸일기, 옥사졸일기, 트리아졸일기, 테트라졸일기, 옥사디아졸일기, 트리아지닐기, 디벤조푸라닐기, 디벤조티오펜일기, 이미다조피리디미디닐기 및 이미다조피리디닐기; 및

- [0061] -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) ;
- [0062] 중에서 선택되고,
- [0063] 상기 Q<sub>1</sub> 내지 Q<sub>3</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>20</sub>알킬기, C<sub>1</sub>-C<sub>20</sub>알콕시기, 페닐기, 나프틸기, 안트라세닐기, 파이레닐기, 페난쓰레닐기, 플루오레닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기, 프탈라지닐기, 퀴녹살리닐기, 시놀리닐기 및 퀴나졸리닐기 중에서 선택될 수 있다.
- [0064] 다른 구현예에 따르면, 상기 화학식 1 및 2 중,
- [0065] R<sub>1</sub> 내지 R<sub>6</sub>, R<sub>11</sub> 내지 R<sub>13</sub>, R<sub>20</sub> 내지 R<sub>26</sub> 및 R<sub>29</sub>는 서로 독립적으로,
- [0066] 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기;
- [0067] 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기;
- [0068] 중수소, -F, -Cl, -Br, -I, 히드록실기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기; 및
- [0069] -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) ;
- [0070] 중에서 선택되고,
- [0071] R<sub>7</sub>, R<sub>8</sub>, R<sub>14</sub>, R<sub>27</sub> 및 R<sub>28</sub>은 서로 독립적으로,
- [0072] 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기;
- [0073] 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기;
- [0074] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>31</sub>)(Q<sub>32</sub>)(Q<sub>33</sub>) 중 적어도 하나로 치환된, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기; 및
- [0075] -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) ;
- [0076] 중에서 선택되고,
- [0077] 상기 Q<sub>1</sub> 내지 Q<sub>3</sub> 및 Q<sub>31</sub> 내지 Q<sub>33</sub>은 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기 중에서 선택될 수 있다.

[0078] 또 다른 구현예에 따르면, 상기 화학식 1 및 2 중, R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>23</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, n-펜틸기, 이소펜틸기, sec-펜틸기, tert-펜틸기, n-헥실기, 이소헥실기, sec-헥실기, tert-헥실기 및 -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) 중에서 선택되고,

[0079] 상기 Q<sub>1</sub> 내지 Q<sub>3</sub>는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.

[0080] 상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub> 및 X<sub>21</sub> 내지 X<sub>28</sub> 중 적어도 하나는 C(CN)일 수 있다.

[0081] 예를 들어, 상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub> 및 X<sub>21</sub> 내지 X<sub>28</sub> 중 적어도 2개는 C(CN)일 수 있다.

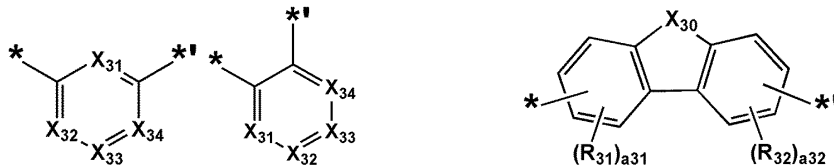
[0082] 다른 구현예에 따르면, 상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>21</sub> 및 X<sub>26</sub> 내지 X<sub>28</sub> 중 적어도 하나는 C(CN)일 수 있다.

[0083] 또 다른 구현예에 따르면, 상기 화학식 1 중, X<sub>7</sub> 및 X<sub>8</sub> 중 적어도 하나는 C(CN)일 수 있다.

[0084] 또 다른 구현예에 따르면, 상기 화학식 1 및 2 중, X<sub>1</sub> 내지 X<sub>6</sub>, X<sub>11</sub> 내지 X<sub>13</sub> 및 X<sub>22</sub> 내지 X<sub>25</sub>은 C(CN)이 아닐 수 있으나, 이에 한정되는 것은 아니다.

[0085] 상기 화학식 1 중 Ar<sub>1</sub>은 하기 화학식 3A 내지 3C 중 하나로 표시될 수 있다:

[0086] <화학식 3A>      <화학식 3B><화학식 3C>



[0087] 상기 화학식 3A 내지 3C 중, X<sub>30</sub>은 O, S, N(R<sub>30</sub>), C(R<sub>30</sub>)(R<sub>35</sub>), Si(R<sub>30</sub>)(R<sub>35</sub>), Se 및 P(=O)(R<sub>30</sub>) 중에서 선택될 수 있다.

[0089] 예를 들어, 상기 화학식 3A 내지 3C 중 X<sub>30</sub>은 O, S, N(R<sub>30</sub>) 및 C(R<sub>30</sub>)(R<sub>35</sub>) 중에서 선택될 수 있다.

[0090] 상기 화학식 3A 내지 3C 중, X<sub>31</sub>은 N 또는 C(R<sub>31</sub>)이고, X<sub>32</sub>는 N 또는 C(R<sub>32</sub>)이고, X<sub>33</sub>은 N 또는 C(R<sub>33</sub>)이고, X<sub>34</sub>는 N 또는 C(R<sub>34</sub>)일 수 있다.

[0091] 상기 화학식 3A 내지 3C 중, R<sub>30</sub> 내지 R<sub>35</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, C<sub>1</sub>-C<sub>4</sub>알킬기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택될 수 있다. 상기 Q<sub>11</sub> 내지 Q<sub>13</sub>에 대한 설명은 후술하는 바를 참조한다.

[0092] 예를 들어, 상기 화학식 3A 내지 3C 중,

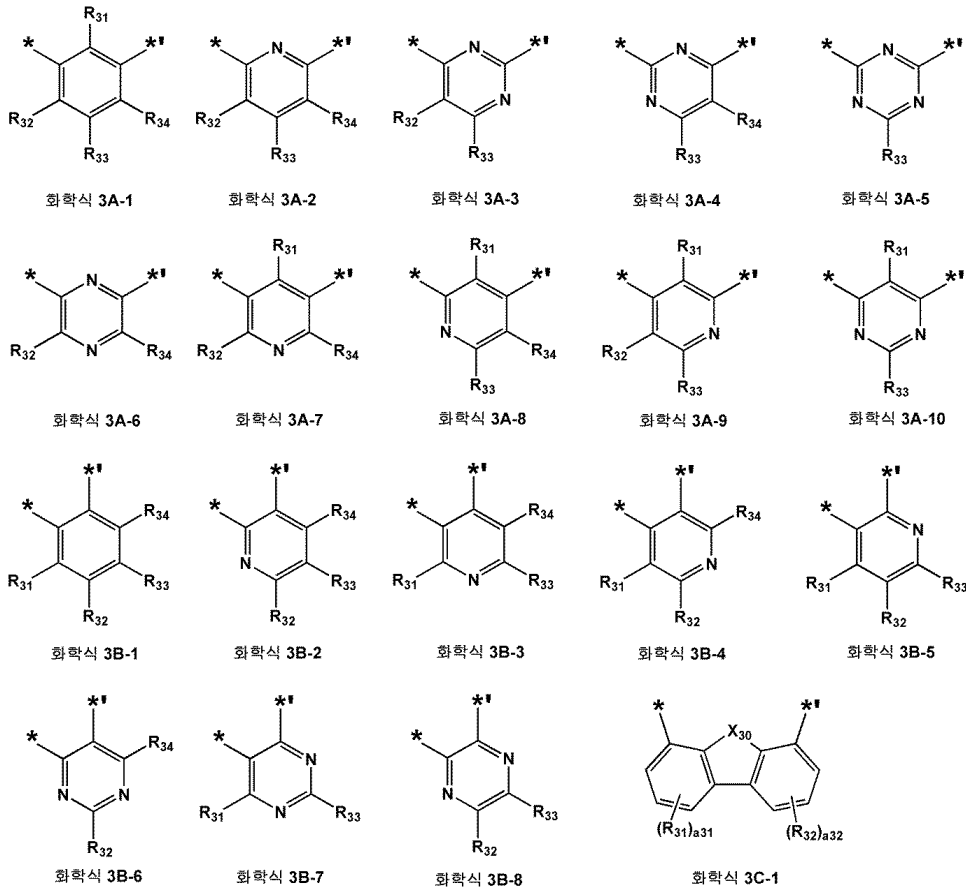
[0093] R<sub>31</sub> 내지 R<sub>34</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, C<sub>1</sub>-C<sub>4</sub>알킬기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,

[0094] R<sub>30</sub> 및 R<sub>35</sub>는 서로 독립적으로, C<sub>1</sub>-C<sub>4</sub>알킬기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기 중에서 선택될 수 있다.

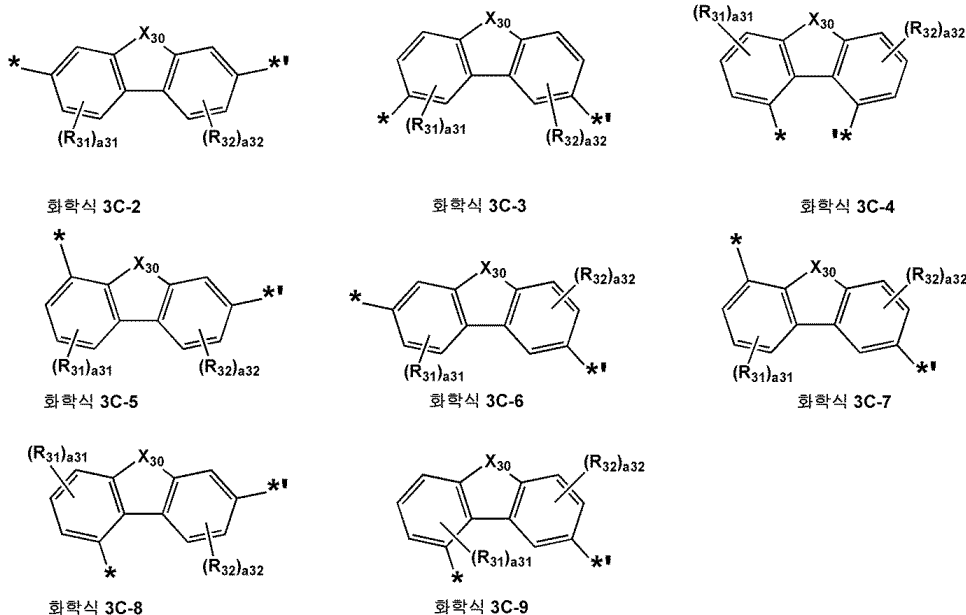
[0095] 상기 화학식 3A 내지 3C 중, a31 및 a32는 각각 R<sub>31</sub> 및 R<sub>32</sub>의 개수를 나타낸 것으로서, a31 및 a32는 서로 독립적으로, 0 내지 3의 정수 중에서 선택될 수 있다. 상기 화학식 a31이 2 이상일 경우 2 이상의 R<sub>31</sub>은 서로 동일하거나 상이하고, a32가 2 이상일 경우 2 이상의 R<sub>32</sub>는 서로 동일하거나 상이하다.

[0096] 예를 들어, 상기 화학식 3A 내지 3C 중, a31 및 a32는 서로 독립적으로 0, 1 또는 2일 수 있다.

[0097] 상기 화학식 1 중, Ar<sub>1</sub>은 하기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-1 내지 3C-9 중 하나로 표시될 수 있으나, 이에 한정되는 것은 아니다:



[0098]



[0099]

[0100]

[0101]

[0102]

상기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-1 내지 3C-9 중,

X<sub>30</sub>은 O, S, N(R<sub>30</sub>), C(R<sub>30</sub>)(R<sub>35</sub>), Si(R<sub>30</sub>)(R<sub>35</sub>), Se 및 P(=O)(R<sub>30</sub>) 중에서 선택되고,

R<sub>31</sub> 내지 R<sub>34</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,

- [0103] R<sub>30</sub> 및 R<sub>35</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기 및 트리아지닐기 중에서 선택되고,
- [0104] 상기 Q<sub>11</sub> 내지 Q<sub>13</sub>는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택되고,
- [0105] a<sub>31</sub> 및 a<sub>32</sub>는 서로 독립적으로 0 또는 1이고,
- [0106] \* 및 \*'은 각각 이웃한 원자와의 결합 사이트이다.
- [0107] 예를 들어, 상기 화학식 1 중, Ar<sub>1</sub>은 상기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-3 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.
- [0108] 다른 구현예에 따르면,
- [0109] i) 상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>27</sub> 및 X<sub>28</sub> 중 하나는 C(CN)이고, 나머지는 C(CN)이 아니고, Ar<sub>1</sub>은 상기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-3 중 하나로 표시되거나; 또는
- [0110] ii) 상기 화학식 1 및 2 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>27</sub> 및 X<sub>28</sub> 중 적어도 2개는 C(CN)이고, 나머지는 C(CN)이 아니고, Ar<sub>1</sub>은 상기 화학식 3A-1 내지 3A-10, 3B-1 내지 3B-8 및 3C-3 중 하나로 표시될 수 있으나, 이에 한정되는 것은 아니다.
- [0111] 상기 화학식 1 중, L<sub>1</sub> 및 L<sub>2</sub>는 서로 독립적으로,
- [0112] 페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조퓨라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기; 및
- [0113] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>) 중 적어도 하나로 치환된, 페닐렌기, 피리디닐렌기, 피리미디닐렌기, 피라지닐렌기, 피리다지닐렌기, 트리아지닐렌기, 디벤조퓨라닐렌기, 디벤조티오펜닐렌기 및 카바졸일렌기;
- [0114] 중에서 선택될 수 있다.
- [0115] 예를 들어, 상기 화학식 1 중, L<sub>1</sub> 및 L<sub>2</sub>는 서로 독립적으로,
- [0116] 페닐렌기, 피리디닐렌기, 피리미디닐렌기 및 트리아지닐렌기; 및
- [0117] 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및 -Si(Q<sub>21</sub>)(Q<sub>22</sub>)(Q<sub>23</sub>) 중 적어도 하나로 치환된, 페닐렌기, 피리디닐렌기, 피리미디닐렌기 및 트리아지닐렌기;
- [0118] 중에서 선택될 수 있다.
- [0119] 상기 화학식 1 중, a<sub>1</sub> 및 a<sub>2</sub>는 서로 독립적으로, 0 내지 5의 정수 중에서 선택될 수 있다. a<sub>1</sub>은 L<sub>1</sub>의 개수를 나타낸 것으로서, a<sub>1</sub>이 0일 경우, \*-(L<sub>1</sub>)<sub>a<sub>1</sub></sub>-\*'은 단일 결합이 된다. a<sub>1</sub>이 2 이상일 경우 2 이상의 L<sub>1</sub>은 서로 동일하거나 상이하다. a<sub>2</sub>는 L<sub>2</sub>의 개수를 나타낸 것으로서, a<sub>2</sub>가 0일 경우, \*-(L<sub>2</sub>)<sub>a<sub>2</sub></sub>-\*'은 단일 결합이 된다. a<sub>2</sub>이 2 이상일 경우 2 이상의 L<sub>2</sub>는 서로 동일하거나 상이하다.
- [0120] 일 구현예에 따르면, 상기 a<sub>1</sub> 및 a<sub>2</sub>는 서로 독립적으로, 0, 1 또는 2일 수 있다.
- [0121] 다른 구현예에 따르면, 상기 a<sub>1</sub> 및 a<sub>2</sub>는 서로 독립적으로, 0 또는 1일 수 있다.
- [0122] 예를 들어, 상기 화학식 1 중, L<sub>1</sub> 및 L<sub>2</sub>는 서로 독립적으로,
- [0123] 페닐렌기; 및
- [0124] 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸

기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기 및  $-Si(Q_{21})(Q_{22})(Q_{23})$  중 적어도 하나로 치환된 페닐렌기;

[0125]

중에서 선택되고,

[0126]

상기  $Q_{21}$  내지  $Q_{23}$ 는 서로 독립적으로, 수소,  $C_1$ - $C_{10}$ 알킬기,  $C_1$ - $C_{10}$ 알콕시기 및 페닐기 중에서 선택되고,

[0127]

$a_1$  및  $a_2$ 는 서로 독립적으로, 0 또는 1일 수 있다.

[0128]

한편,  $Ar_1$ 이 화학식 3A 또는 3B로 표시되고,  $a_1$  및  $a_2$ 의 합이 1이고,  $L_1$  또는  $L_2$ 가 페닐렌기일 경우, 상기 화학식 1 중  $-(L_1)_{a_1}-Ar_1-(L_2)_{a_2}-*$ 로 표시되는 그룹은 치환기로서 시아노기(CN)를 비포함할 수 있다,

[0129]

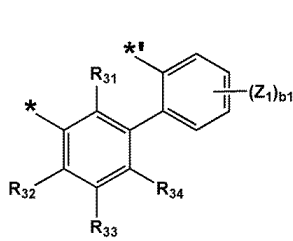
예를 들어, 상기 화학식 1 중  $Ar_1$ 이 상기 화학식 3A-1 또는 3B-1로 표시되고,  $a_1$  및  $a_2$ 의 합이 1이고,  $L_1$  및  $L_2$ 가 페닐렌기일 경우, 상기 화학식 1 중  $-(L_1)_{a_1}-Ar_1-(L_2)_{a_2}-*$ 로 표시되는 그룹은 치환기로서 시아노기를 비포함할 수 있다.

[0130]

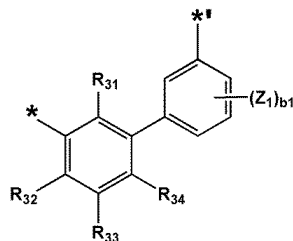
다른 구현예에 따르면, 상기 화학식 1 중  $a_1$  및  $a_2$ 는 0이고,  $Ar_1$ 은 상기 화학식 3A-1, 3A-2, 3B-1 및 3C-3로 표시되는 그룹 중에서 선택될 수 있다.

[0131]

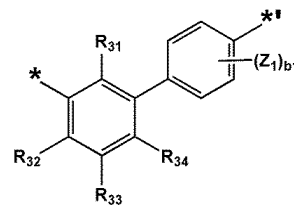
또 다른 구현예에 따르면, 상기 화학식 1 중  $a_1$  및  $a_2$ 의 합이 1 이상이고,  $-(L_1)_{a_1}-Ar_1-(L_2)_{a_2}-*$ 이 하기 화학식 3-1 내지 3-57 중 하나로 표시될 수 있으나, 이에 한정되는 것은 아니다:



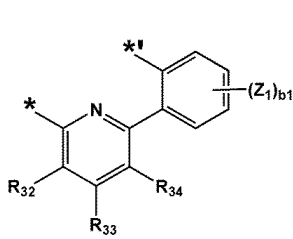
화학식 3-1



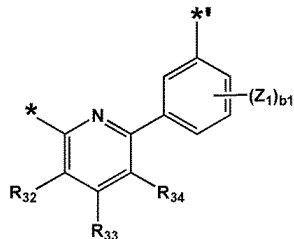
화학식 3-2



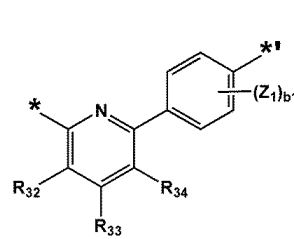
화학식 3-3



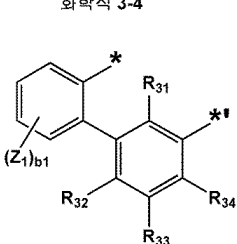
화학식 3-4



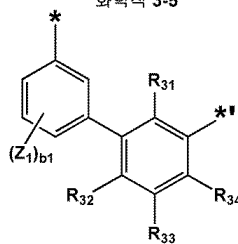
화학식 3-5



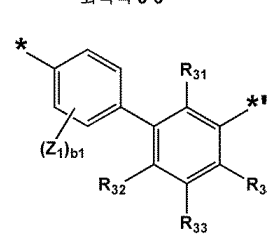
화학식 3-6



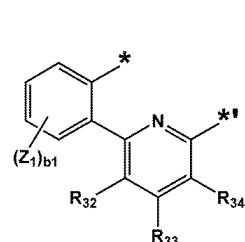
화학식 3-7



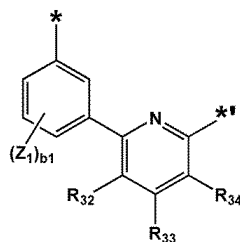
화학식 3-8



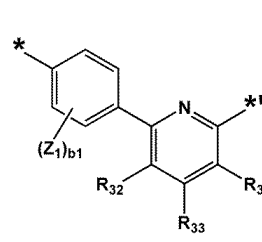
화학식 3-9



화학식 3-10

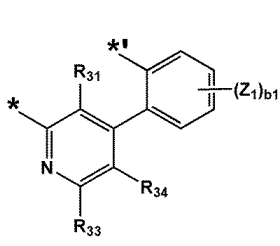


화학식 3-11

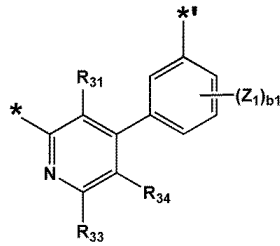


화학식 3-12

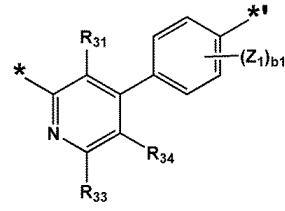
[0132]



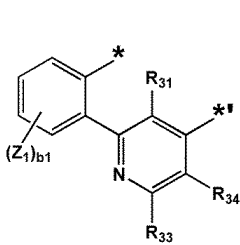
화학식 3-13



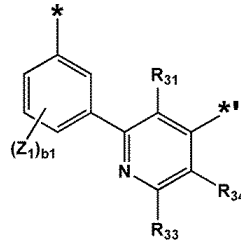
화학식 3-14



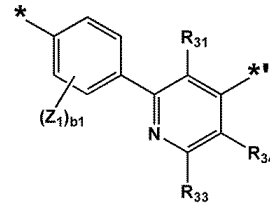
화학식 3-15



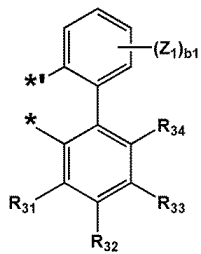
화학식 3-16



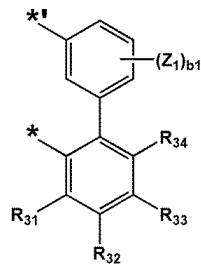
화학식 3-17



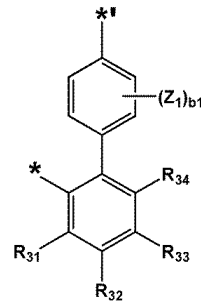
화학식 3-18



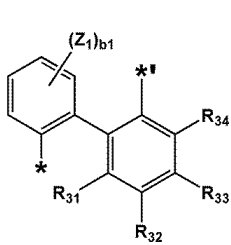
화학식 3-19



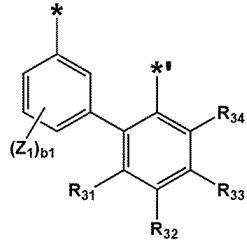
화학식 3-20



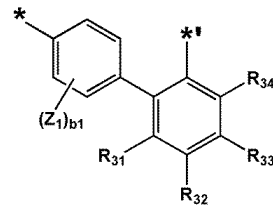
화학식 3-21



화학식 3-22

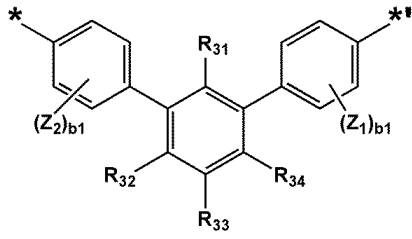


화학식 3-23

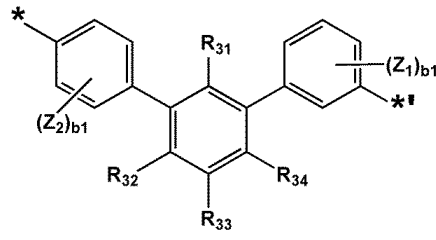


화학식 3-24

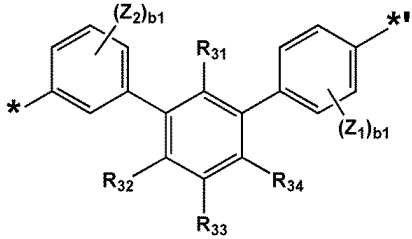
[0133]



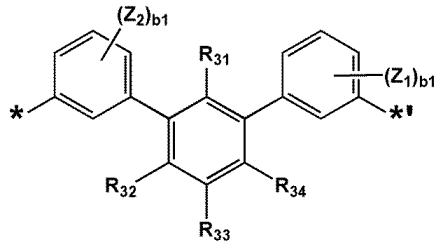
화학식 3-25



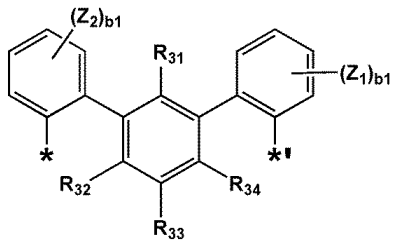
화학식 3-26



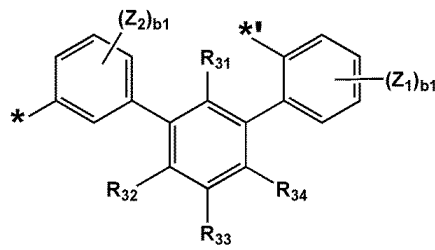
화학식 3-27



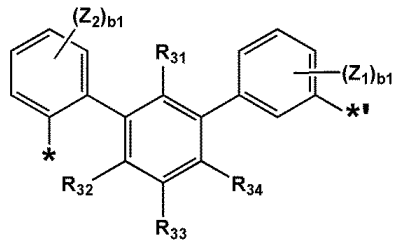
화학식 3-28



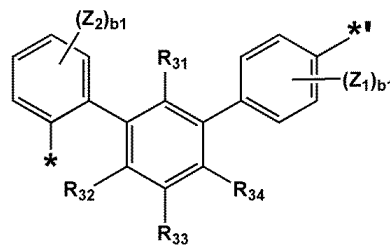
화학식 3-29



화학식 3-30



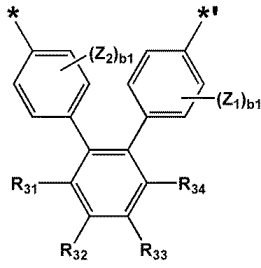
화학식 3-31



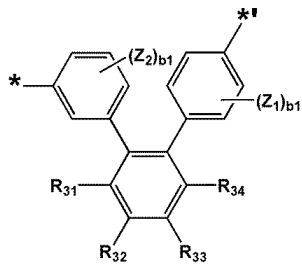
화학식 3-32

[0134]

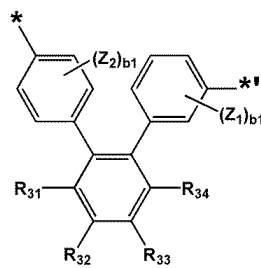




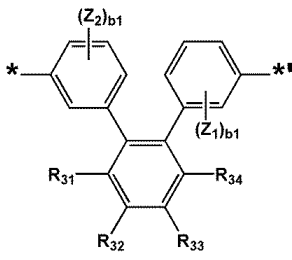
화학식 3-33



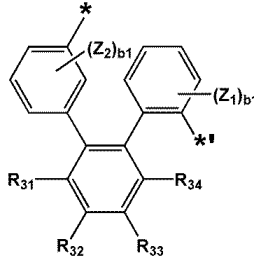
화학식 3-34



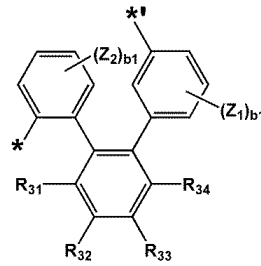
화학식 3-35



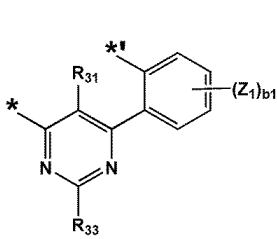
화학식 3-36



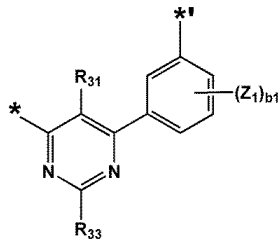
화학식 3-37



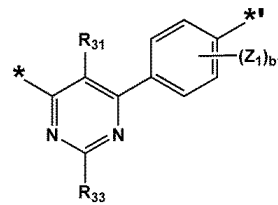
화학식 3-38



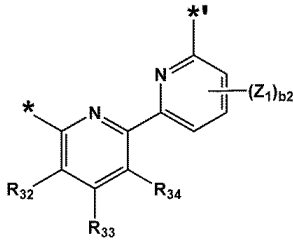
화학식 3-39



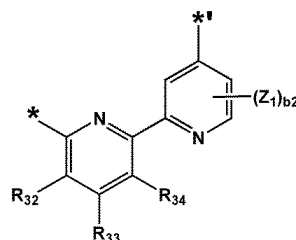
화학식 3-40



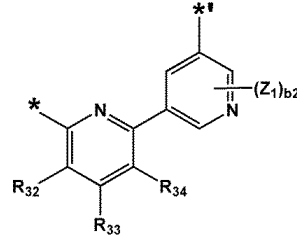
화학식 3-41



화학식 3-42

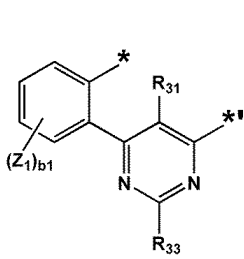


화학식 3-43

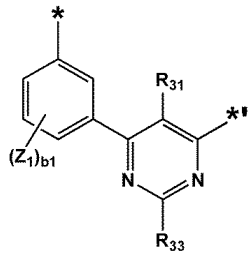


화학식 3-44

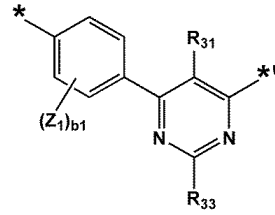
[0135]



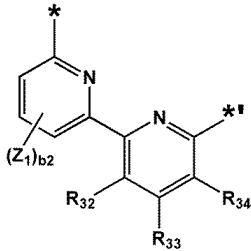
화학식 3-45



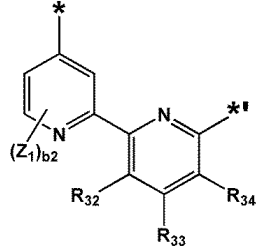
화학식 3-46



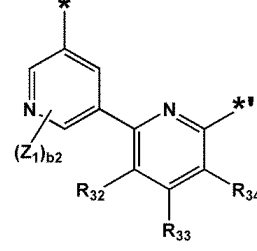
화학식 3-47



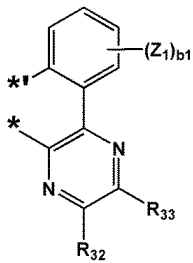
화학식 3-48



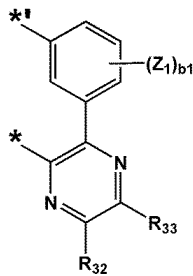
화학식 3-49



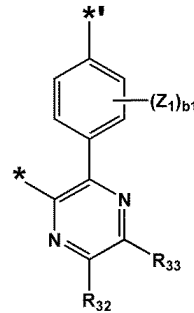
화학식 3-50



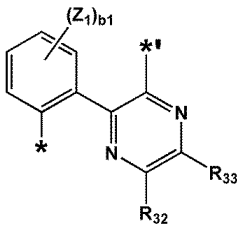
화학식 3-51



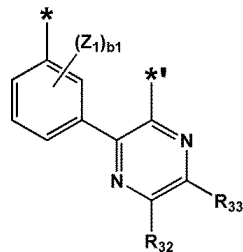
화학식 3-52



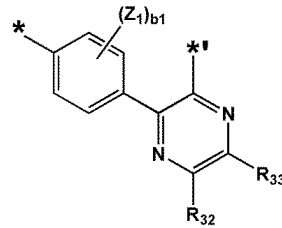
화학식 3-53



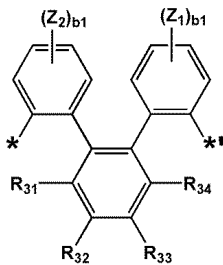
화학식 3-54



화학식 3-55



화학식 3-56



화학식 3-57

[0136]

[0137]

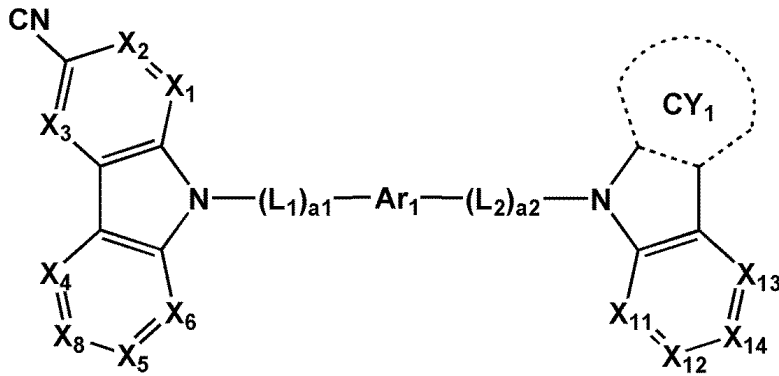
[0138]

[0139]

상기 화학식 3-1 내지 3-57 중

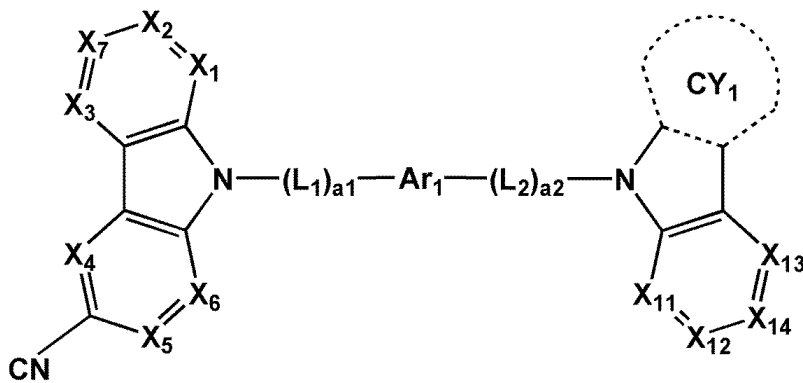
R<sub>31</sub> 내지 R<sub>34</sub>, Z<sub>1</sub> 및 Z<sub>2</sub>는 서로 독립적으로, 수소, 중수소, 시아노기, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, 페닐기, 피리디닐기, 피리미디닐기, 피라지닐기, 피라다지닐기, 트리아지닐기 및 -Si(Q<sub>11</sub>)(Q<sub>12</sub>)(Q<sub>13</sub>) 중에서 선택되고,

- [0140] 상기 Q<sub>11</sub> 내지 Q<sub>13</sub>는 서로 독립적으로, 수소, C<sub>1</sub>-C<sub>10</sub>알킬기, C<sub>1</sub>-C<sub>10</sub>알콕시기 및 페닐기 중에서 선택되고,  
 [0141] b<sub>1</sub>은 0 내지 4의 정수 중에서 선택되고, b<sub>2</sub>는 0 내지 3의 정수 중에서 선택되고,  
 [0142] \* 및 \*'은 각각 이웃한 질소 원자와의 결합 사이트이다.  
 [0143] 일 구현예에 따르면, 상기 축합환 화합물은, 하기 화학식 1(1) 내지 1(7) 중 하나로 표시될 수 있다:  
 [0144] <화학식 1(1)>



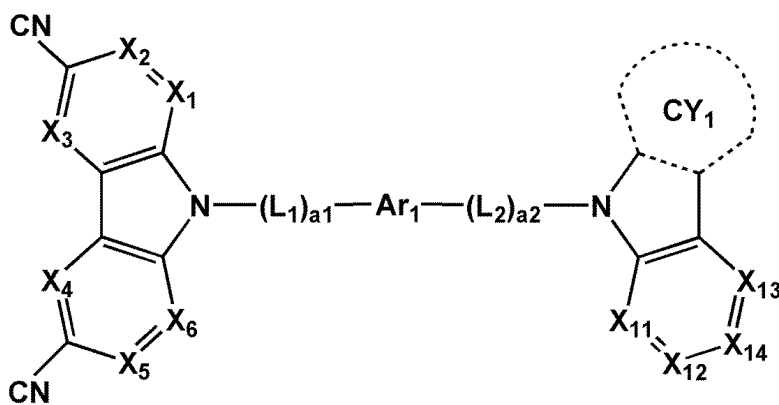
[0145]

[0146] <화학식 1(2)>



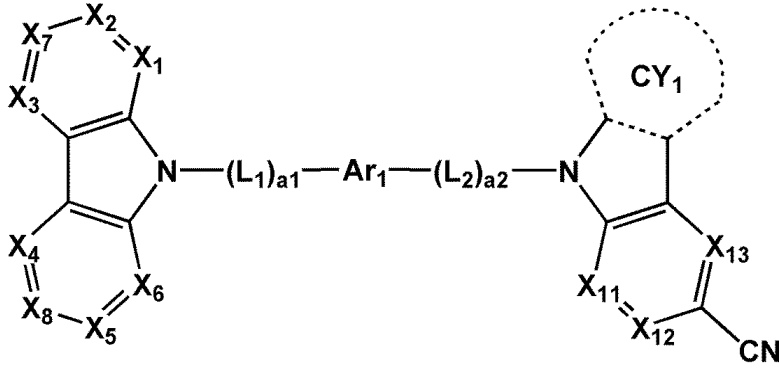
[0147]

[0148] <화학식 1(3)>



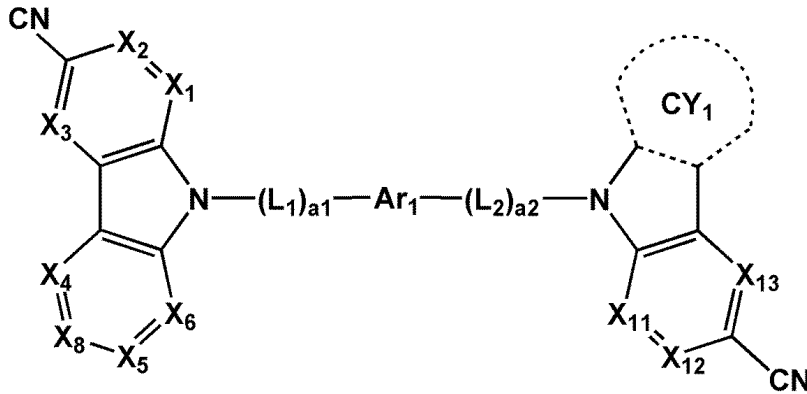
[0149]

[0150] <화학식 1(4)>



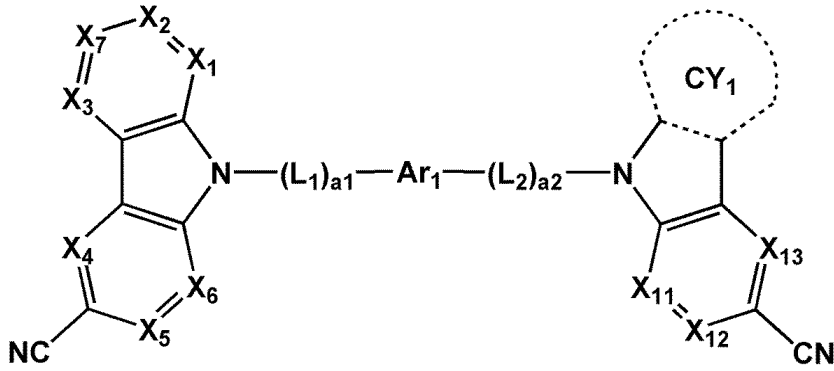
[0151]

[0152] <화학식 1(5)>



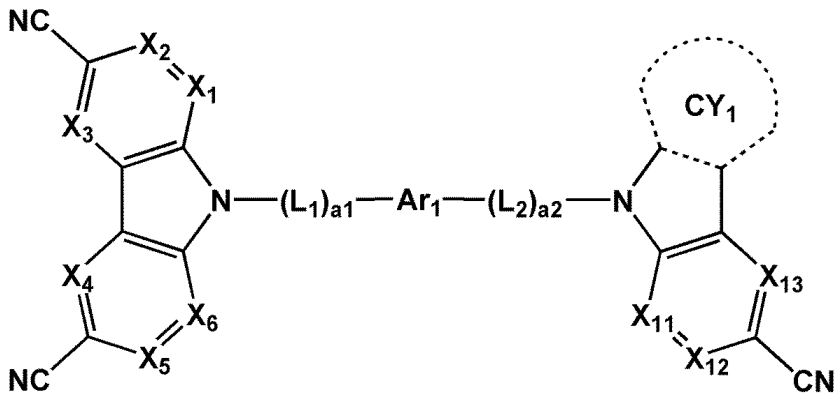
[0153]

[0154] <화학식 1(6)>



[0155]

[0156] <화학식 1(7)>



[0157]

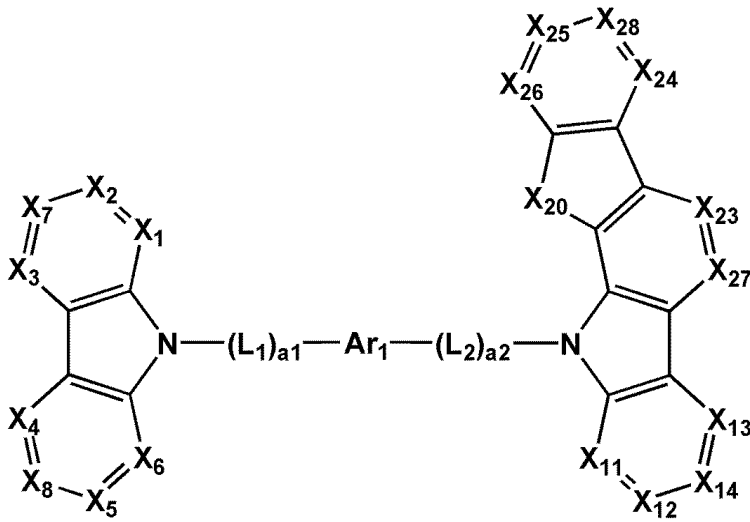
[0158] 상기 화학식 1(1) 내지 1(7) 중, X<sub>1</sub> 내지 X<sub>8</sub>, X<sub>11</sub> 내지 X<sub>14</sub>, CY<sub>1</sub>, Ar<sub>1</sub>, L<sub>1</sub>, L<sub>2</sub>, a<sub>1</sub> 및 a<sub>2</sub>는 본 명세서에 기재된 바

를 참조한다.

[0159] 예를 들어, X<sub>1</sub>은 N 또는 C(R<sub>1</sub>)이고, X<sub>2</sub>는 N 또는 C(R<sub>2</sub>)이고, X<sub>3</sub>은 N 또는 C(R<sub>3</sub>)이고, X<sub>4</sub>는 N 또는 C(R<sub>4</sub>)이고, X<sub>5</sub>는 N 또는 C(R<sub>5</sub>)이고, X<sub>6</sub>은 N 또는 C(R<sub>6</sub>)이고, X<sub>11</sub>은 N 또는 C(R<sub>11</sub>)이고, X<sub>12</sub>는 N 또는 C(R<sub>12</sub>)이고, X<sub>13</sub>은 N 또는 C(R<sub>13</sub>)이고, X<sub>1</sub> 내지 X<sub>8</sub> 및 X<sub>11</sub> 내지 X<sub>13</sub>은 C(CN)이 아닐 수 있다.

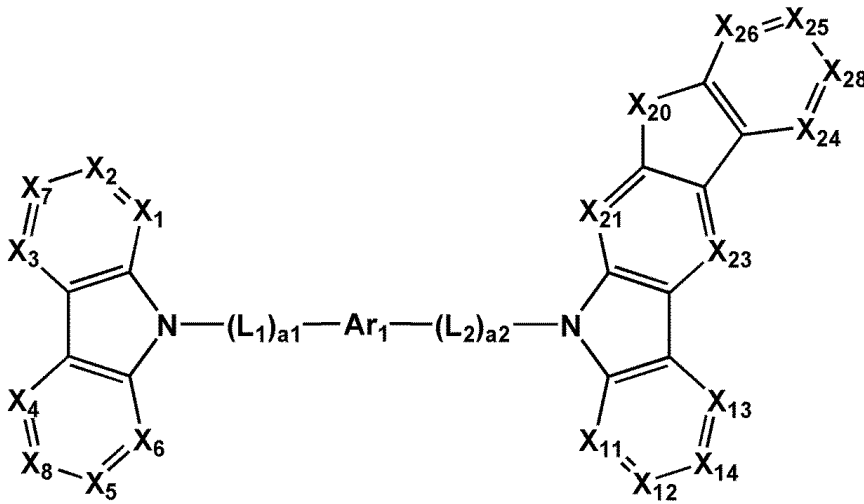
[0160] 다른 구현예에 따르면, 상기 화학식 1로 표시되는 축합환 화합물은 하기 화학식 1A 내지 1F 중 하나로 표시될 수 있다:

[0161] <화학식 1A>



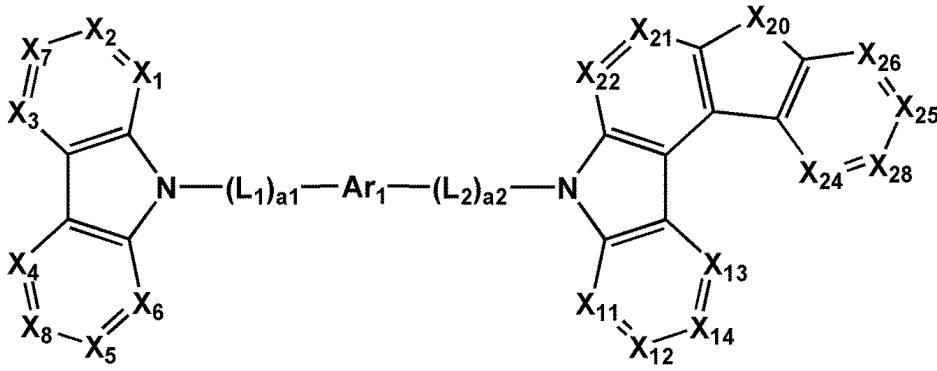
[0162]

[0163] <화학식 1B>



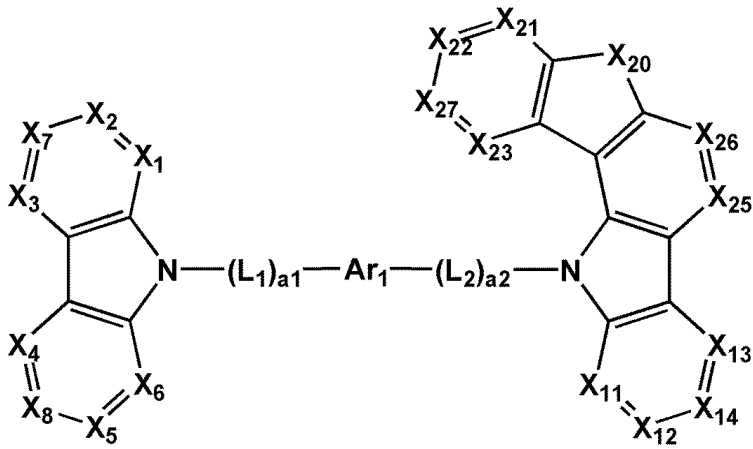
[0164]

[0165] <화학식 1C>



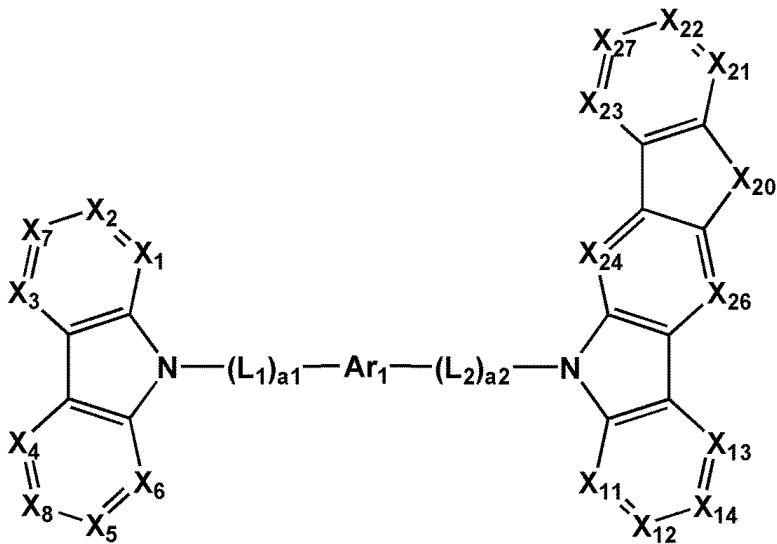
[0166]

[0167] <화학식 1D>



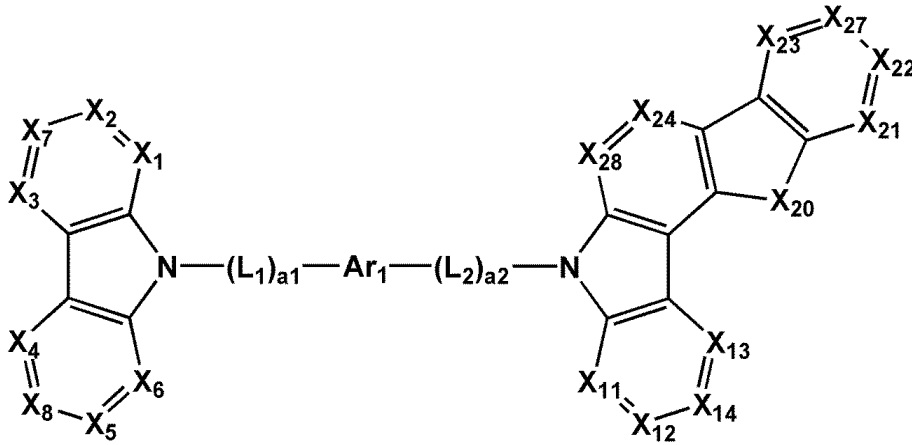
[0168]

[0169] <화학식 1E>



[0170]

[0171] <화학식 1F>



[0172]

[0173] 상기 화학식 1A 내지 1F 중, X<sub>1</sub> 내지 X<sub>8</sub>, X<sub>11</sub> 내지 X<sub>14</sub>, X<sub>20</sub> 내지 X<sub>28</sub>, Ar<sub>1</sub>, L<sub>1</sub>, L<sub>2</sub>, a<sub>1</sub> 및 a<sub>2</sub>에 대한 설명은 본 명세서에 기재된 바를 참조한다.

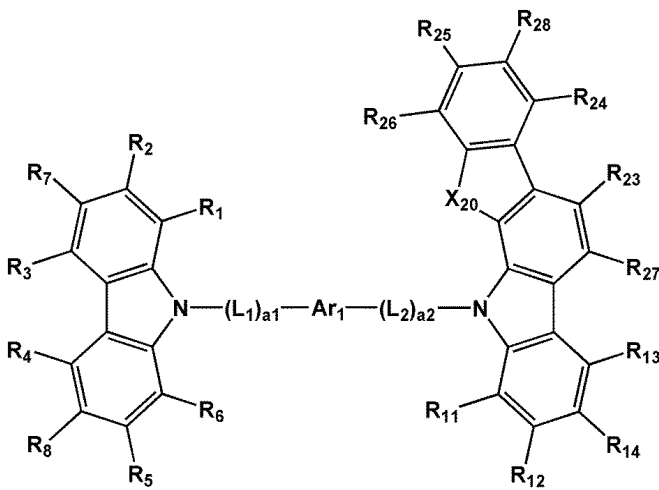
[0174] 예를 들어, 상기 화학식 1A 내지 1F 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>21</sub>, X<sub>26</sub>, X<sub>27</sub> 및 X<sub>28</sub> 중 적어도 하나는 C(CN)일 수 있다.

[0175] 다른 예로서, 상기 화학식 1A 내지 1F 중, X<sub>7</sub>, X<sub>8</sub>, X<sub>14</sub>, X<sub>21</sub>, X<sub>26</sub>, X<sub>27</sub> 및 X<sub>28</sub> 중 적어도 2개는 C(CN)일 수 있다.

[0176] 또 다른 예로서, 상기 화학식 1A 내지 1F 중, X<sub>7</sub> 및 X<sub>8</sub> 중 적어도 하나는 C(CN)일 수 있다.

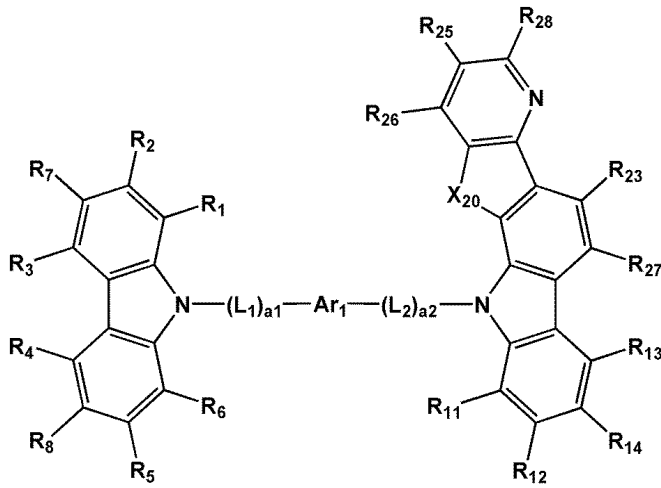
[0177] 또 다른 구현예에 따르면, 상기 화학식 1로 표시되는 축합환 화합물은, 하기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중 하나로 표시될 수 있으나, 이에 한정되는 것은 아니다:

[0178] <화학식 1A(1)>



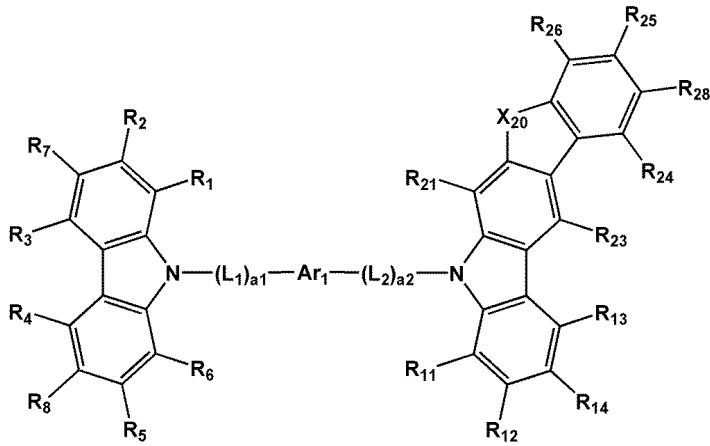
[0179]

[0180] <화학식 1A(2)>



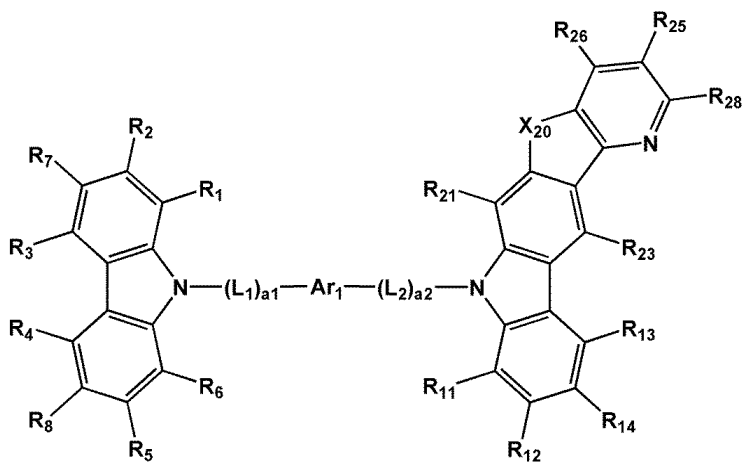
[0181]

[0182] <화학식 1B(1)>



[0183]

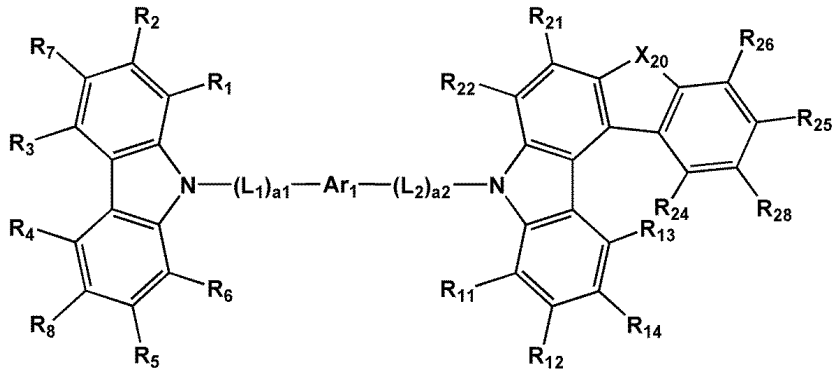
[0184] <화학식 1B(2)>



[0185]

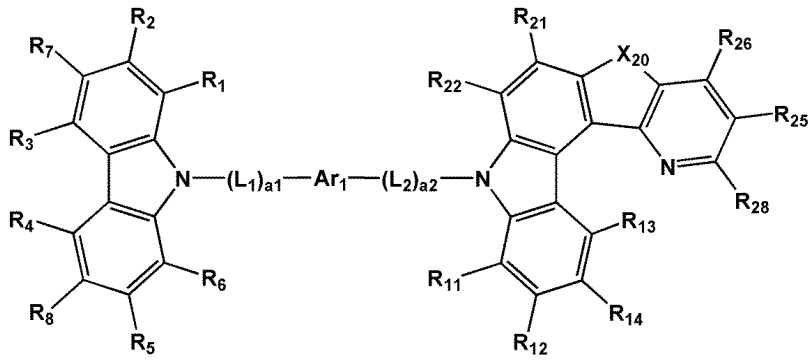


[0186] <화학식 1C(1)>



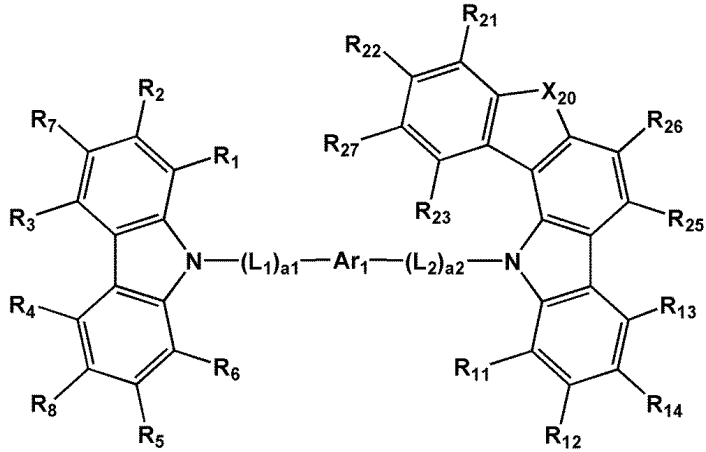
[0187]

[0188] <화학식 1C(2)>



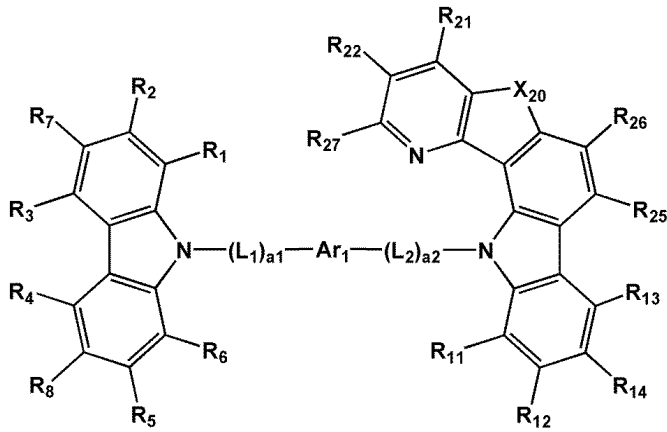
[0189]

[0190] <화학식 1D(1)>



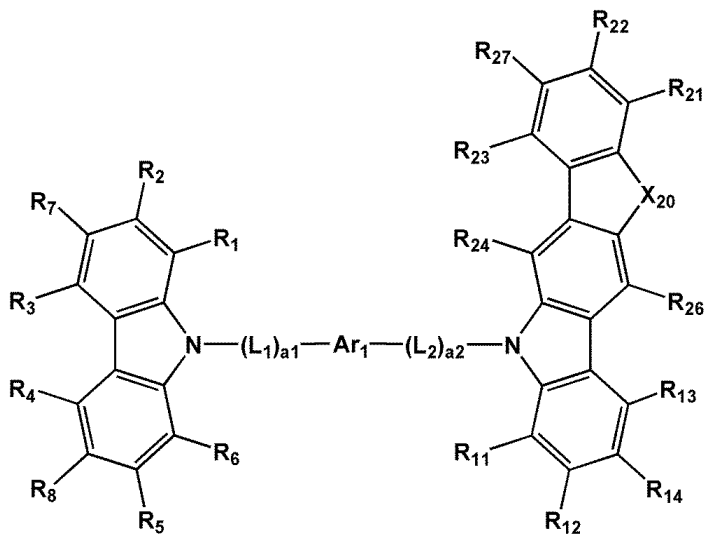
[0191]

[0192] <화학식 1D(2)>



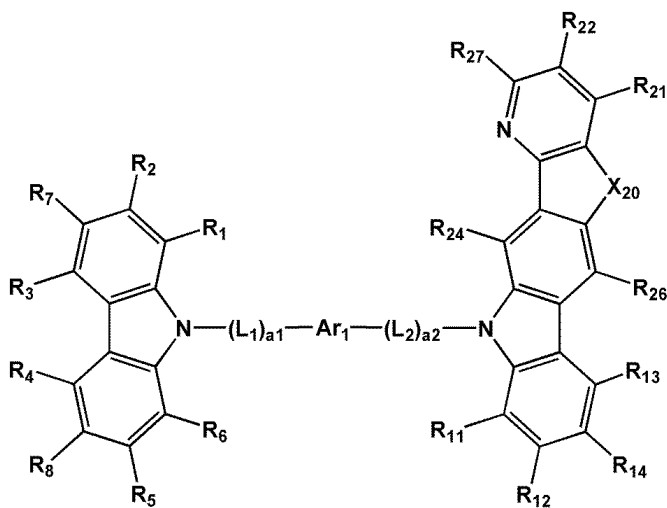
[0193]

[0194] <화학식 1E(1)>



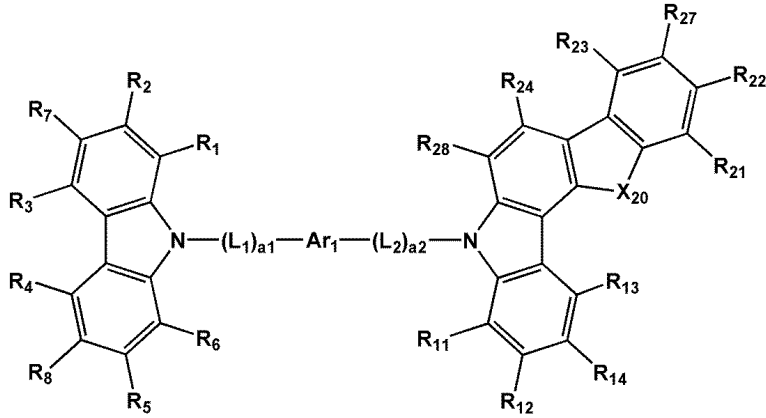
[0195]

[0196] <화학식 1E(2)>



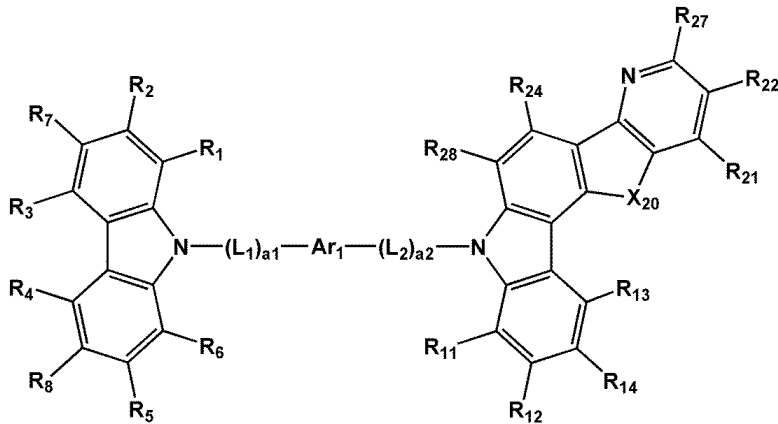
[0197]

[0198] <화학식 1F(1)>



[0199]

[0200] <화학식 1F(2)>



[0201]

[0202] 상기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중,

[0203] Ar<sub>1</sub>, L<sub>1</sub>, L<sub>2</sub>, a<sub>1</sub>, a<sub>2</sub> 및 X<sub>20</sub>은 본 명세서에 기재된 바를 참조하고,

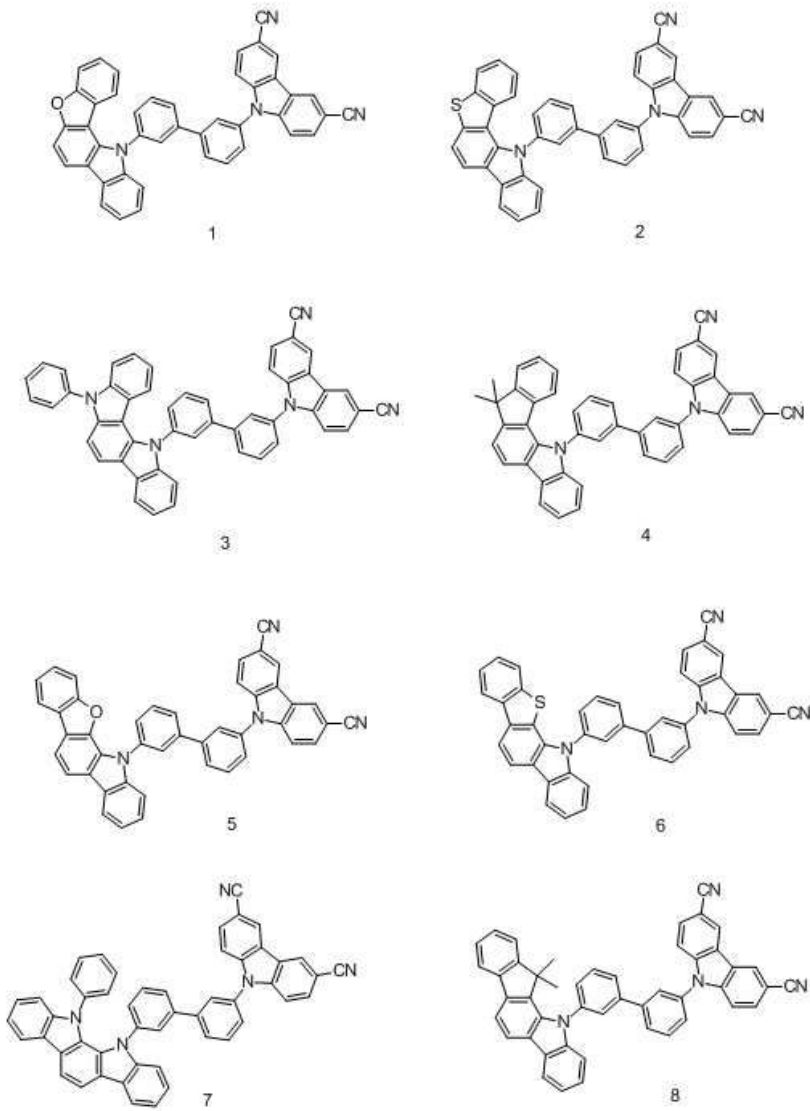
[0204] R<sub>1</sub> 내지 R<sub>8</sub>, R<sub>11</sub> 내지 R<sub>14</sub> 및 R<sub>20</sub> 내지 R<sub>29</sub>는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, 메틸기, 에틸기, n-프로필기, 이소프로필기, n-부틸기, 이소부틸기, sec-부틸기, tert-부틸기, n-펜틸기, 이소펜틸기, sec-펜틸기, tert-펜틸기, n-헥실기, 이소헥실기, sec-헥실기, tert-헥실기, n-헵틸기, 이소헵틸기, sec-헵틸기, tert-헵틸기, n-옥틸기, 이소옥틸기, sec-옥틸기, tert-옥틸기, n-노닐기, 이소노닐기, sec-노닐기, tert-노닐기, n-데실기, 이소데실기, sec-데실기, tert-데실기, 메톡시기, 에톡시기, 프로폭시기, 부톡시기, 펜톡시기, 페닐기, 나프틸기, 피리디닐기, 피리미디닐기, 트리아지닐기 및 -Si(Q<sub>1</sub>)(Q<sub>2</sub>)(Q<sub>3</sub>) 중에서 선택되고,

[0205] R<sub>7</sub>, R<sub>8</sub>, R<sub>14</sub>, R<sub>27</sub> 및 R<sub>28</sub> 중 적어도 하나는 시아노기일 수 있다.

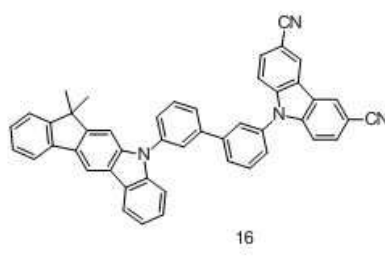
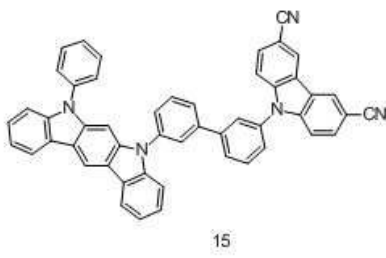
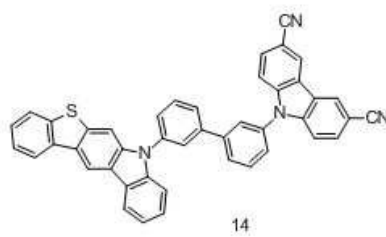
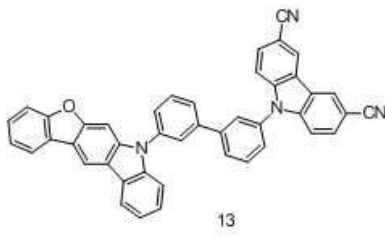
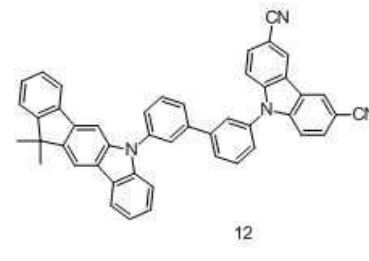
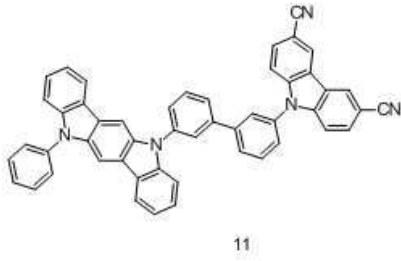
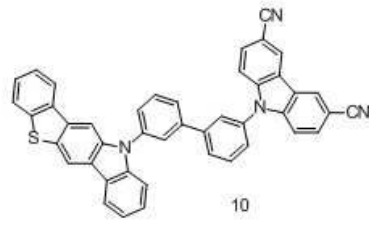
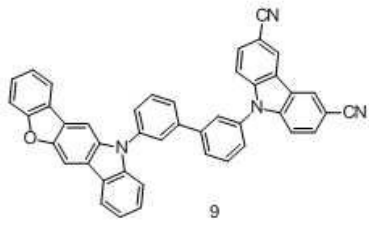
[0206] 예를 들어, 상기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중, R<sub>7</sub> 및 R<sub>8</sub> 중 적어도 하나는 시아노기일 수 있다.

[0207] 다른 예로서, 상기 화학식 1A(1), 1A(2), 1B(1), 1B(2), 1C(1), 1C(2), 1D(1), 1D(2), 1E(1), 1E(2), 1F(1) 및 1F(2) 중, R<sub>7</sub>, R<sub>8</sub>, R<sub>14</sub>, R<sub>27</sub> 및 R<sub>28</sub> 중 적어도 하나는 시아노기이고, R<sub>1</sub> 내지 R<sub>6</sub>, R<sub>11</sub> 내지 R<sub>13</sub>, R<sub>20</sub> 및 R<sub>29</sub>는 시아노기가 아닐 수 있다.

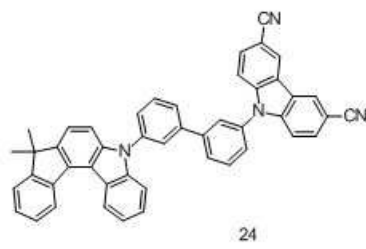
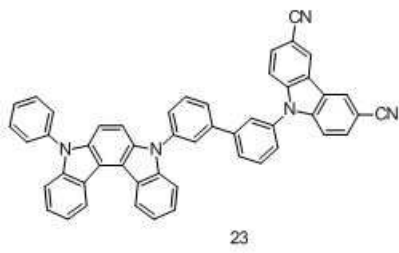
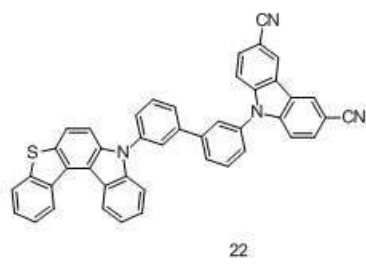
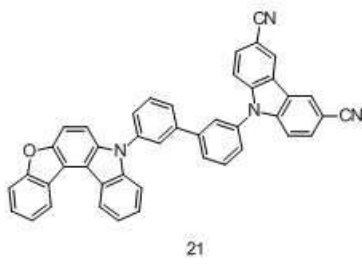
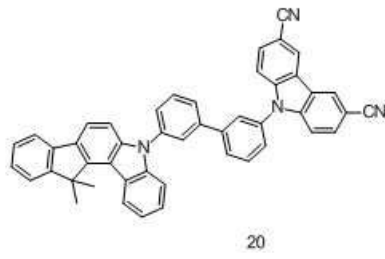
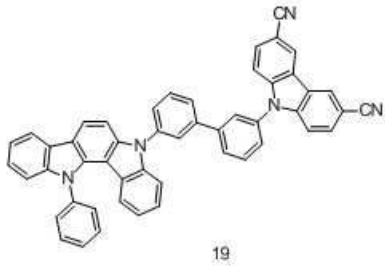
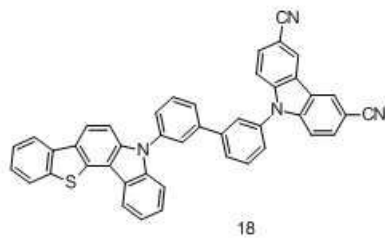
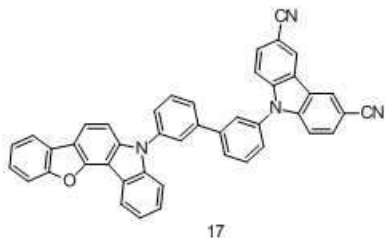
[0208] 상기 축합환 화합물은 하기 화합물 1 내지 876 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다:



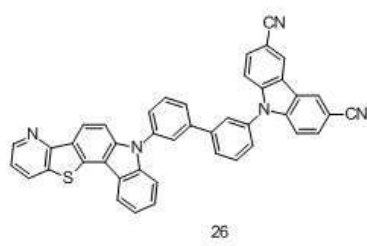
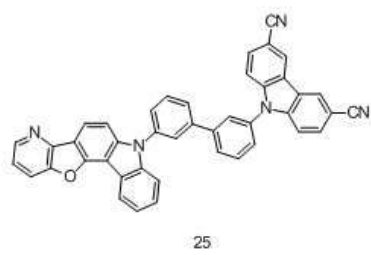
[0209]



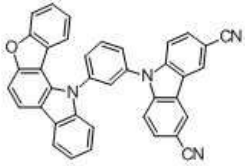
[0210]



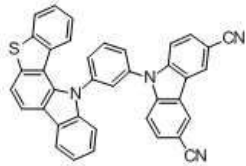
[0211]



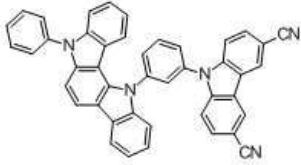
[0212]



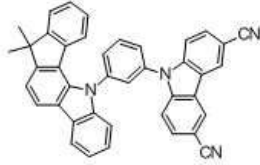
27



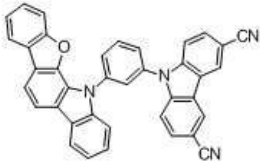
28



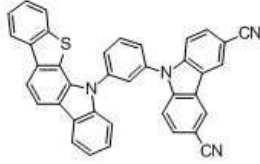
29



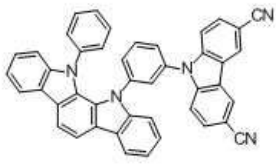
30



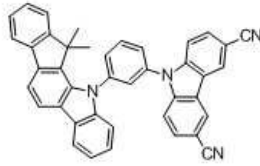
31



32

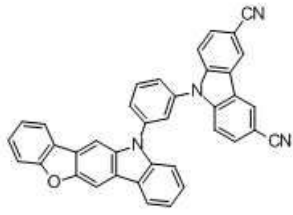


33

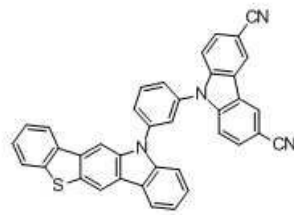


34

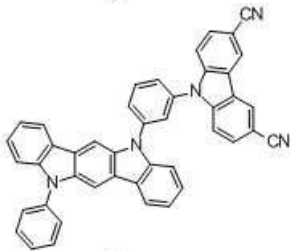
[0213]



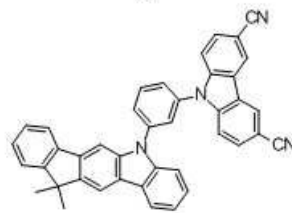
35



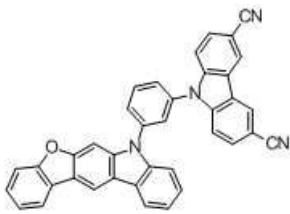
36



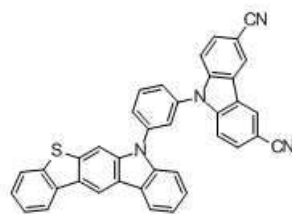
37



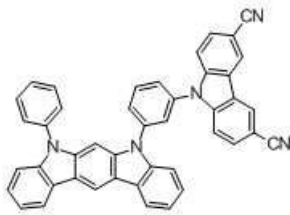
38



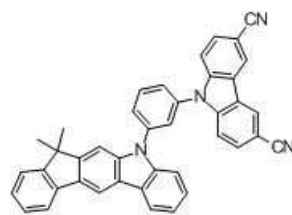
39



40



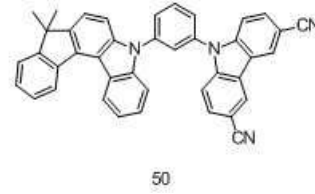
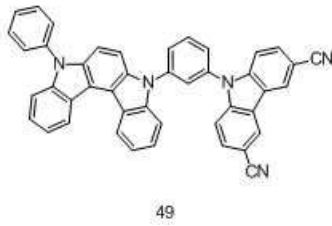
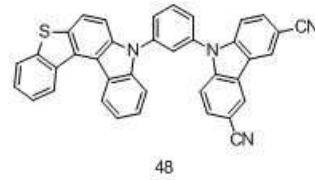
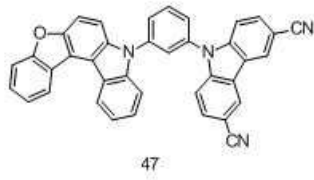
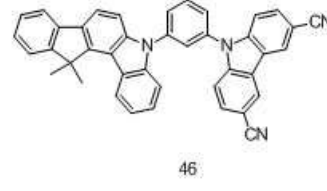
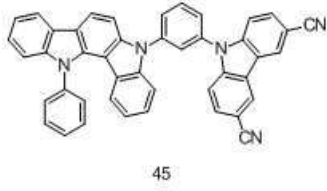
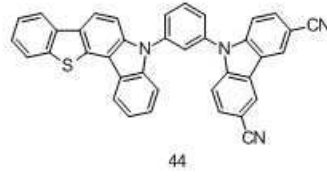
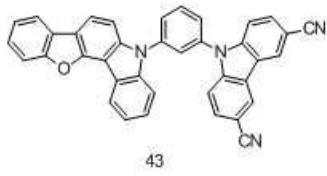
41



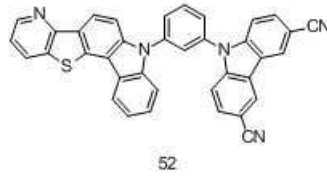
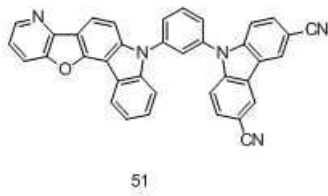
42

[0214]

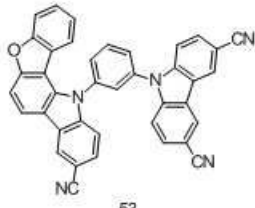




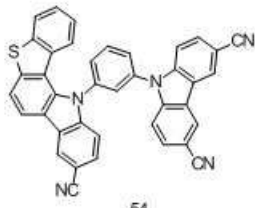
[0215]



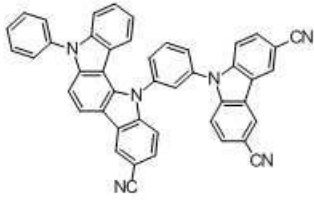
[0216]



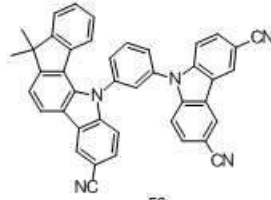
53



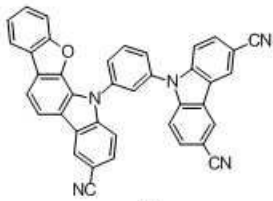
54



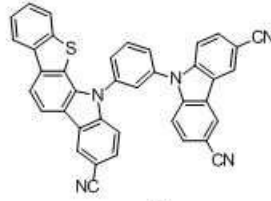
55



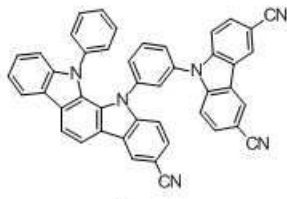
56



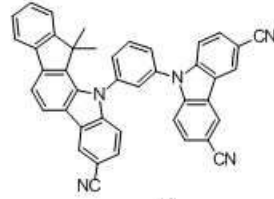
57



58

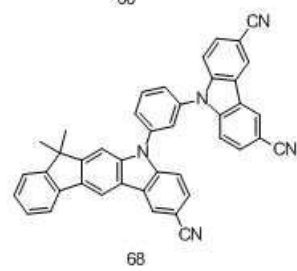
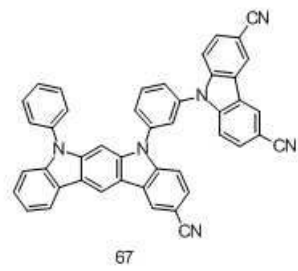
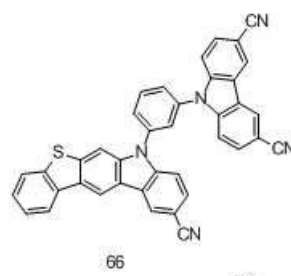
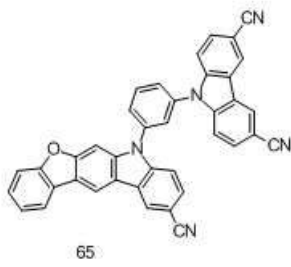
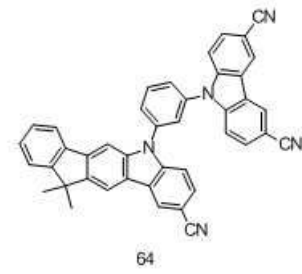
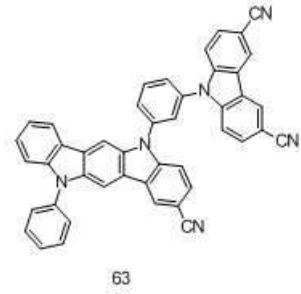
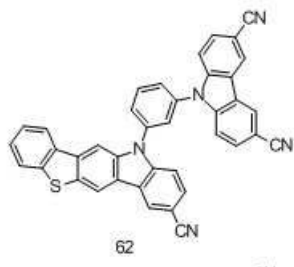
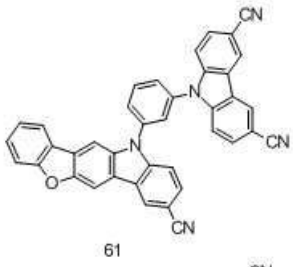


59

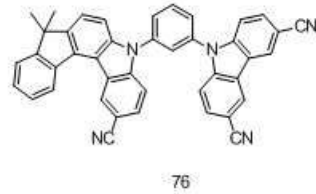
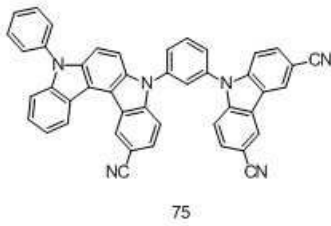
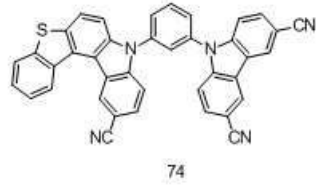
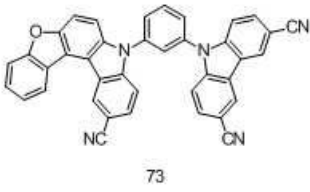
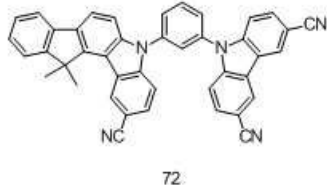
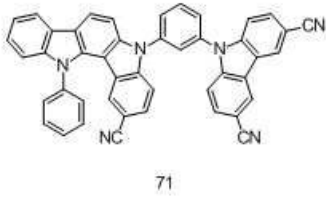
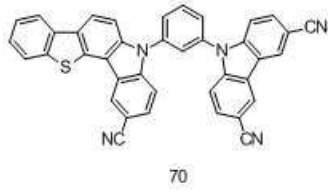
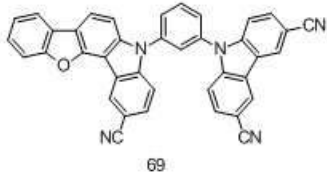


60

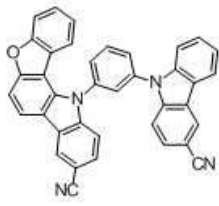
[0217]



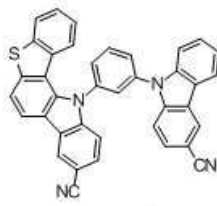
[0218]



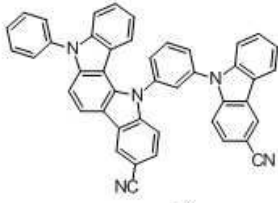
[0219]



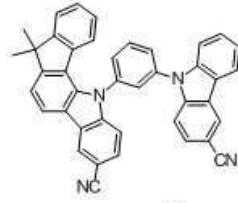
77



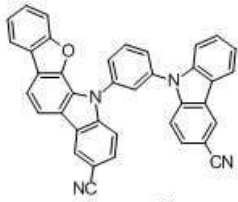
78



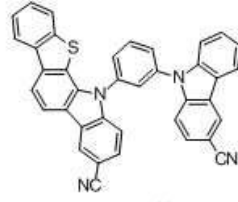
79



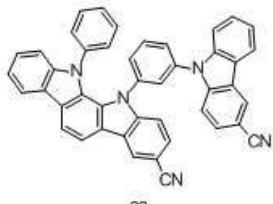
80



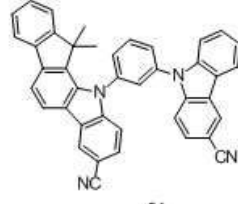
81



82

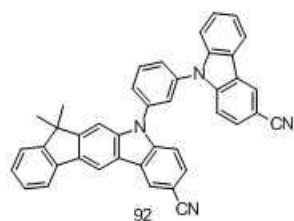
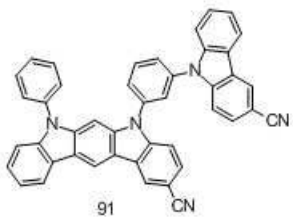
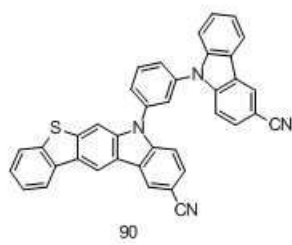
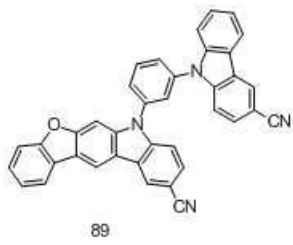
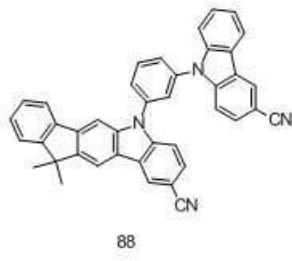
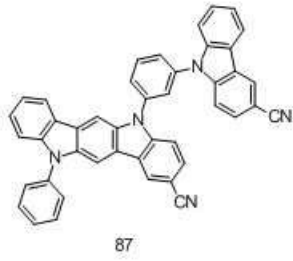
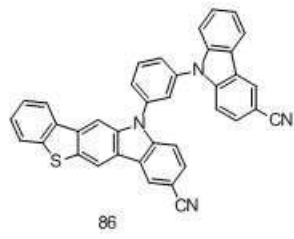
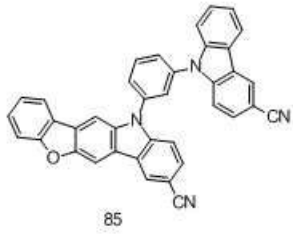


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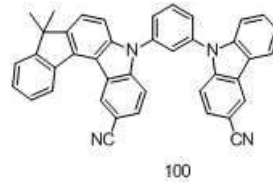
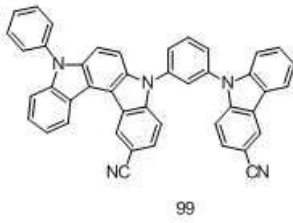
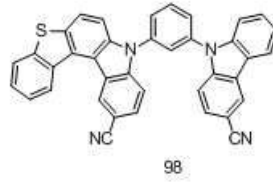
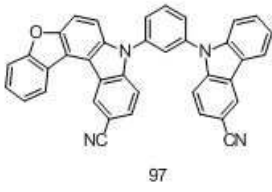
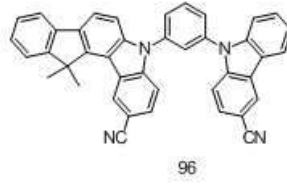
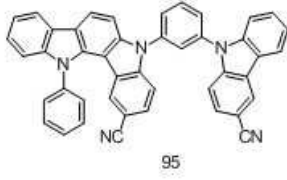
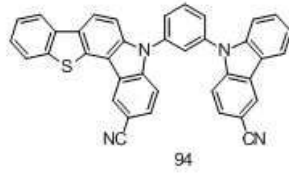
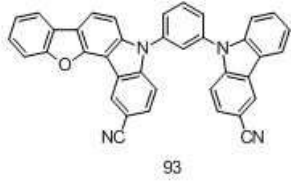


84

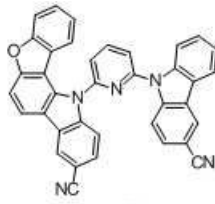
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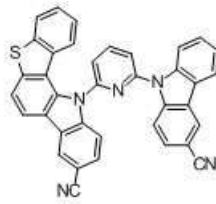
[0221]



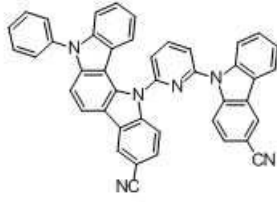
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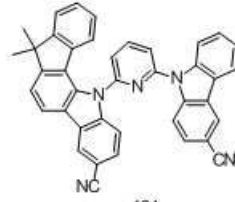
101



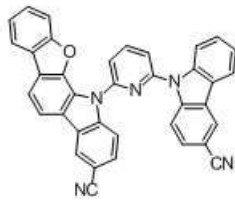
102



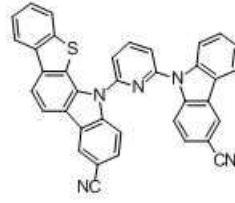
103



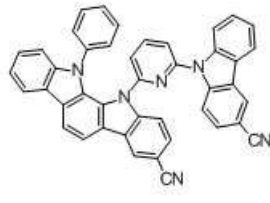
104



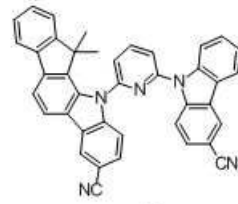
105



106



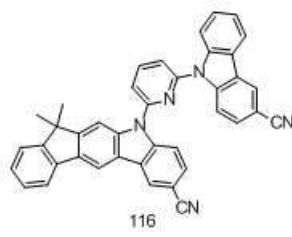
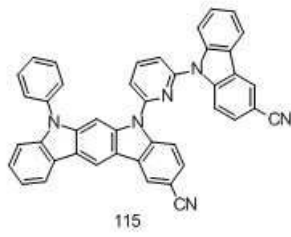
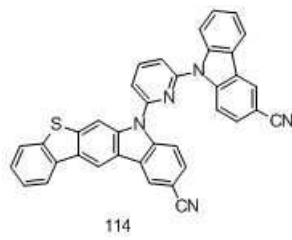
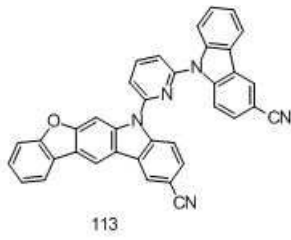
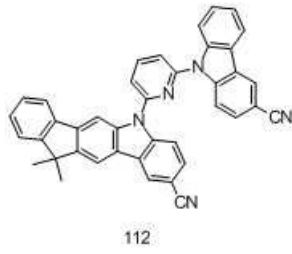
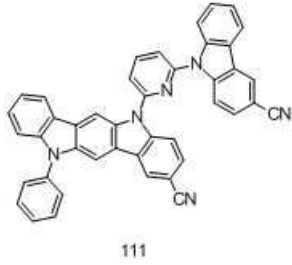
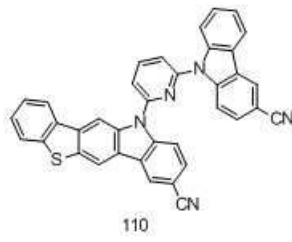
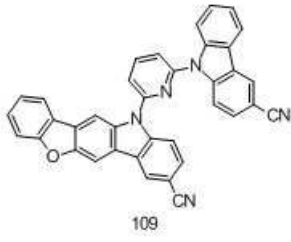
107



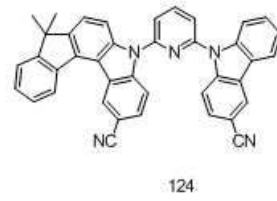
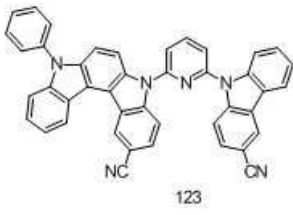
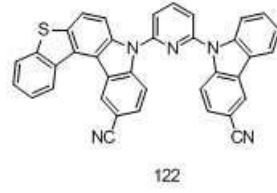
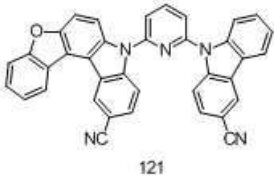
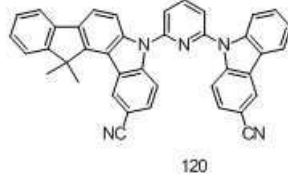
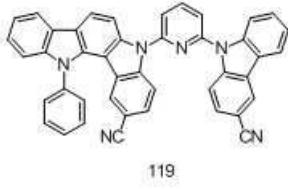
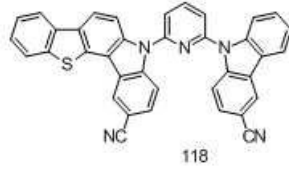
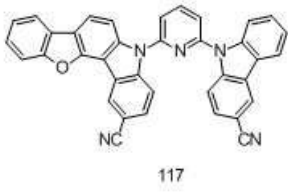
108

[0223]

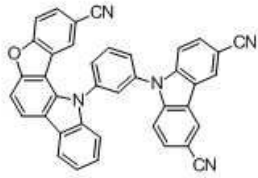




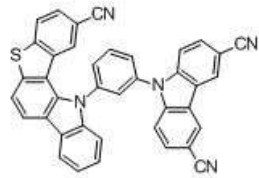
[0224]



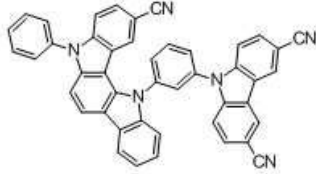
[0225]



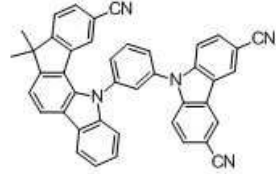
125



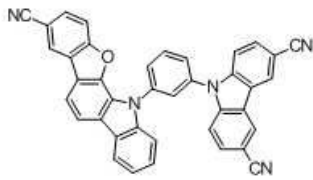
126



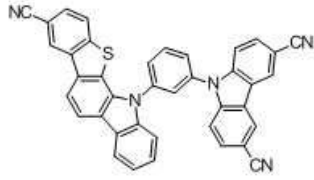
127



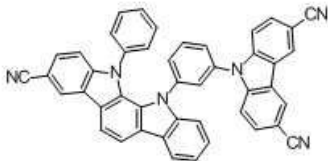
128



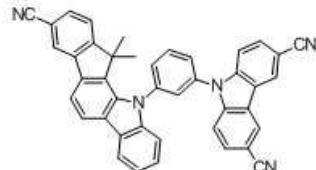
129



130

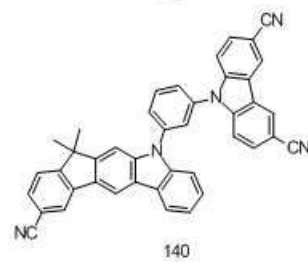
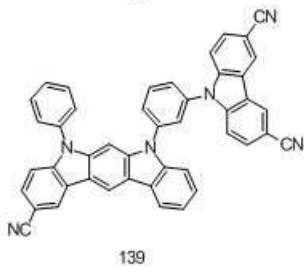
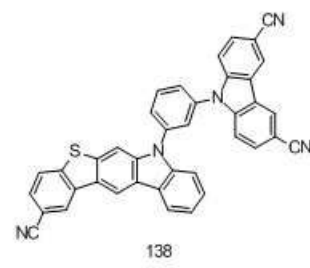
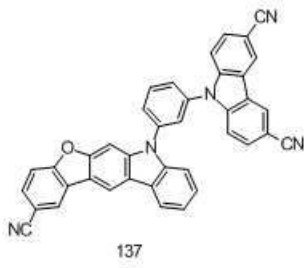
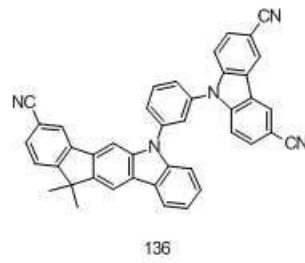
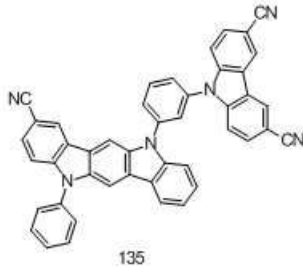
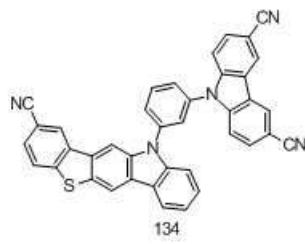
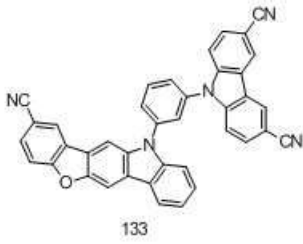


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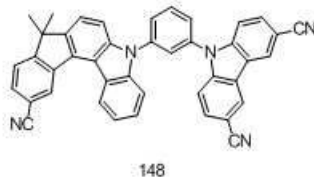
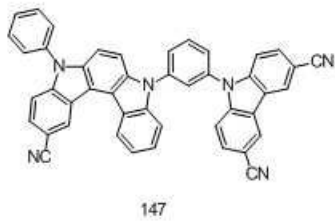
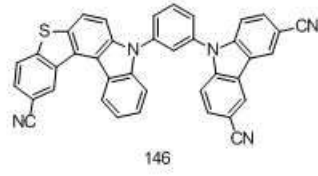
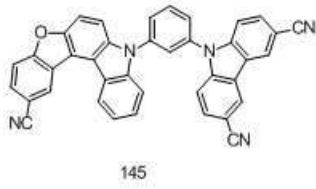
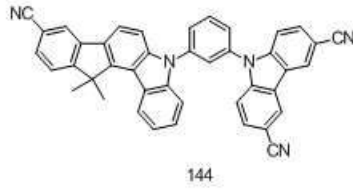
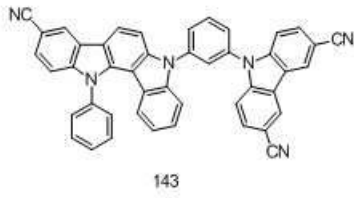
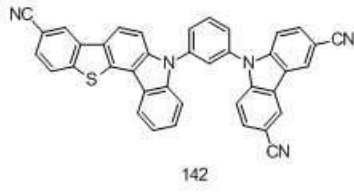
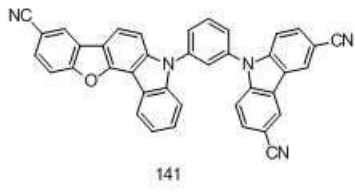


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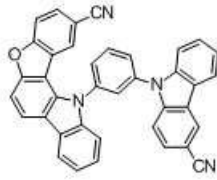
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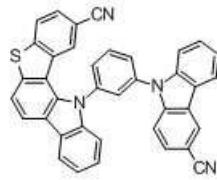
[0227]



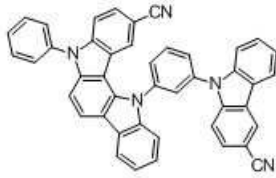
[0228]



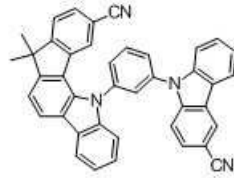
149



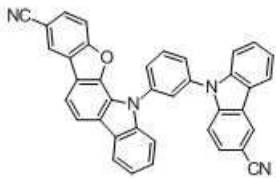
150



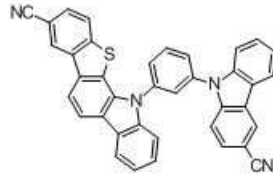
151



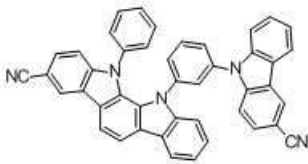
152



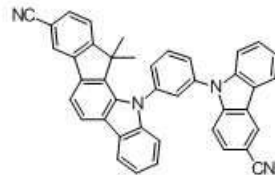
153



154

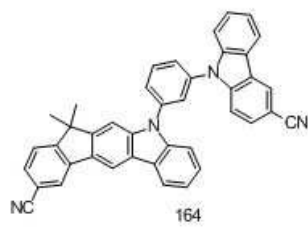
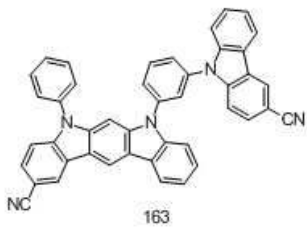
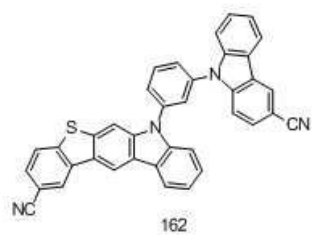
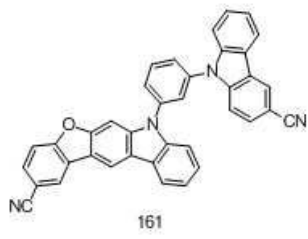
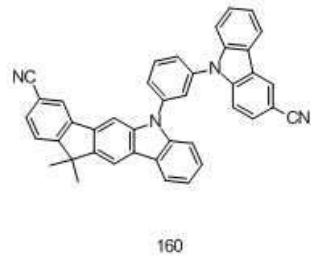
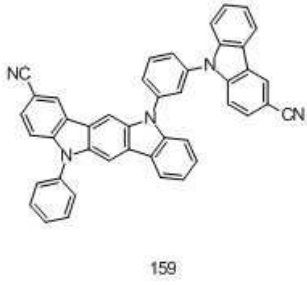
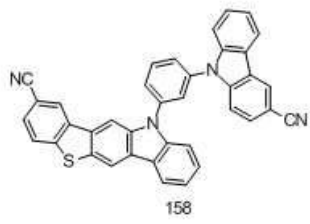
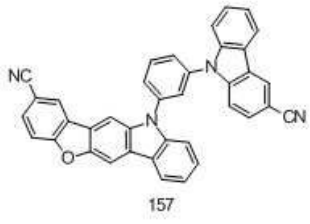


155

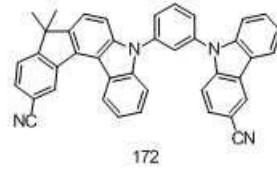
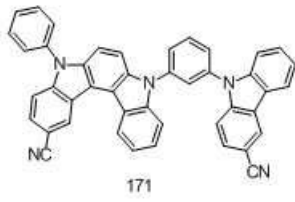
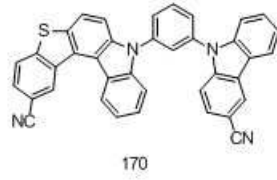
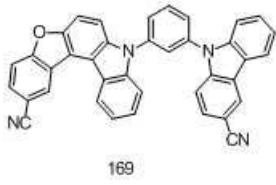
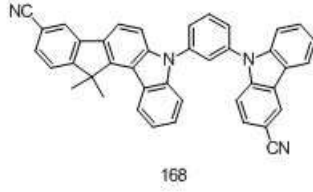
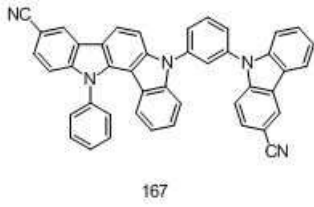
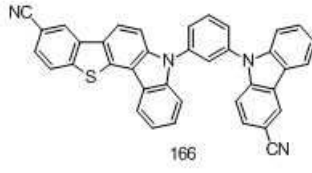
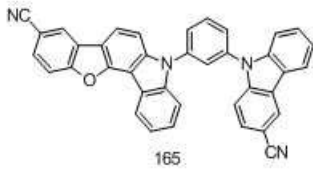


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[0229]

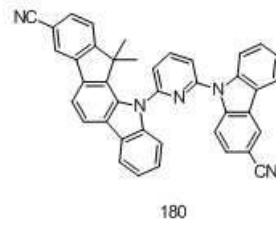
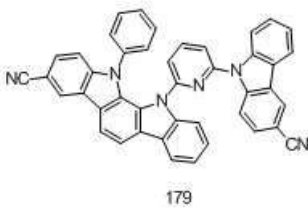
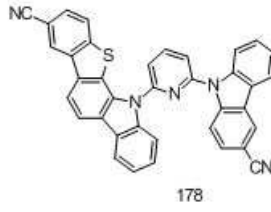
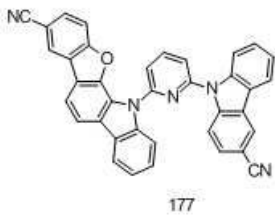
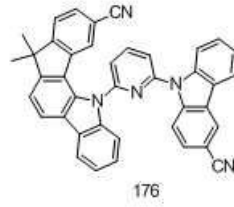
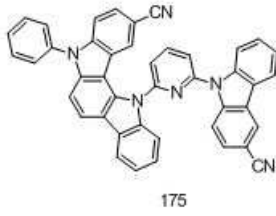
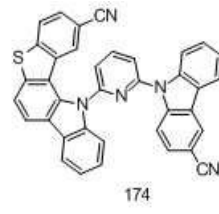
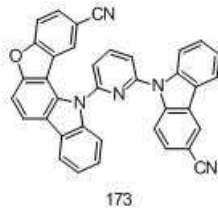


[0230]

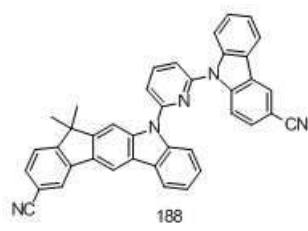
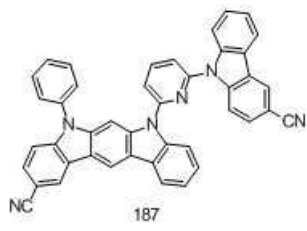
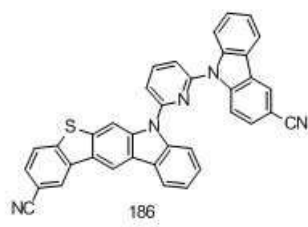
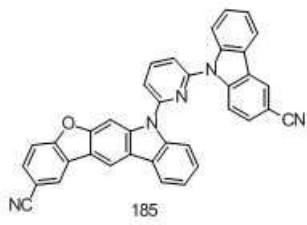
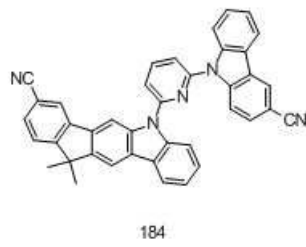
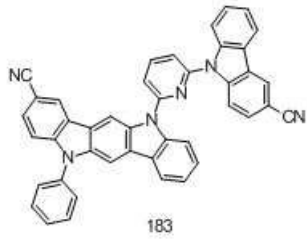
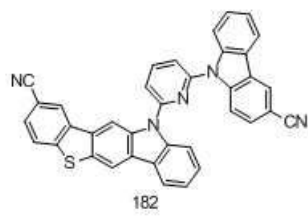
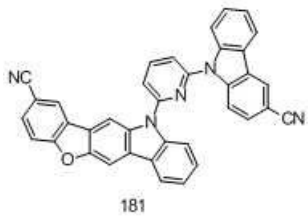


[0231]

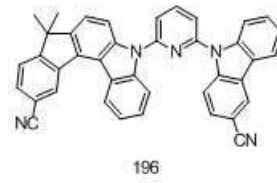
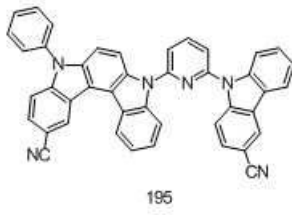
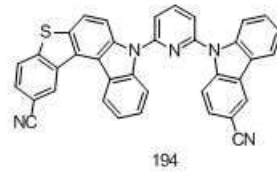
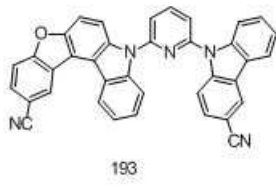
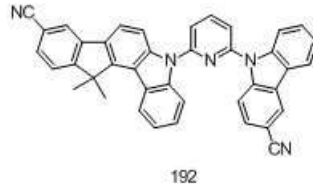
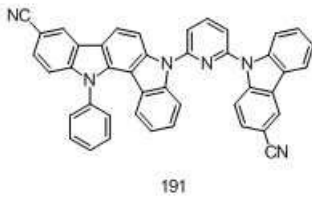
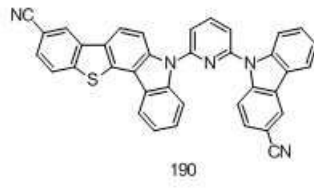
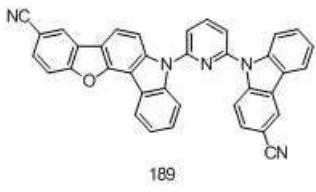




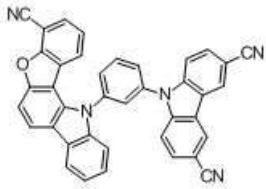
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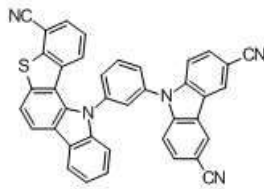
[0233]



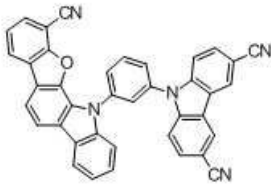
[0234]



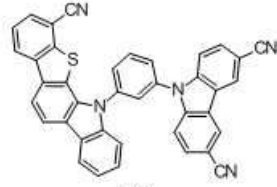
197



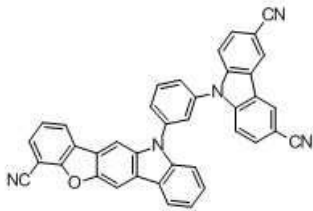
198



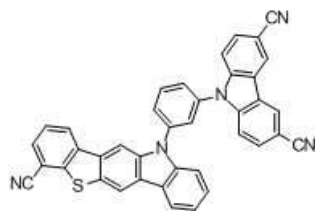
199



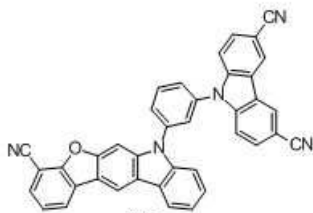
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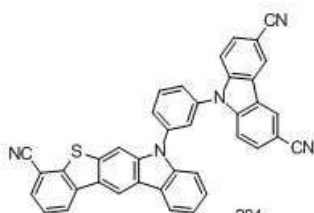
201



202

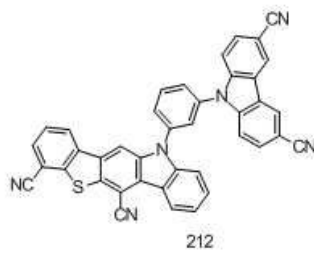
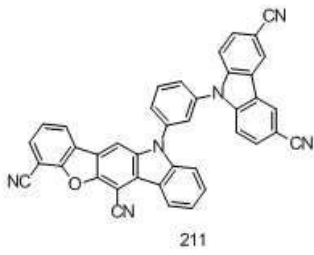
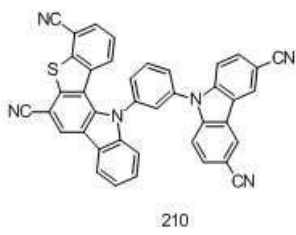
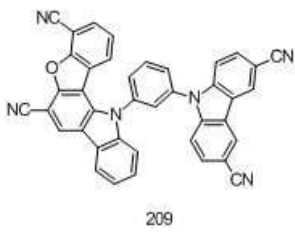
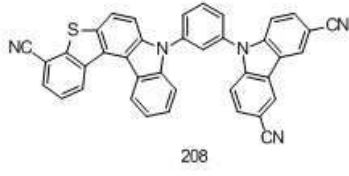
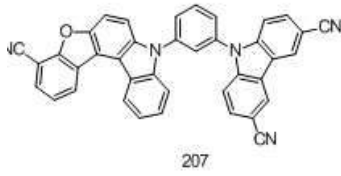
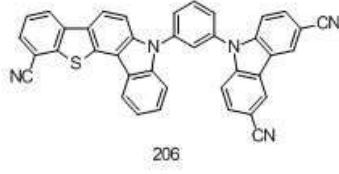
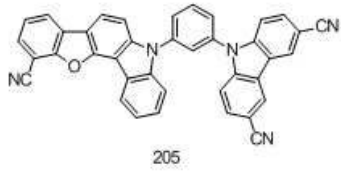


203

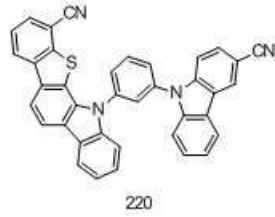
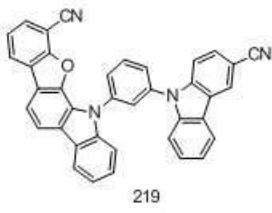
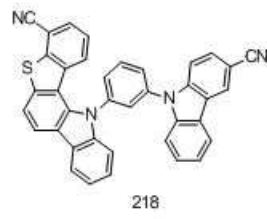
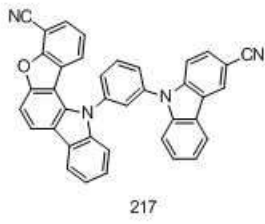
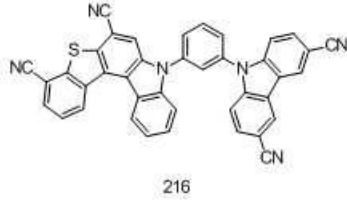
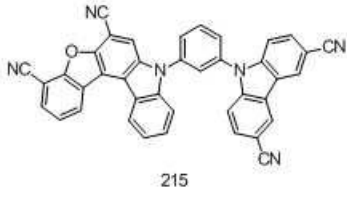
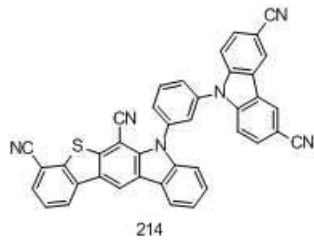
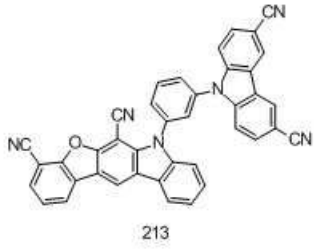


204

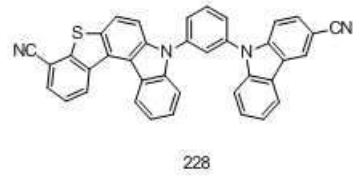
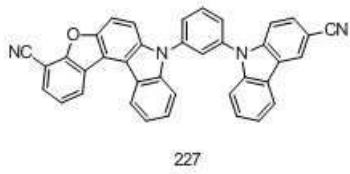
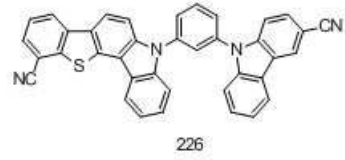
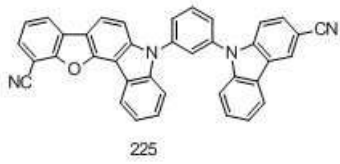
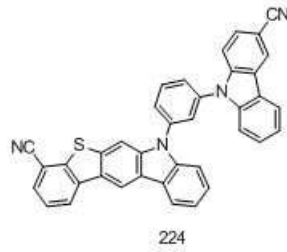
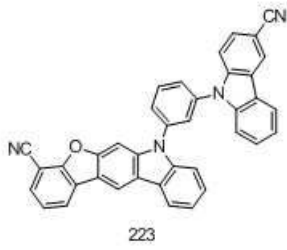
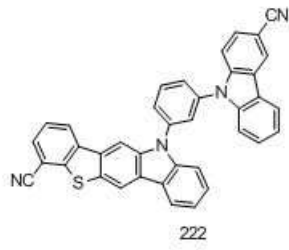
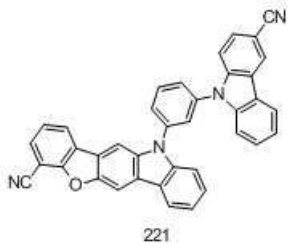
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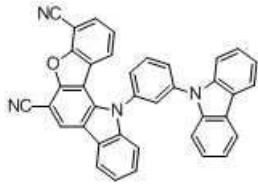
[0236]



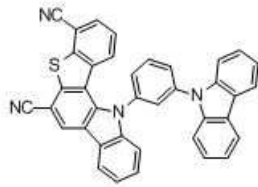
[0237]



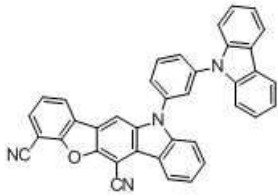
[0238]



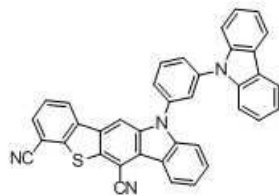
229



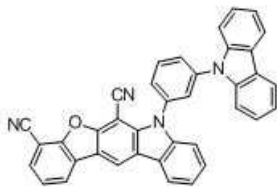
230



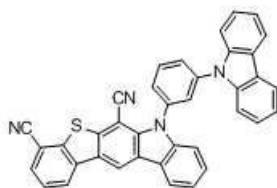
231



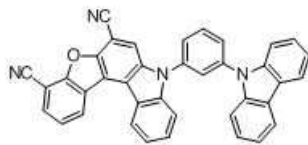
232



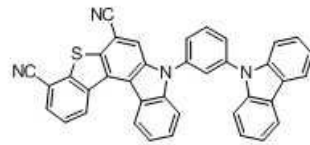
233



234



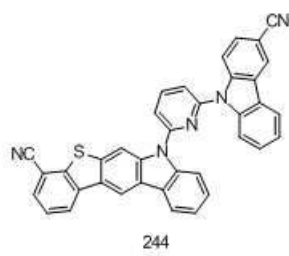
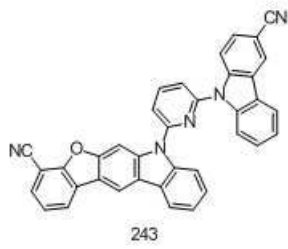
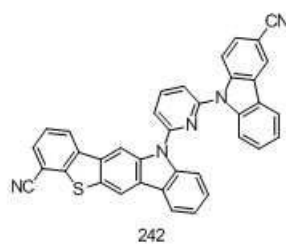
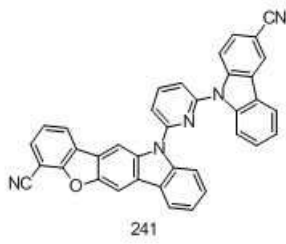
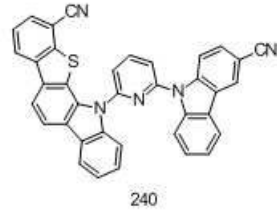
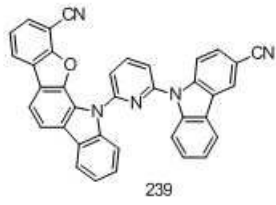
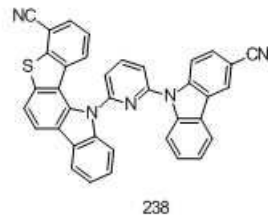
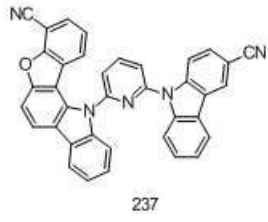
235



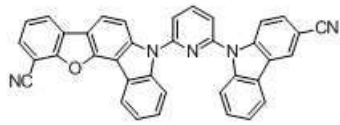
236

[0239]

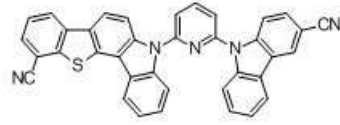




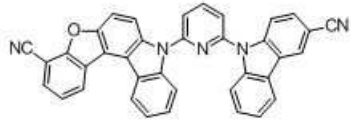
[0240]



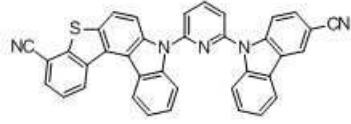
245



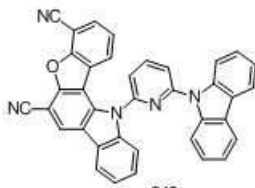
246



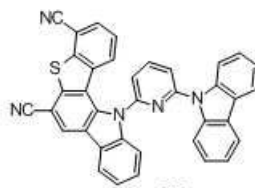
247



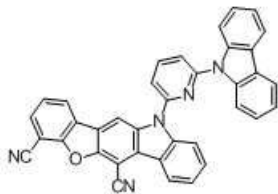
248



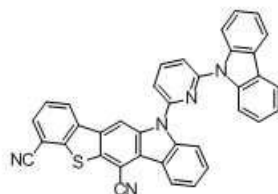
249



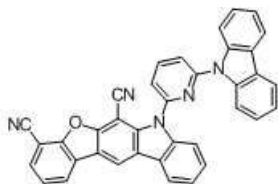
250



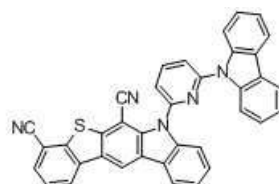
251



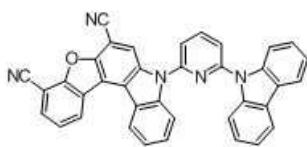
252



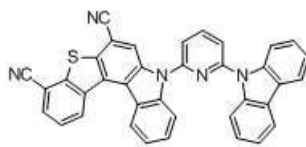
253



254



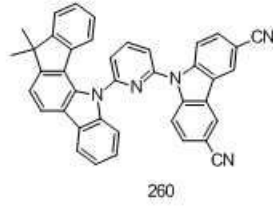
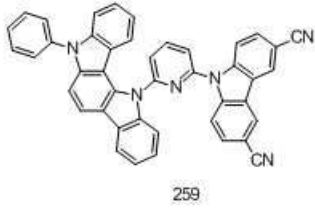
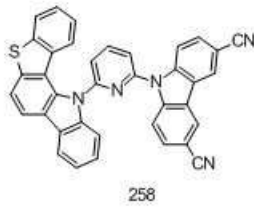
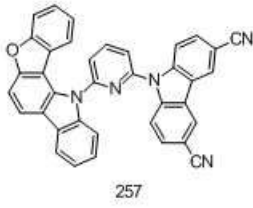
255



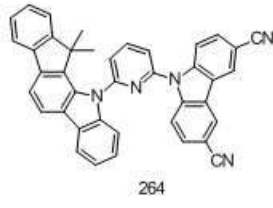
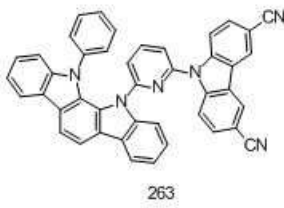
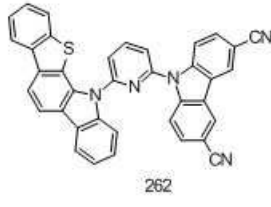
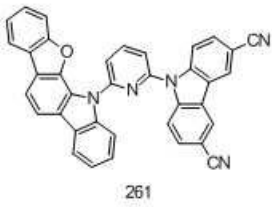
256

[0241]

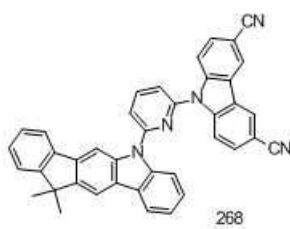
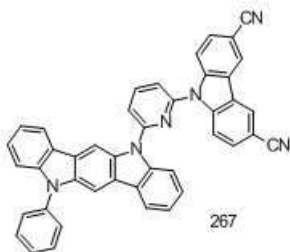
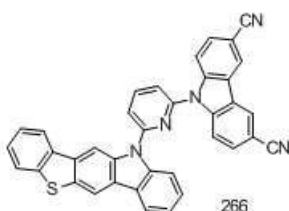
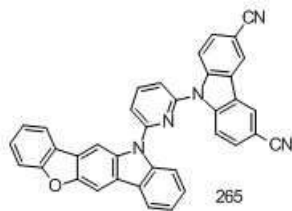
[0242]



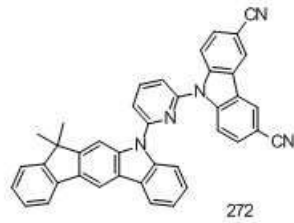
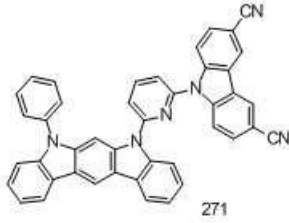
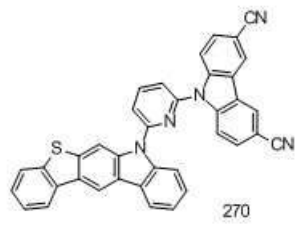
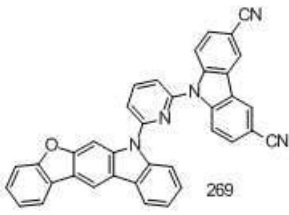
[0243]



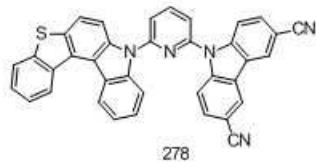
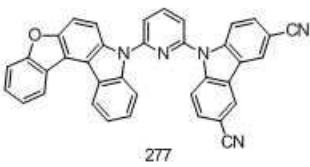
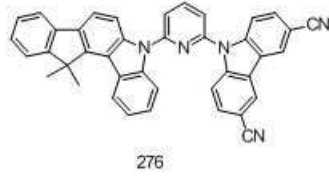
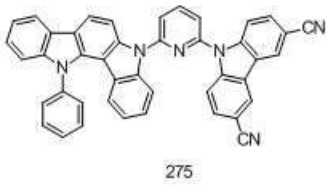
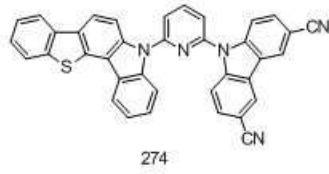
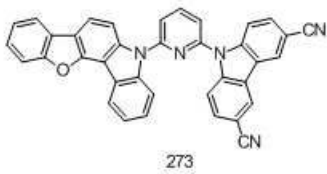
[0244]



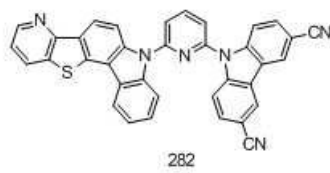
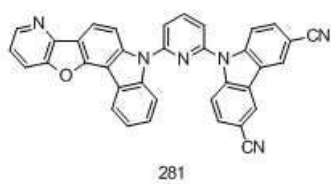
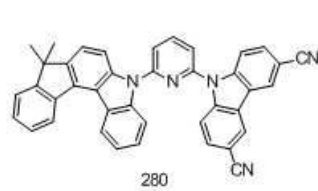
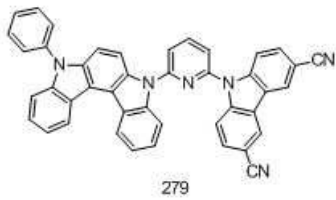
[0245]



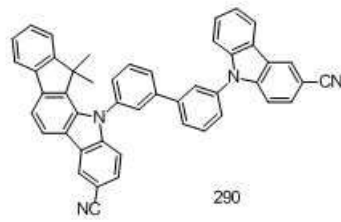
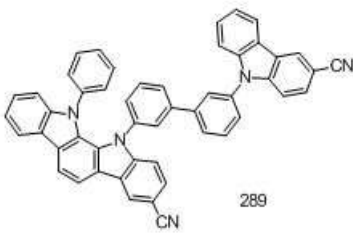
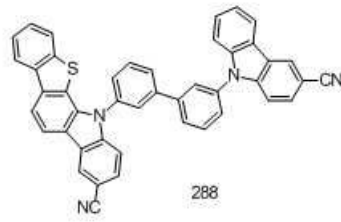
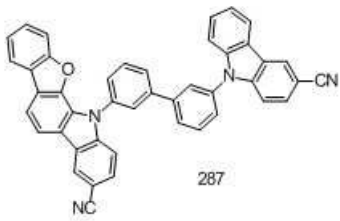
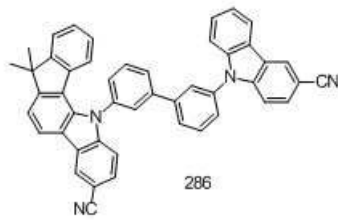
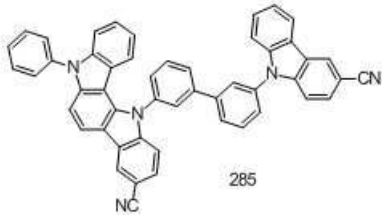
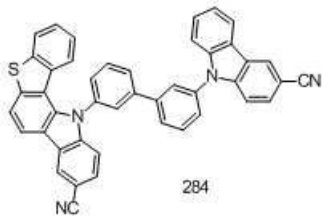
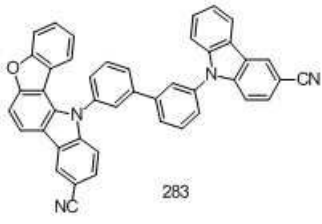
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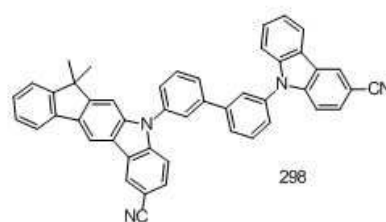
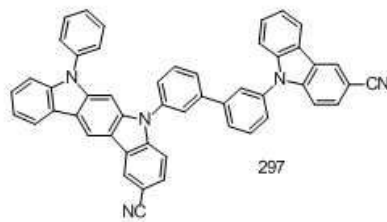
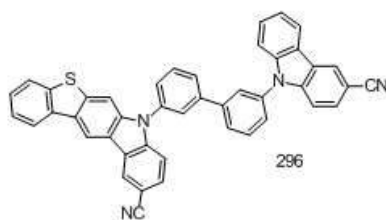
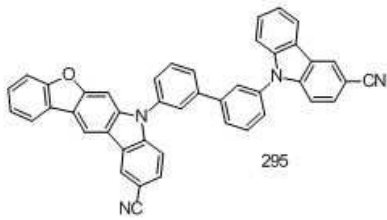
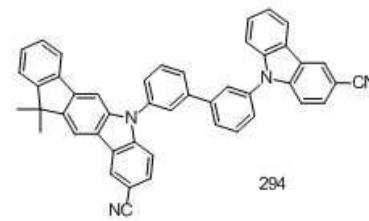
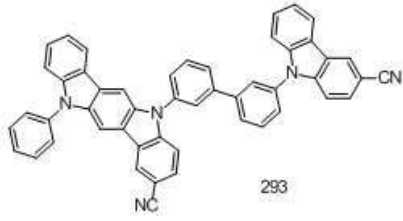
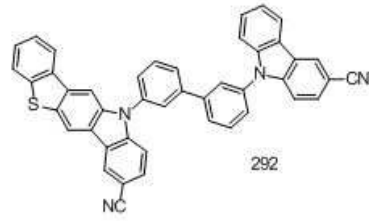
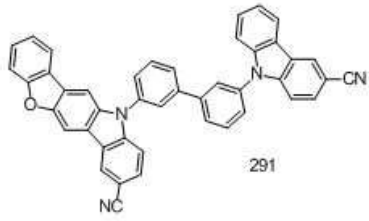
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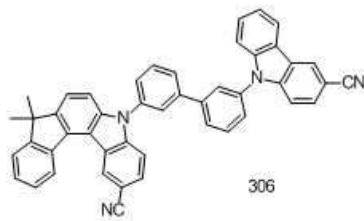
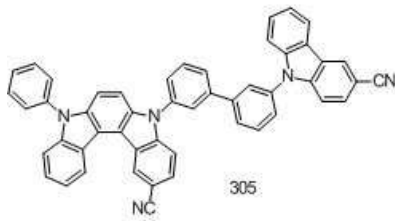
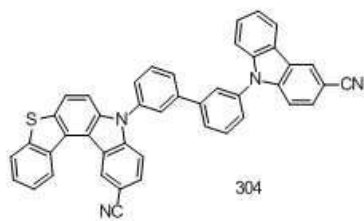
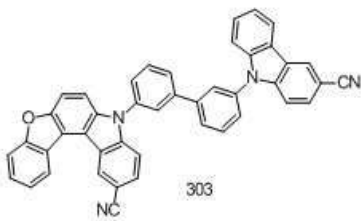
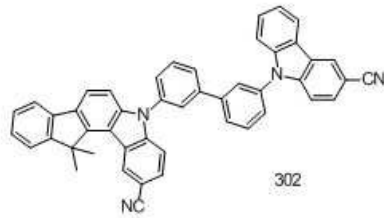
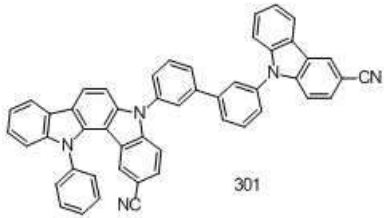
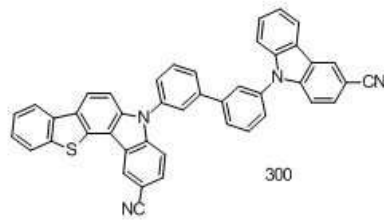
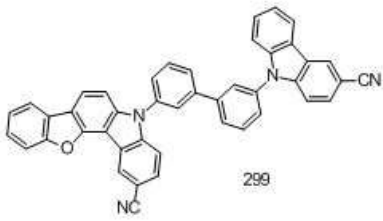
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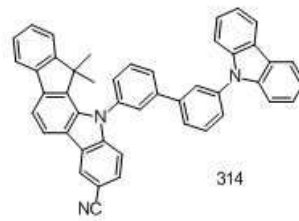
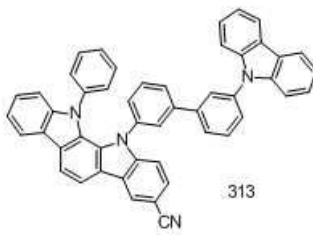
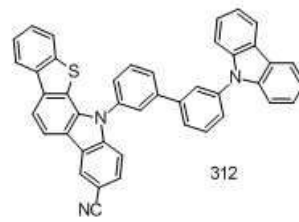
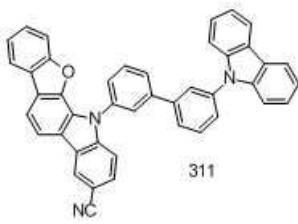
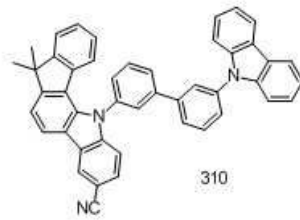
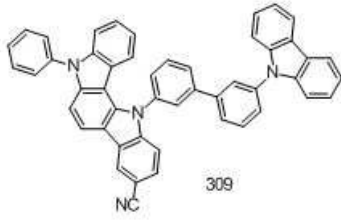
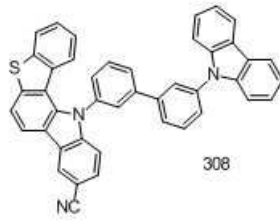
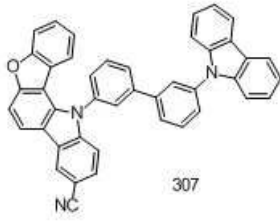
[0249]



[0250]

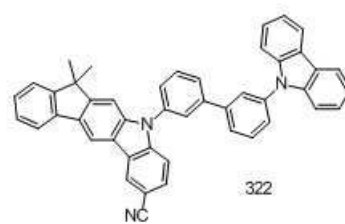
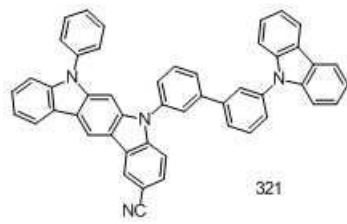
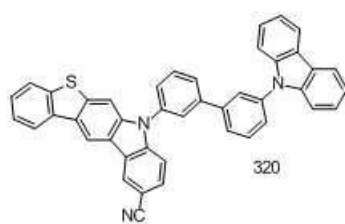
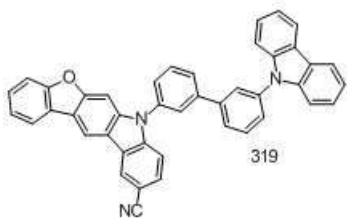
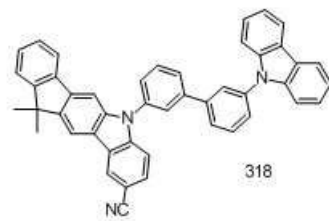
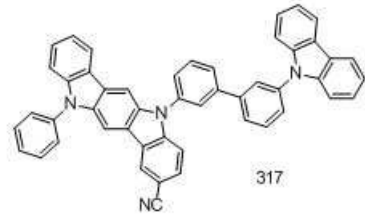
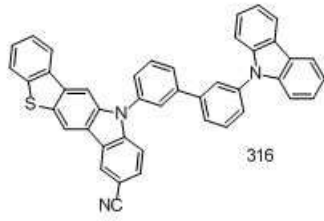
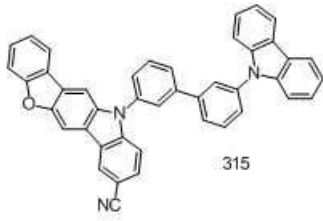


[0251]

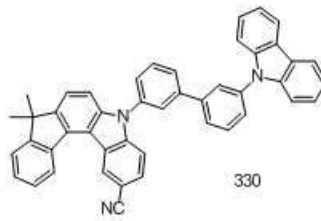
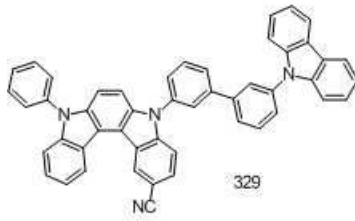
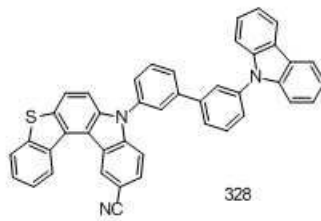
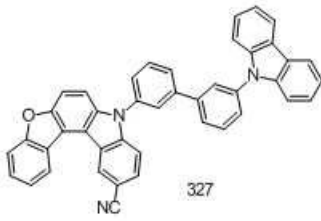
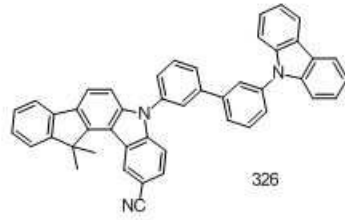
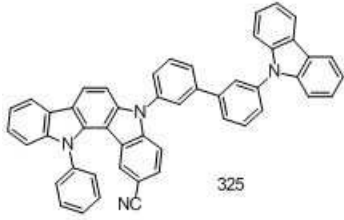
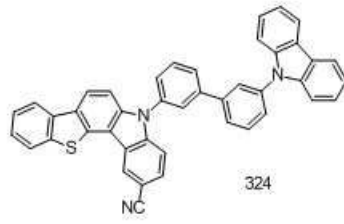
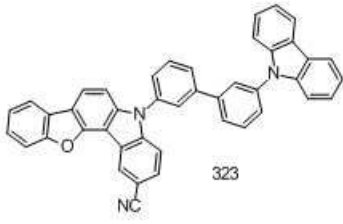


[0252]

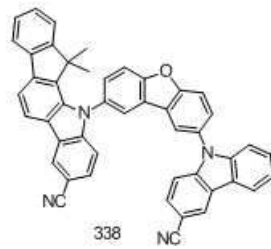
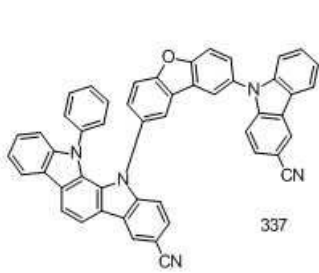
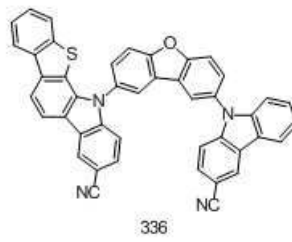
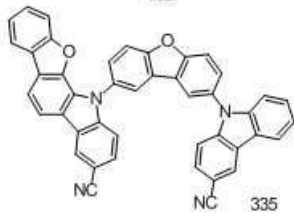
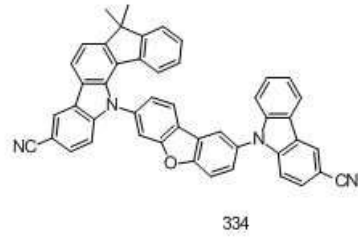
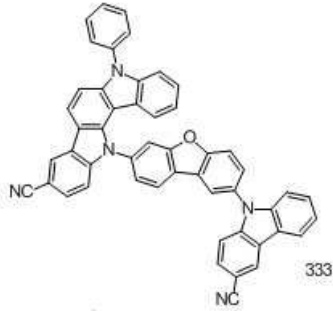
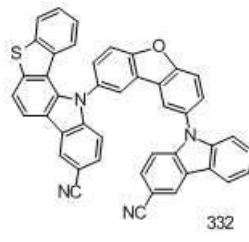
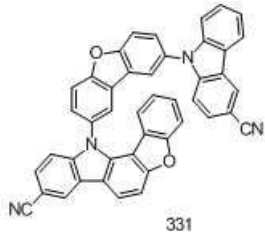




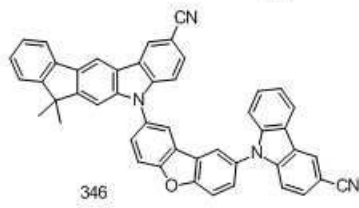
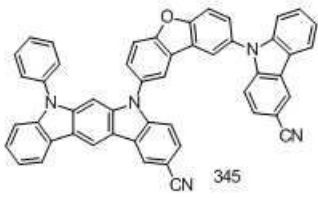
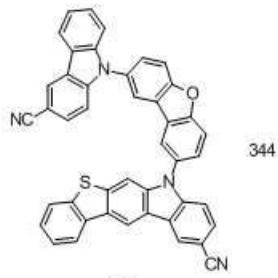
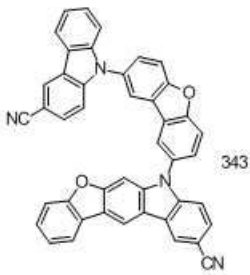
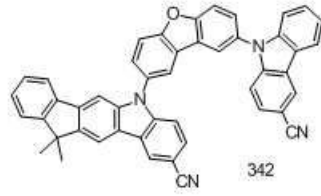
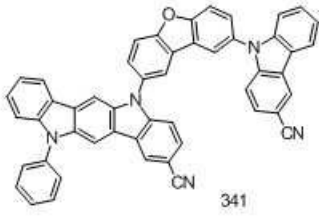
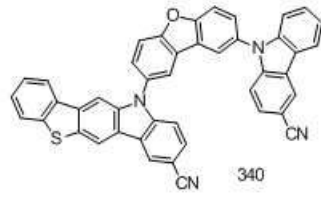
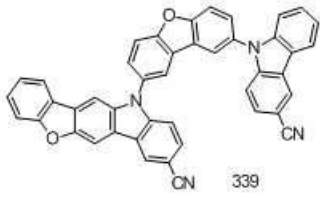
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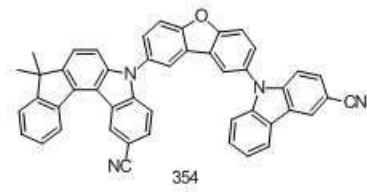
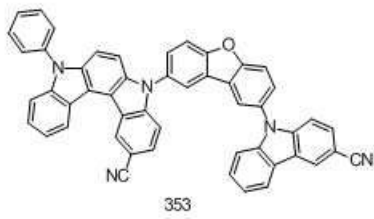
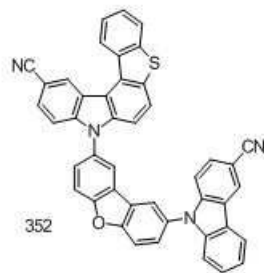
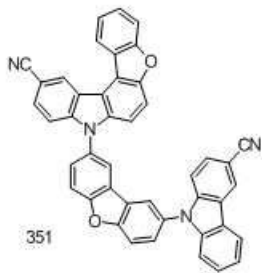
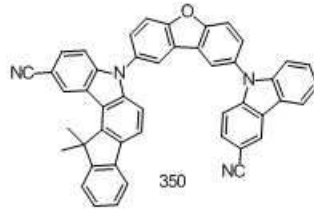
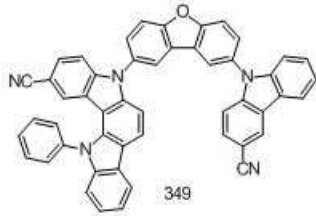
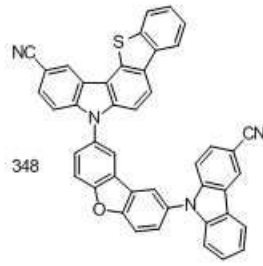
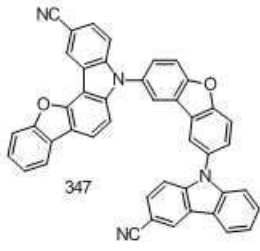
[0254]



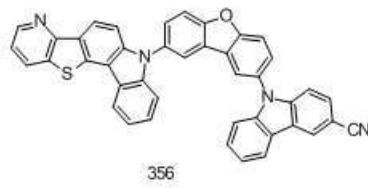
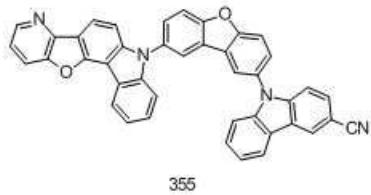
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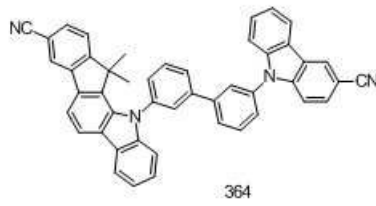
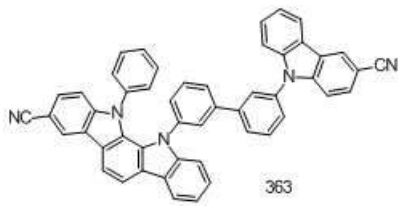
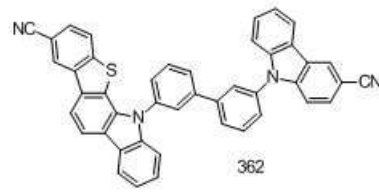
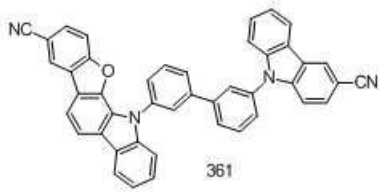
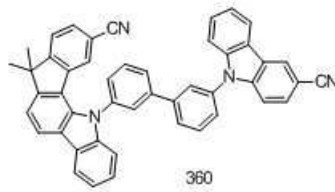
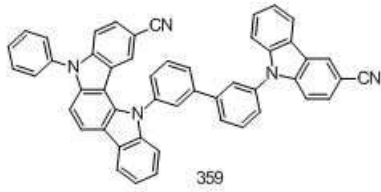
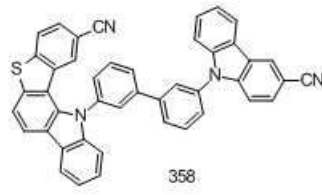
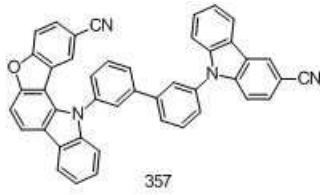
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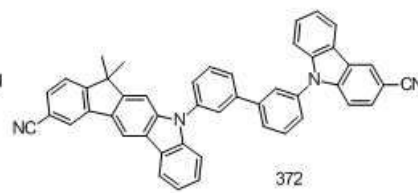
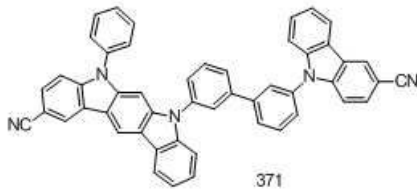
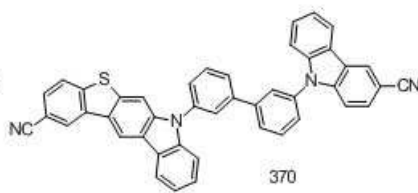
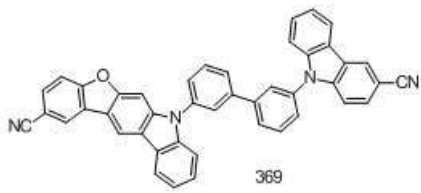
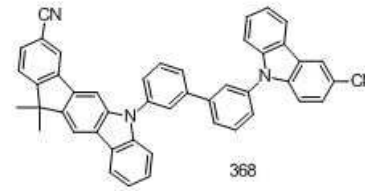
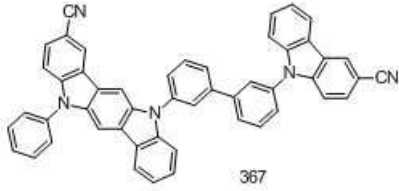
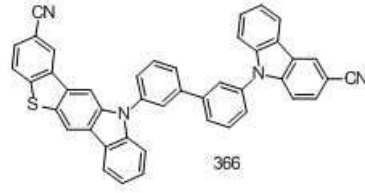
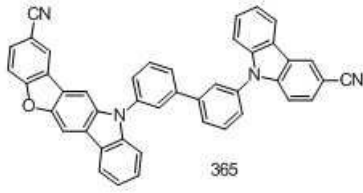
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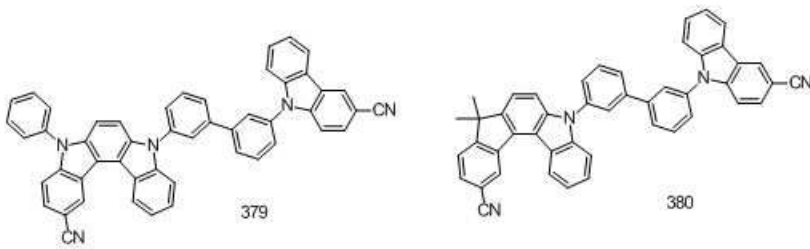
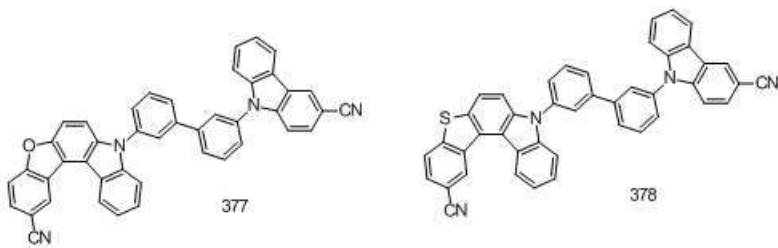
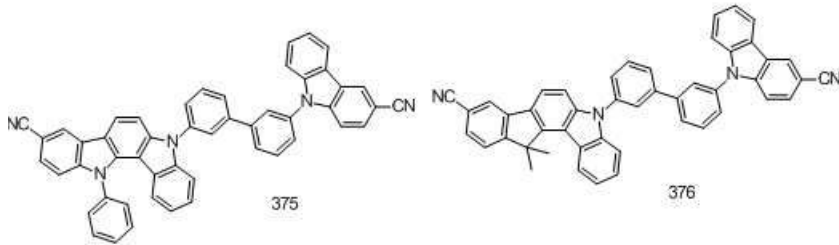
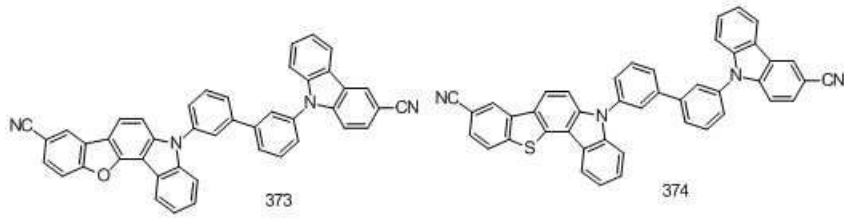
[0258]



[0259]

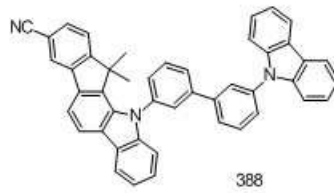
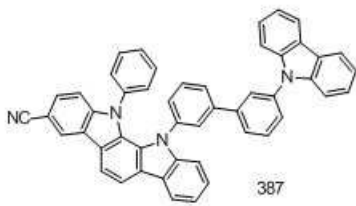
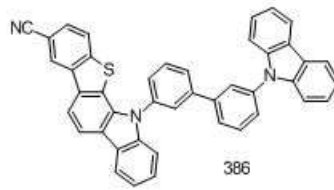
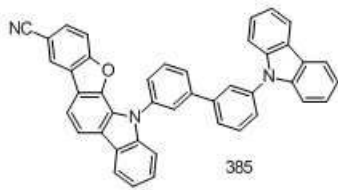
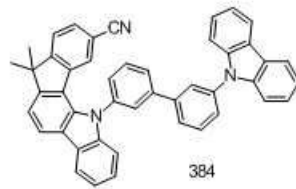
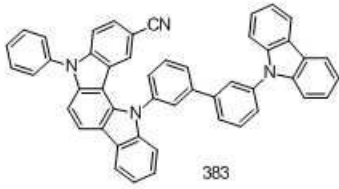
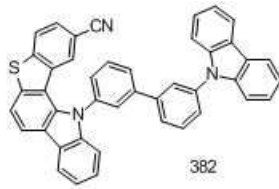
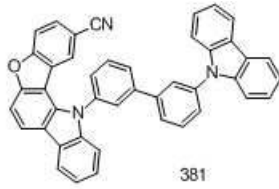


[0260]

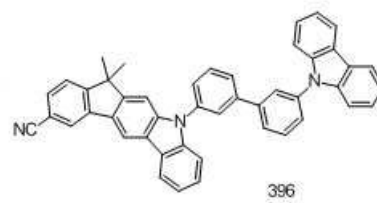
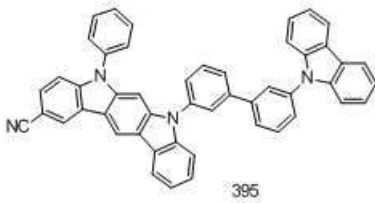
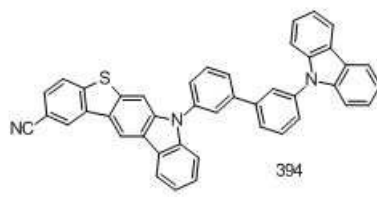
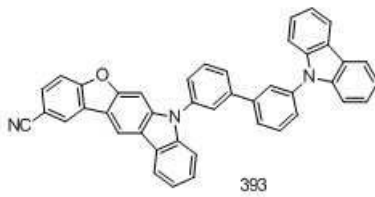
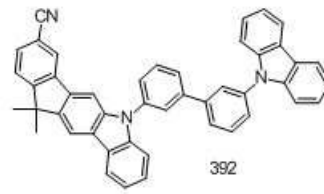
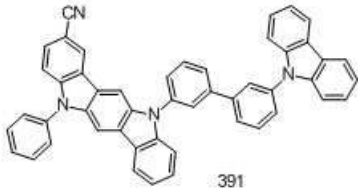
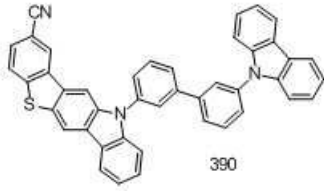
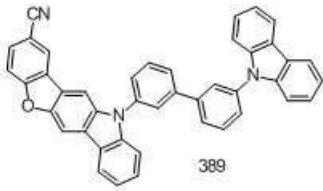


[0261]

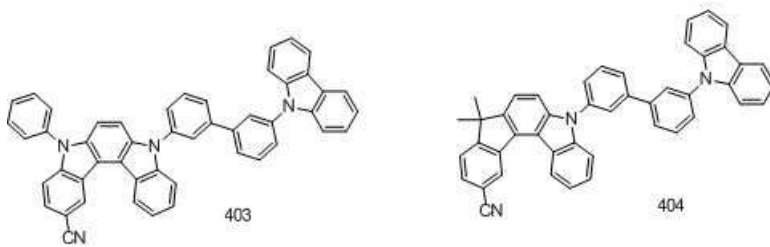
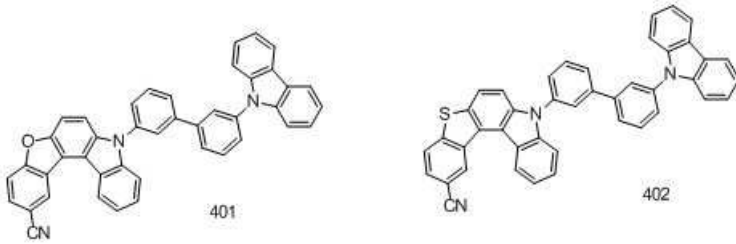
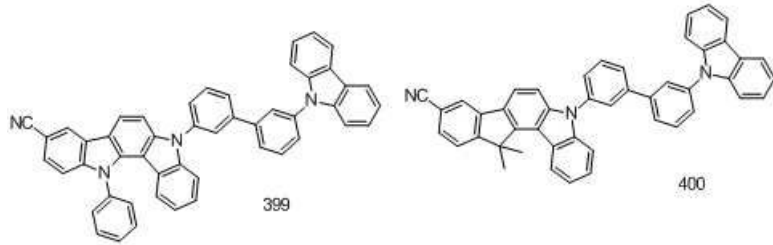
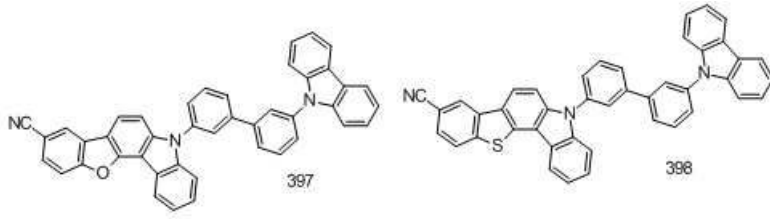




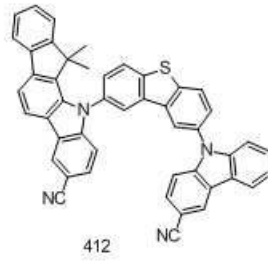
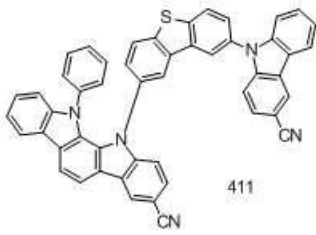
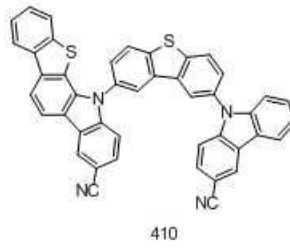
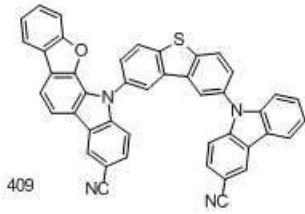
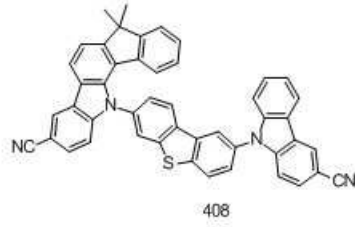
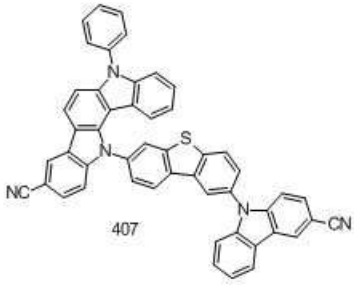
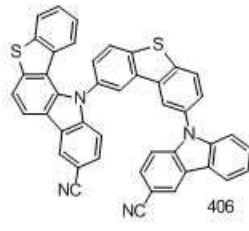
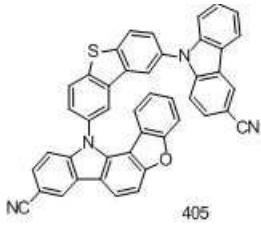
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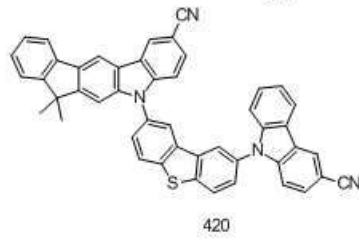
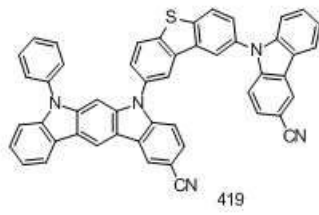
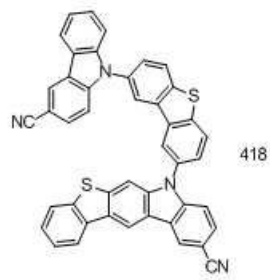
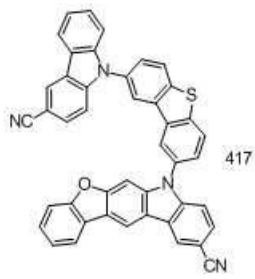
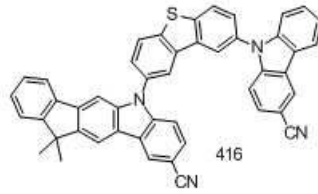
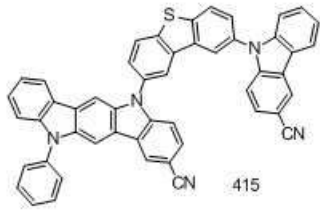
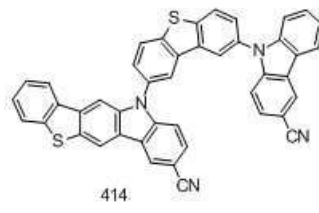
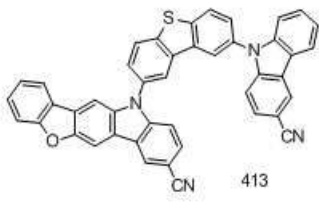
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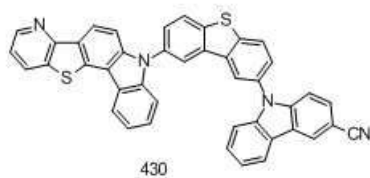
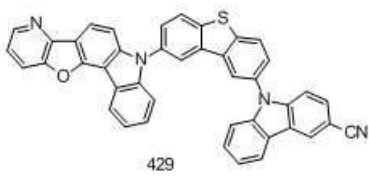
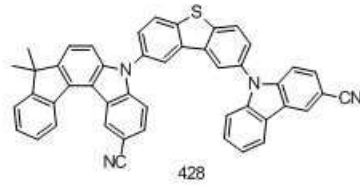
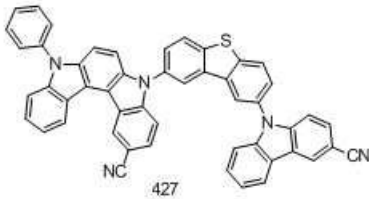
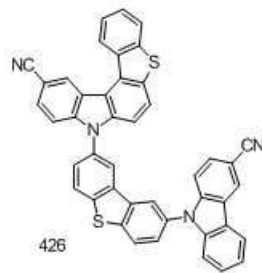
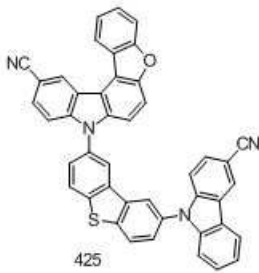
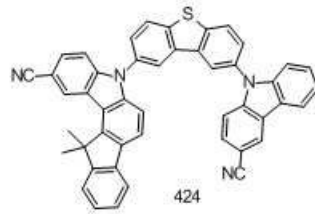
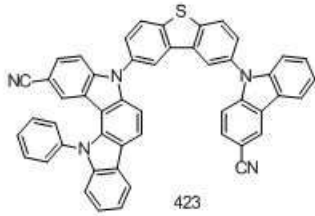
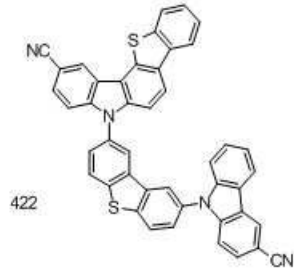
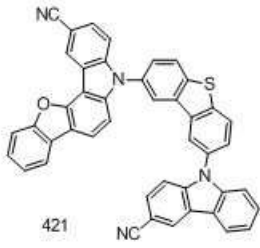
[0264]



[0265]

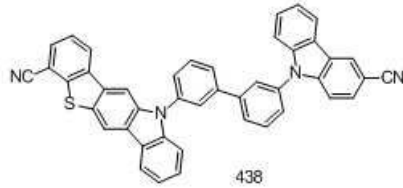
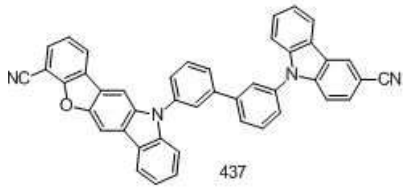
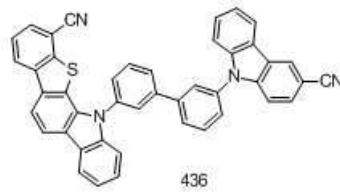
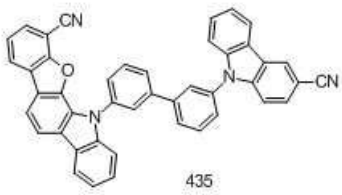
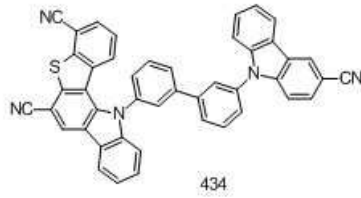
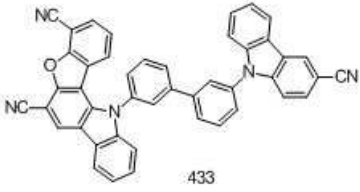
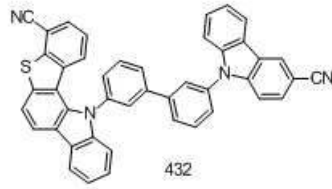
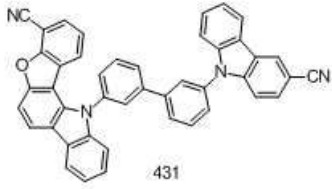


[0266]

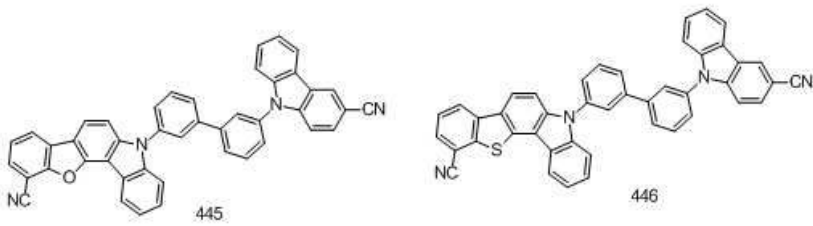
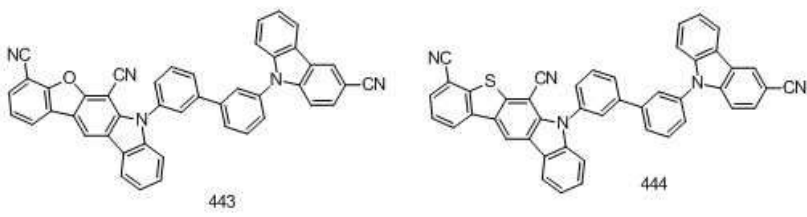
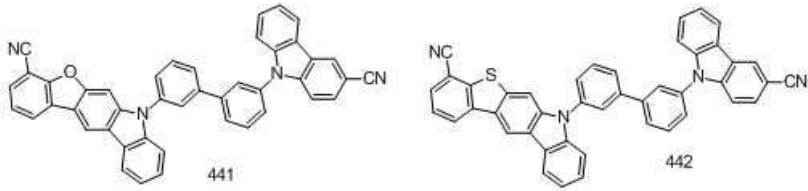
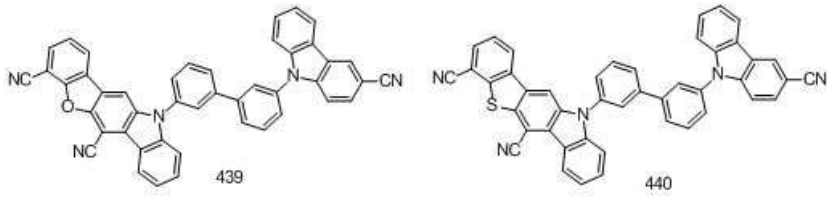


[0267]

[0268]

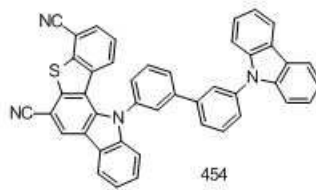
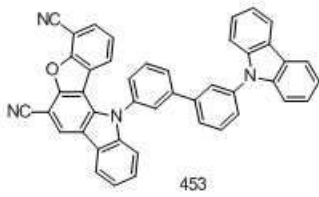
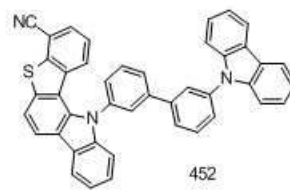
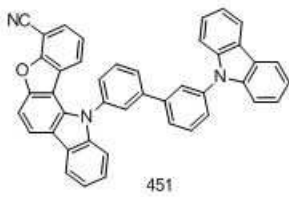
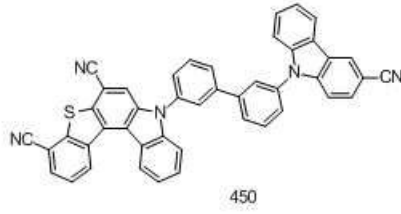
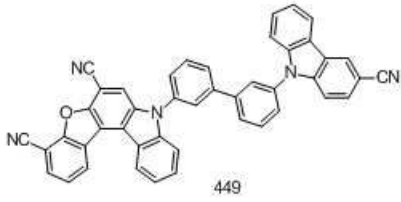
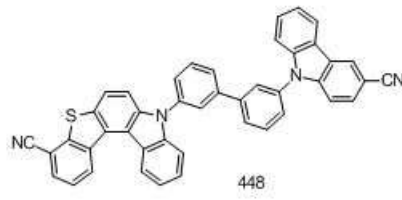
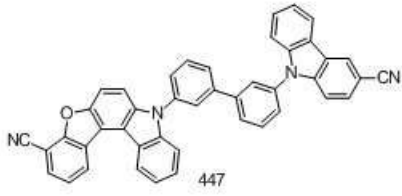


[0269]

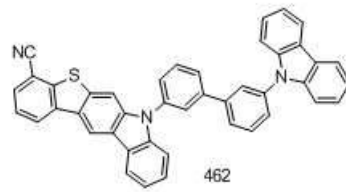
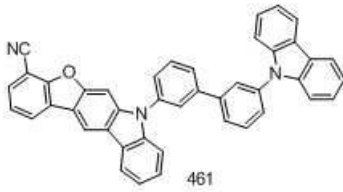
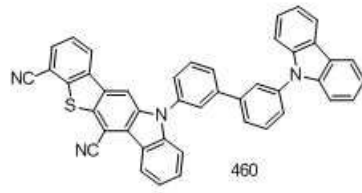
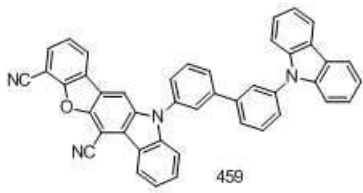
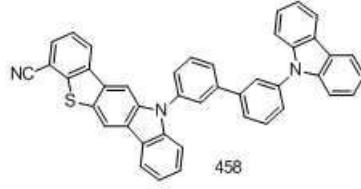
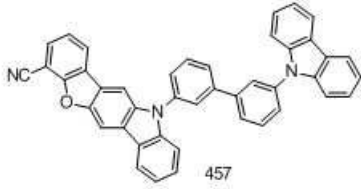
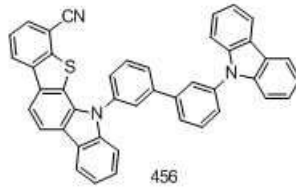
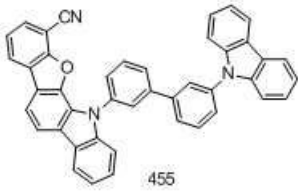


[0270]

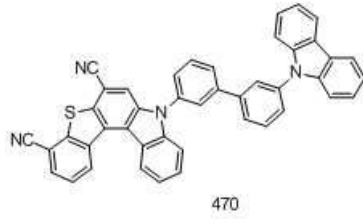
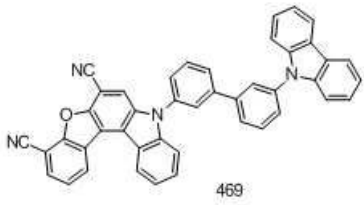
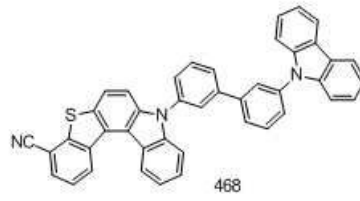
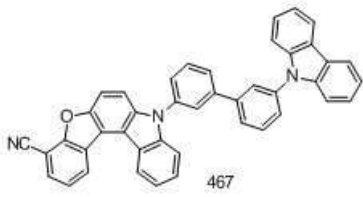
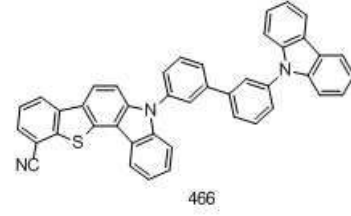
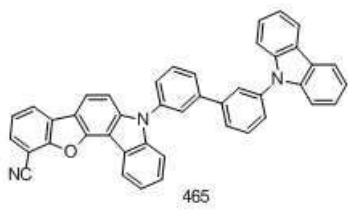
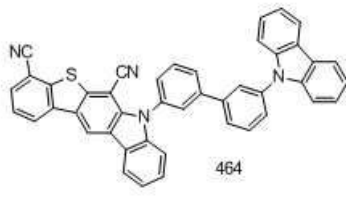
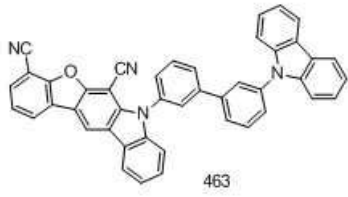




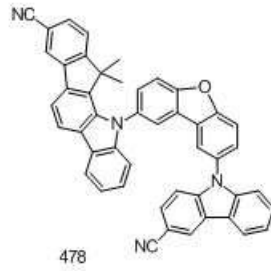
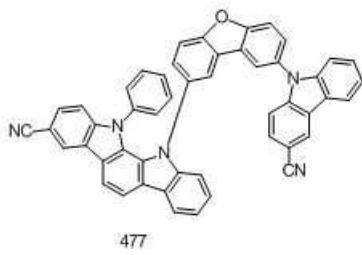
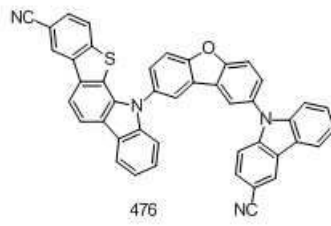
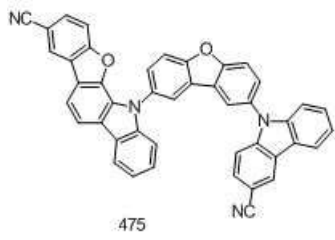
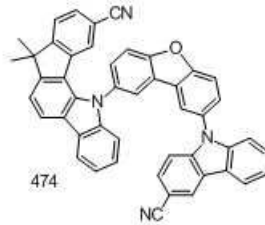
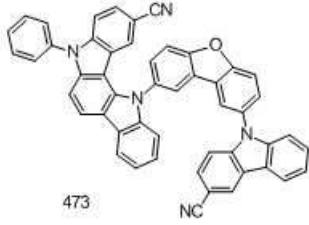
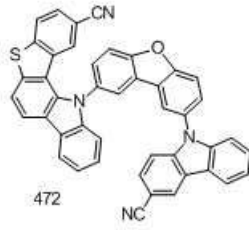
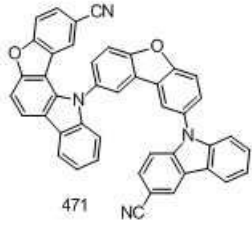
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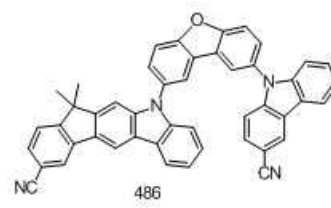
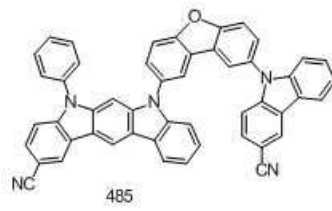
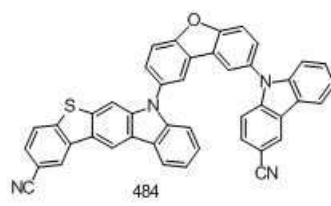
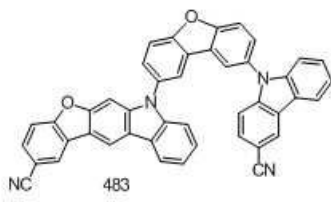
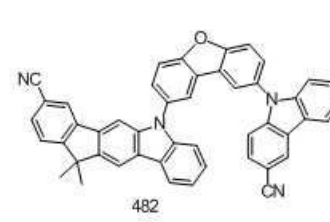
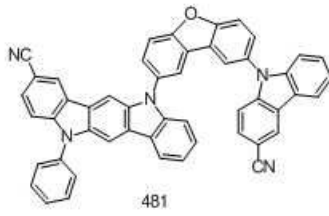
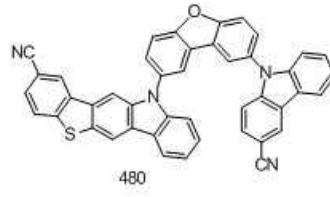
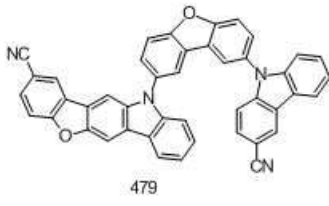
[0272]



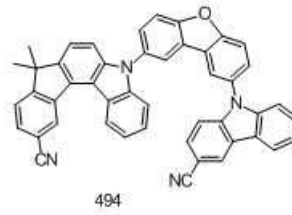
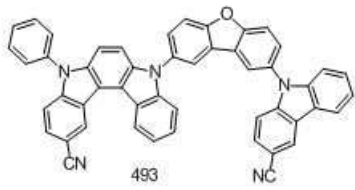
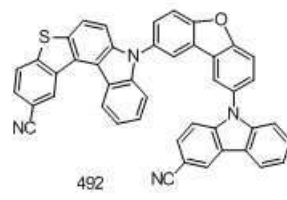
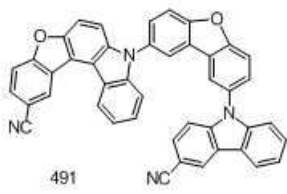
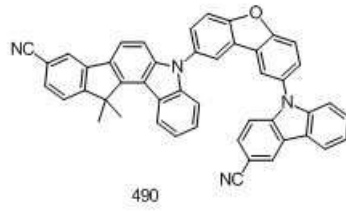
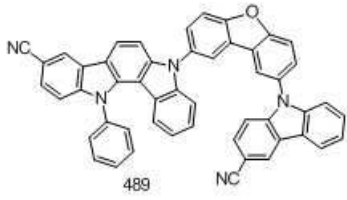
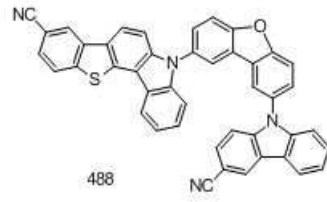
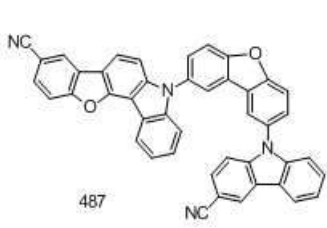
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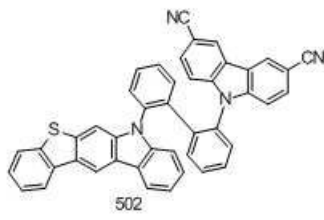
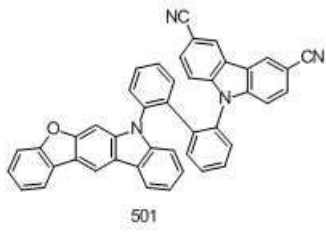
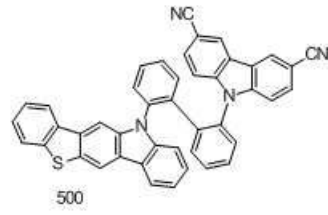
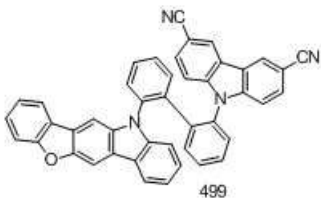
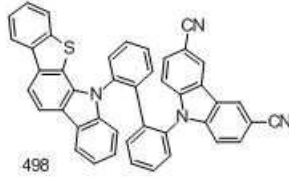
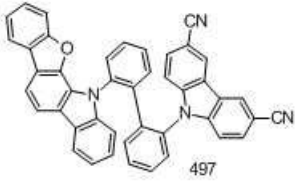
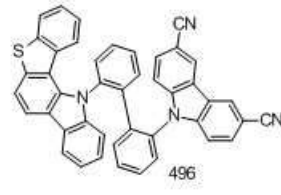
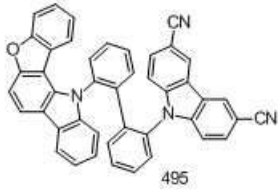
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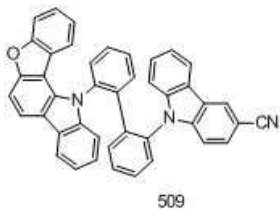
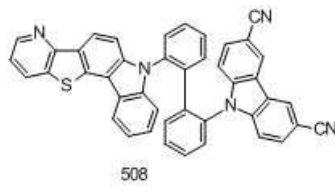
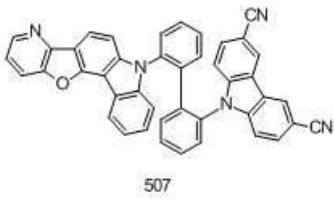
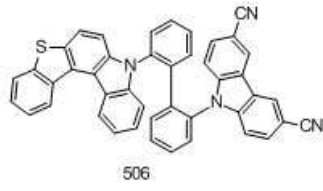
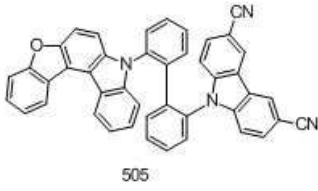
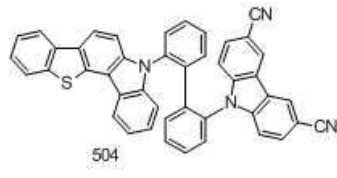
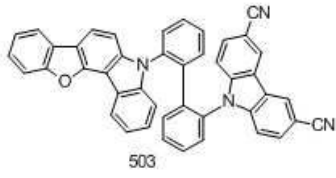
[0275]



[0276]

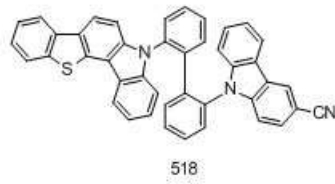
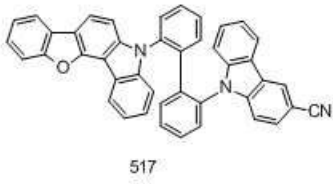
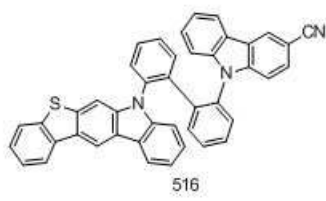
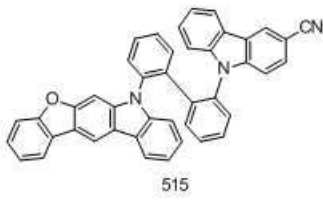
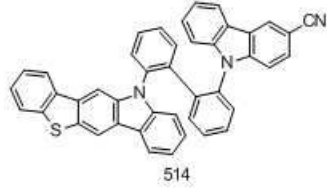
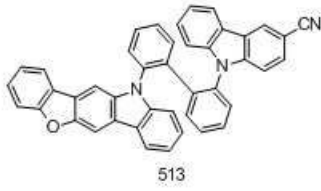
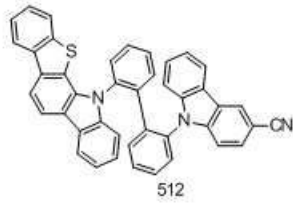
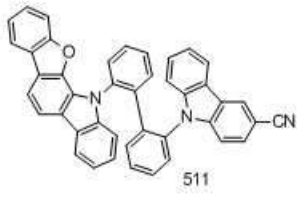


[0277]

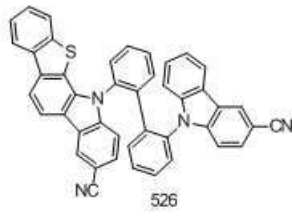
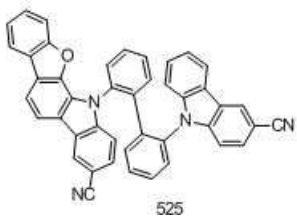
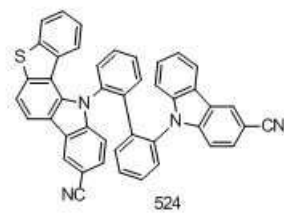
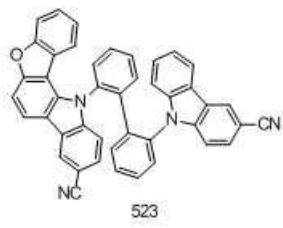
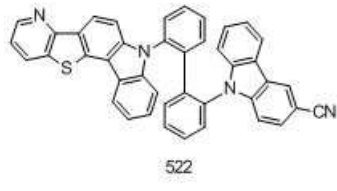
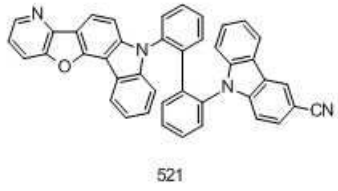
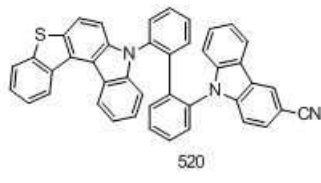
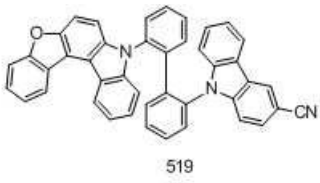


[0278]

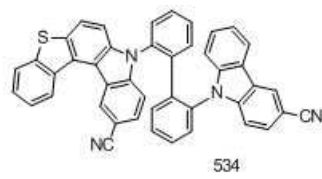
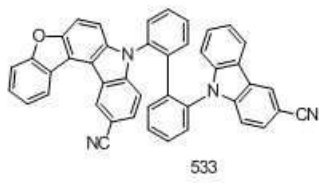
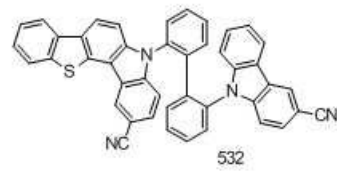
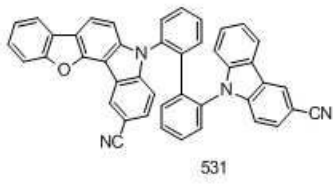
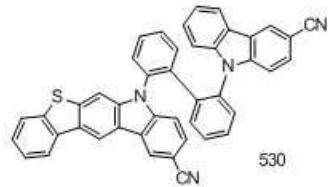
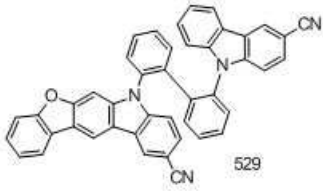
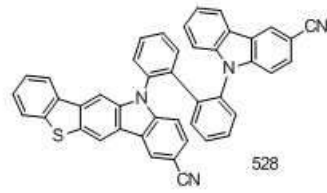
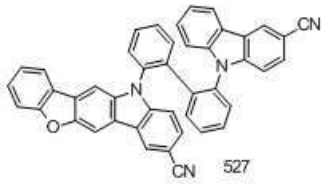




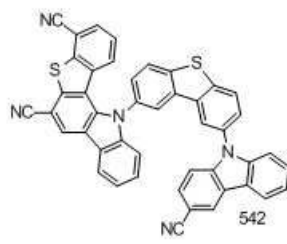
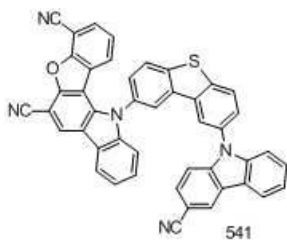
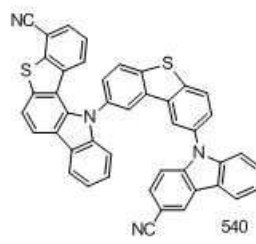
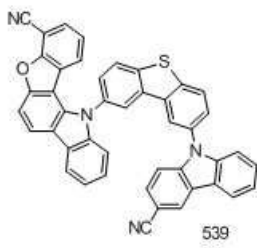
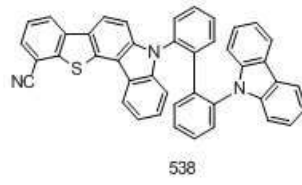
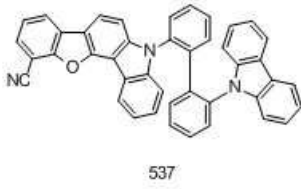
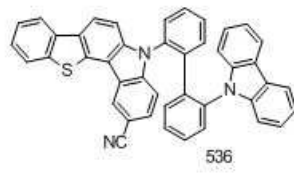
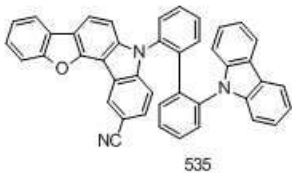
[0279]



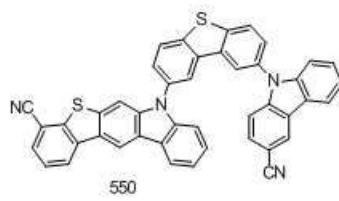
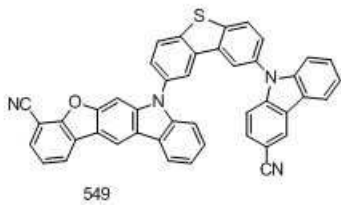
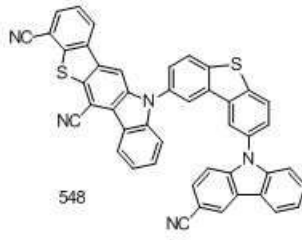
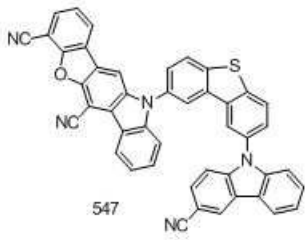
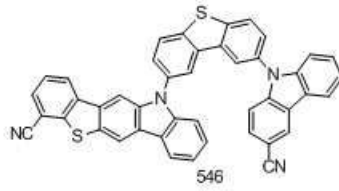
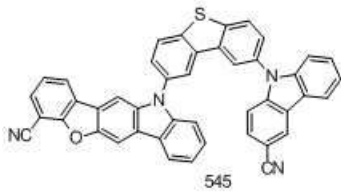
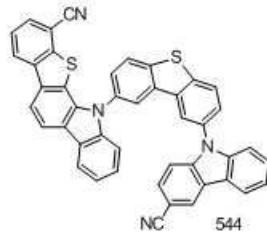
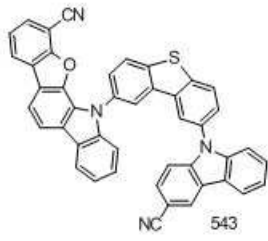
[0280]



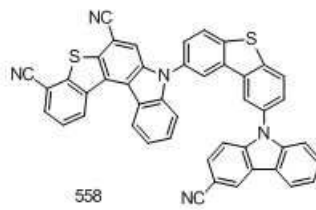
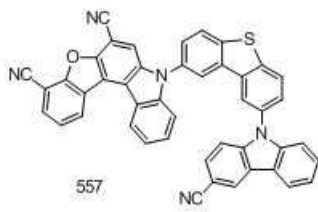
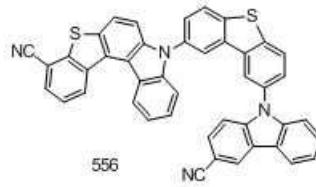
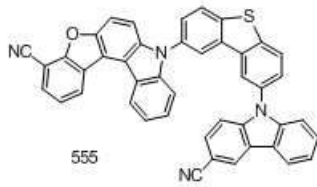
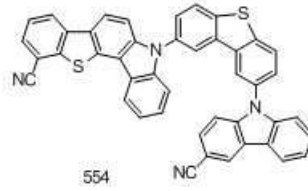
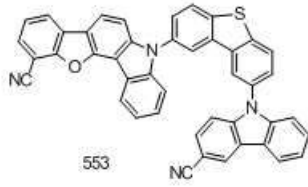
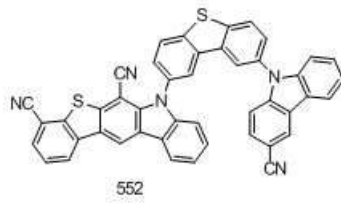
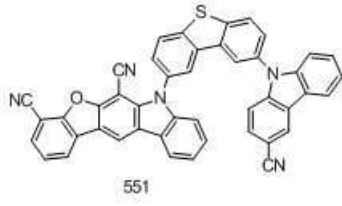
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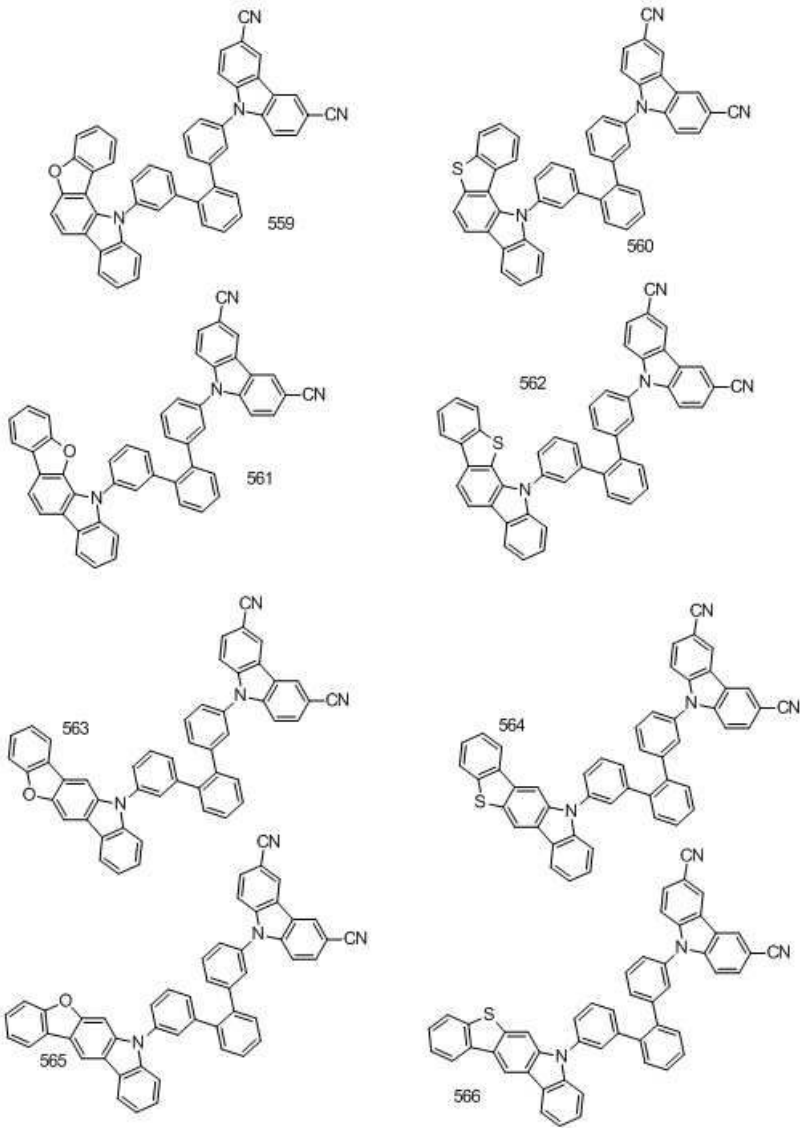
[0282]



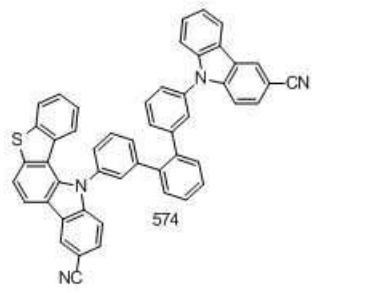
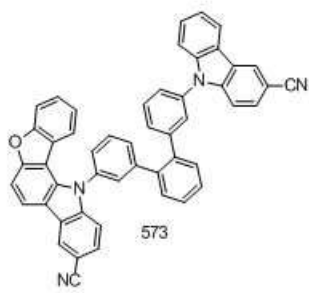
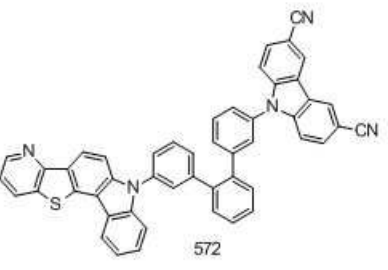
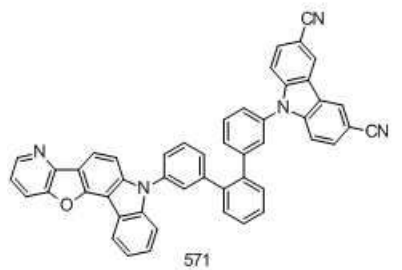
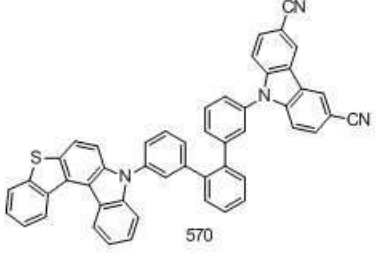
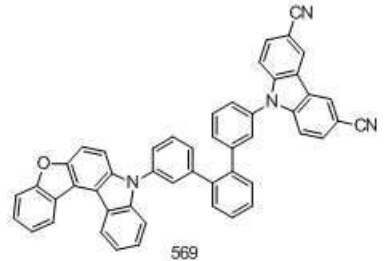
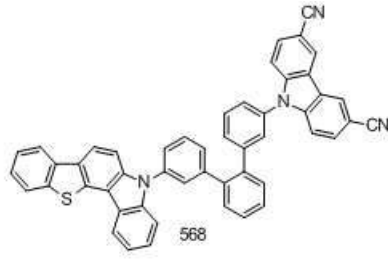
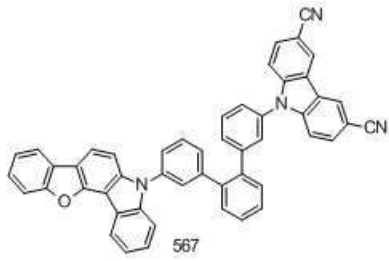
[0283]



[0284]

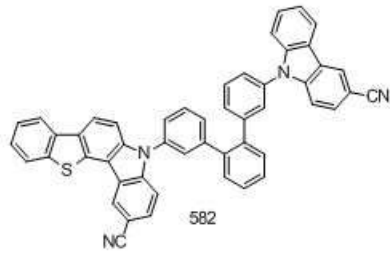
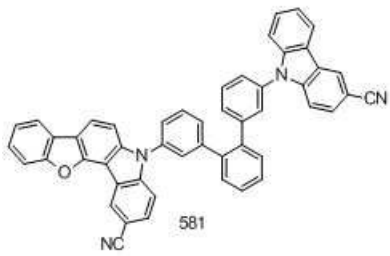
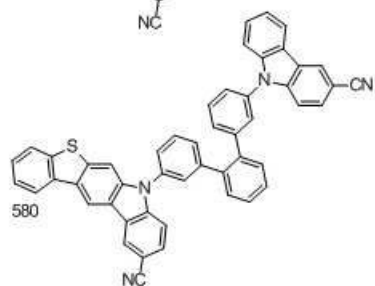
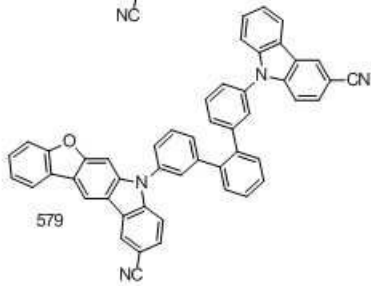
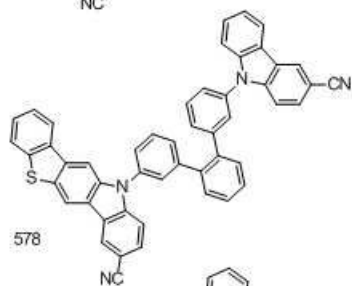
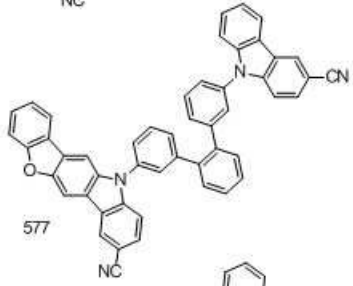
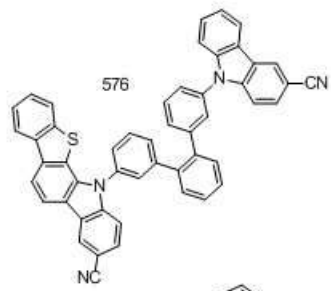
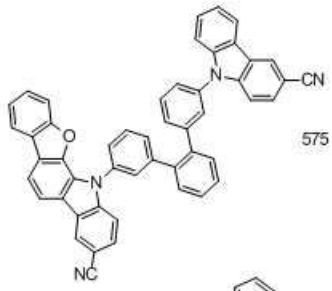


[0285]

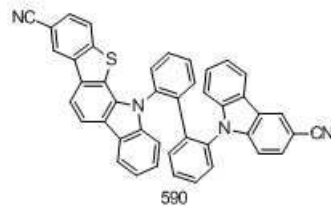
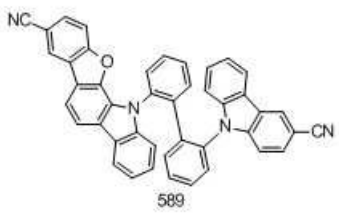
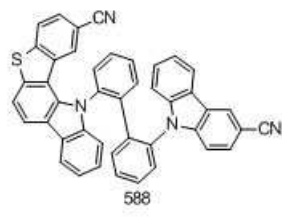
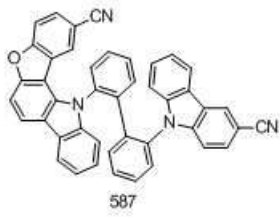
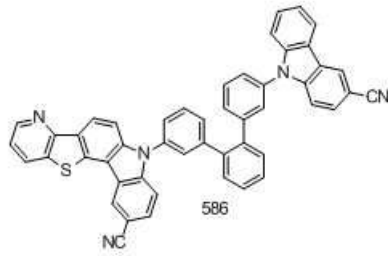
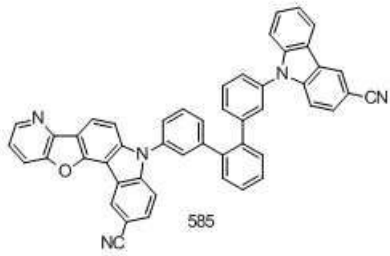
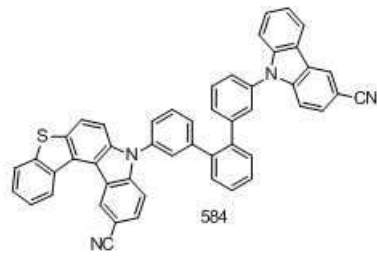
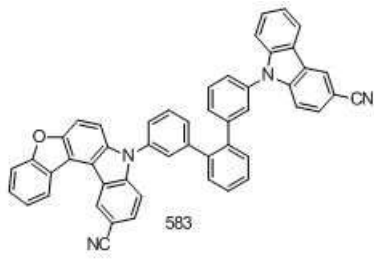


[0286]

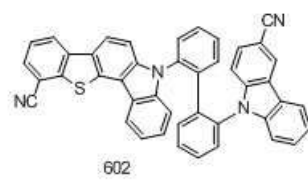
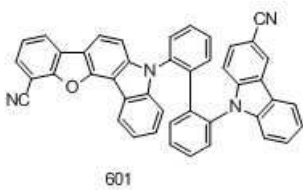
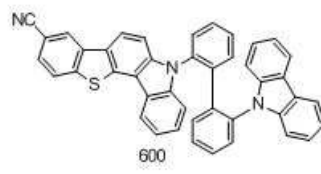
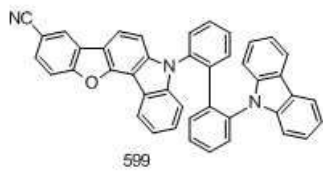
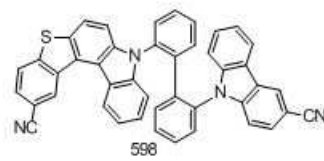
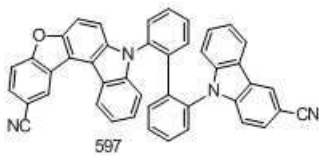
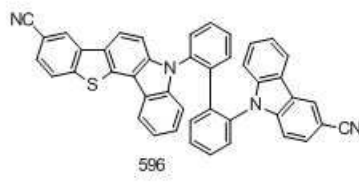
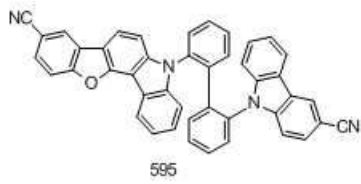
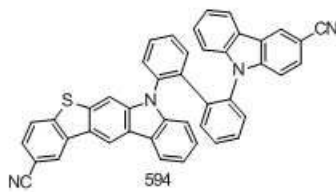
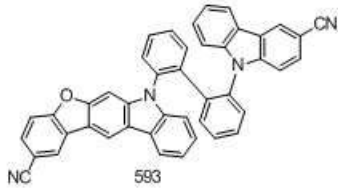
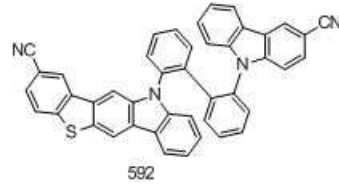
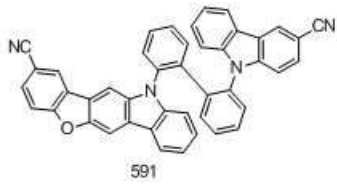




[0287]

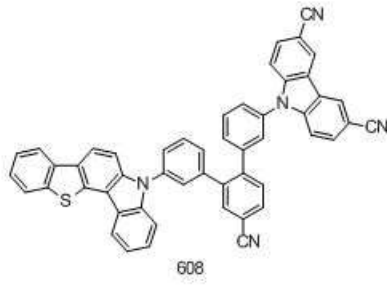
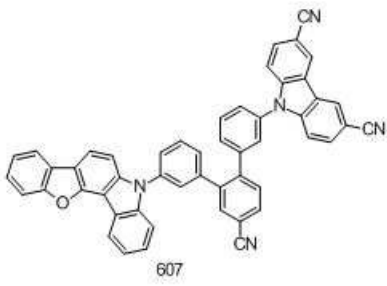
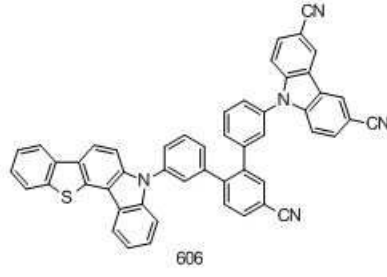
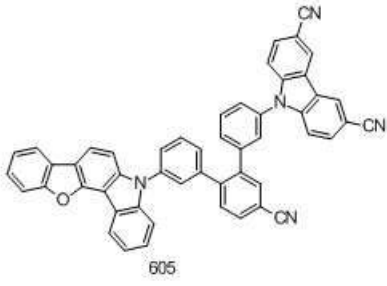
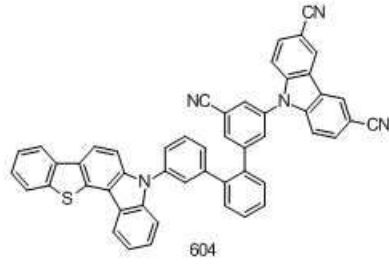
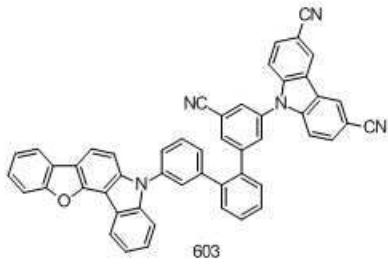


[0288]



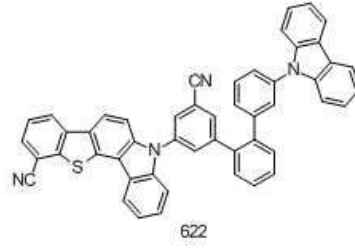
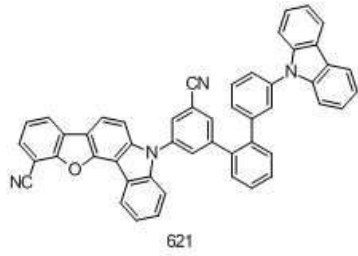
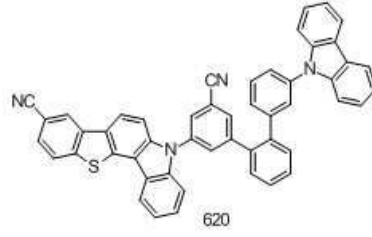
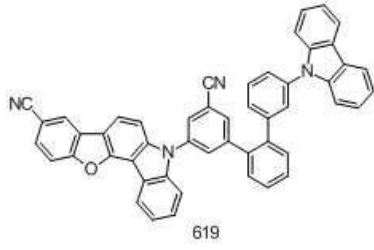
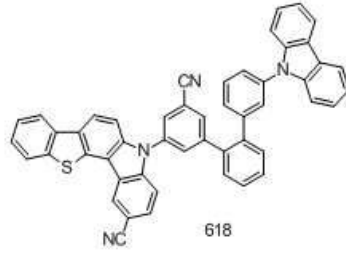
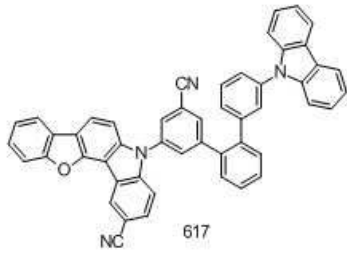
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[0290]

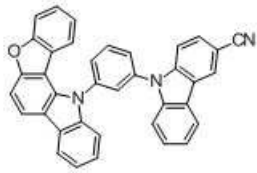


[0291]

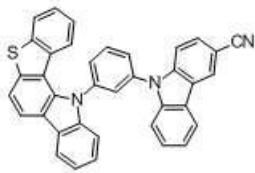




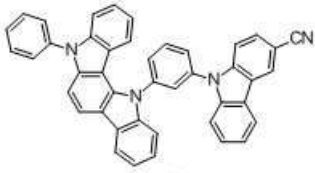
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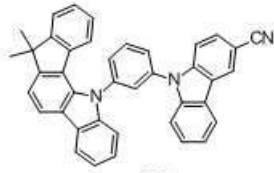
623



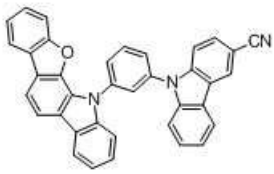
624



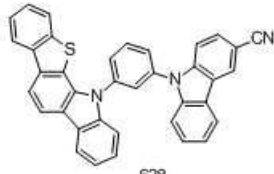
625



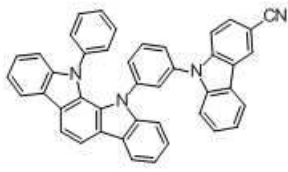
626



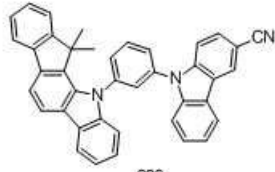
627



628

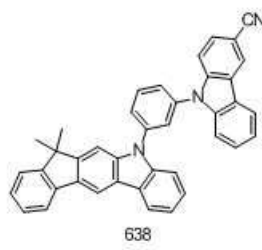
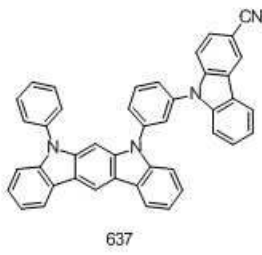
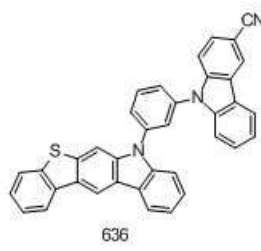
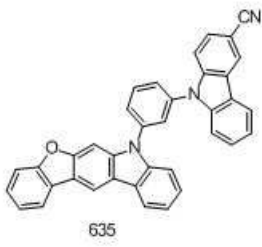
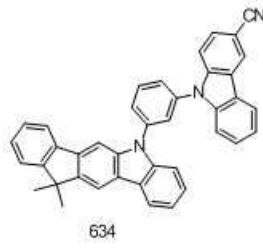
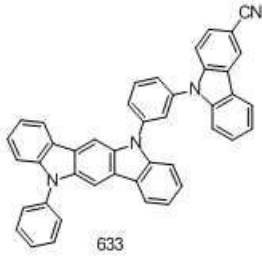
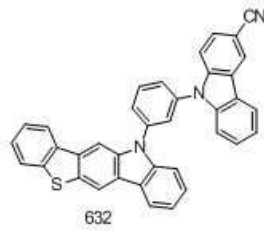
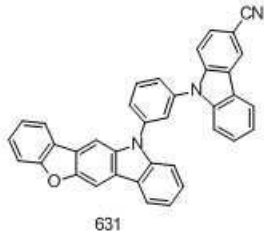


629



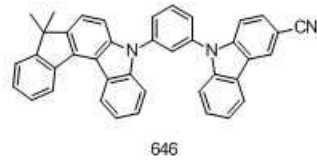
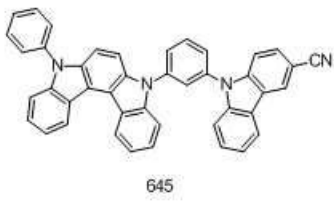
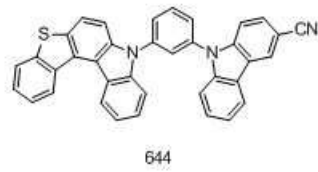
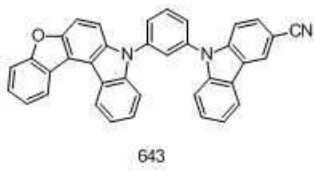
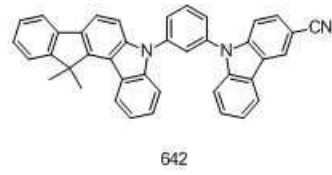
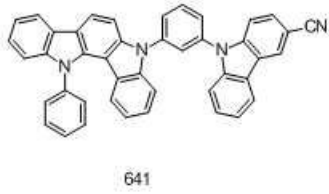
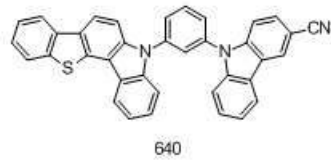
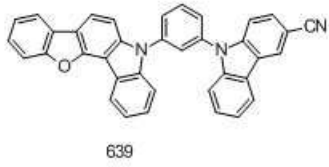
630

[0294]

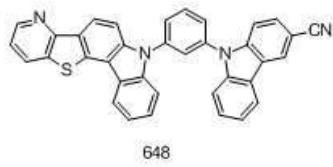
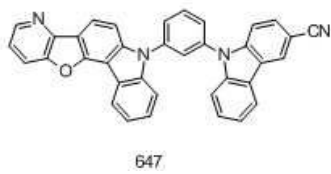


[0295]

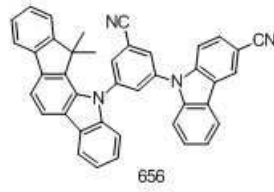
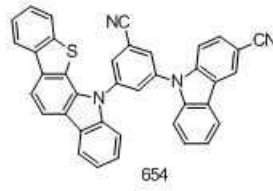
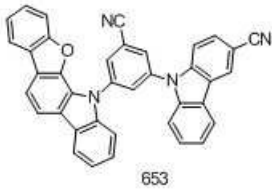
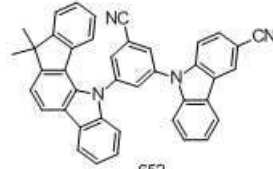
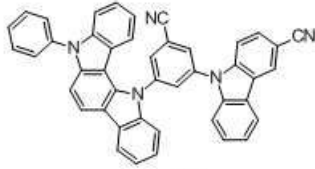
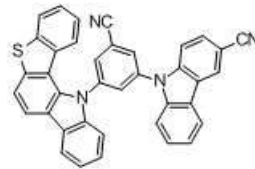
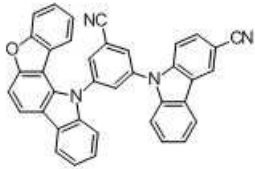




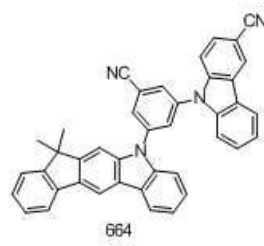
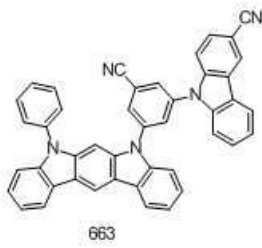
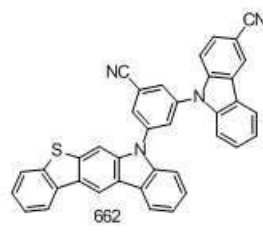
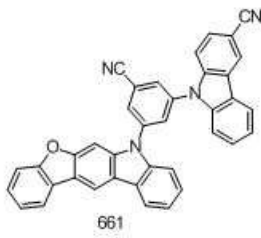
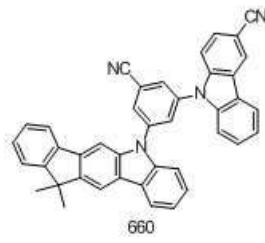
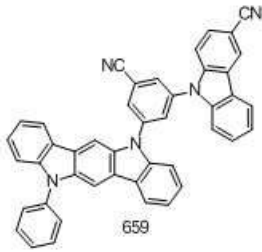
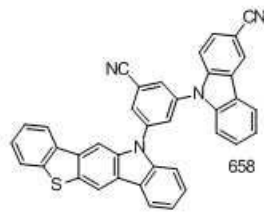
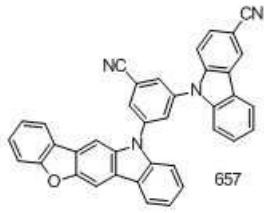
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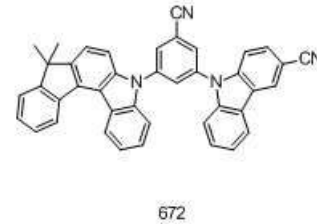
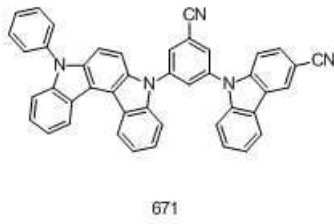
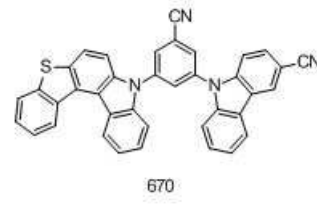
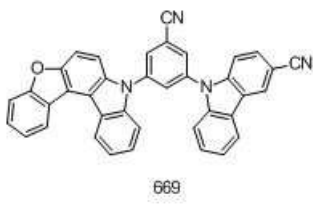
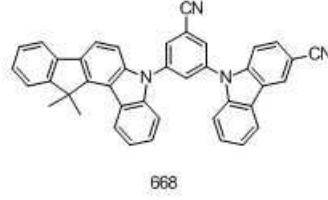
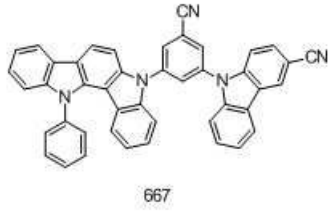
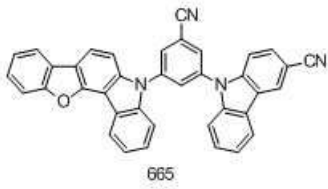
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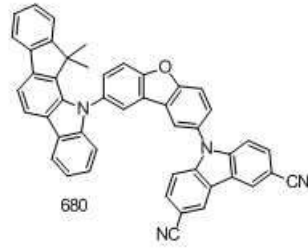
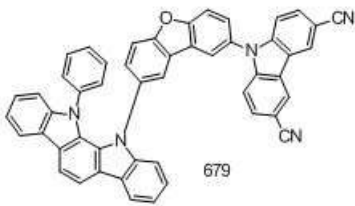
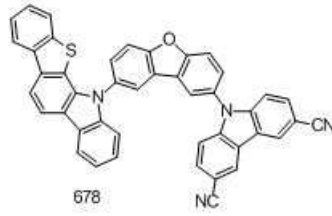
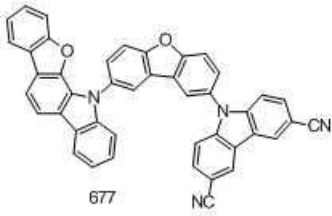
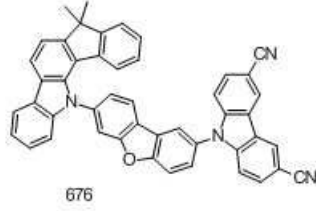
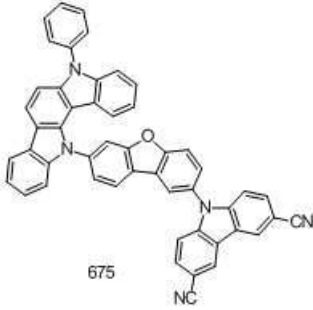
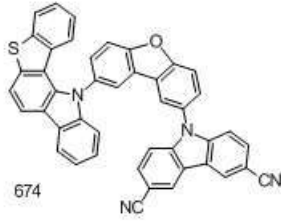
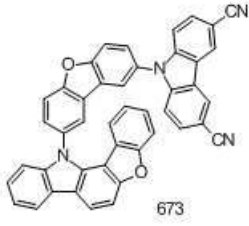
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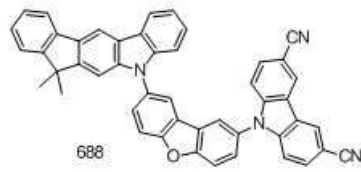
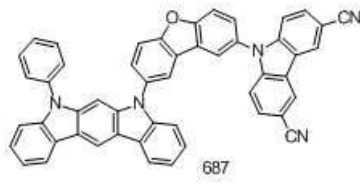
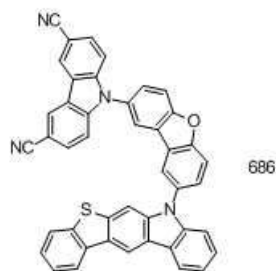
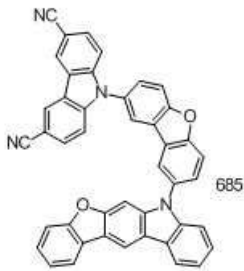
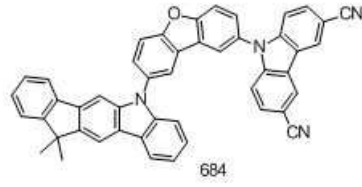
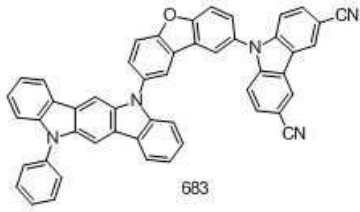
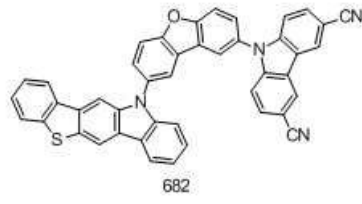
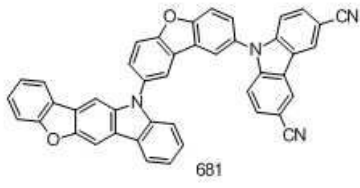
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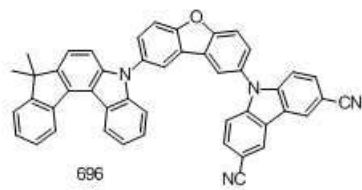
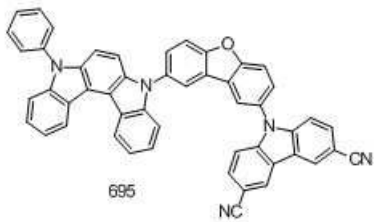
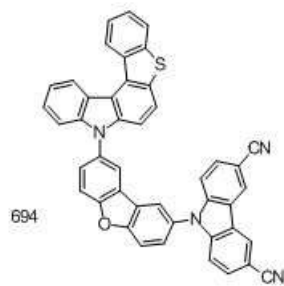
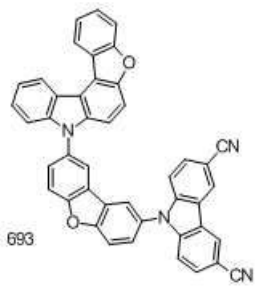
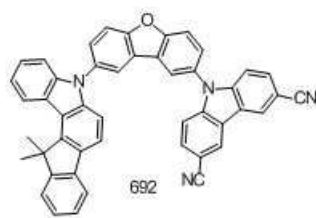
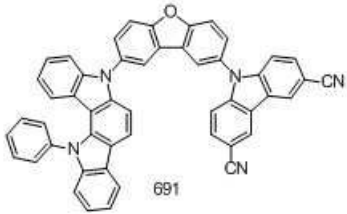
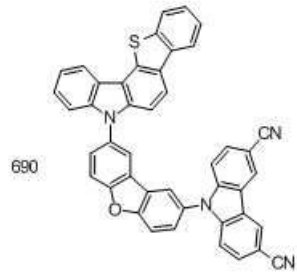
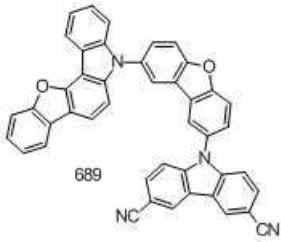
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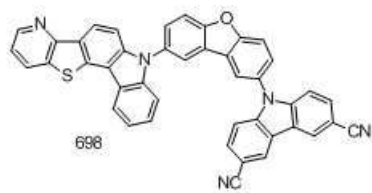
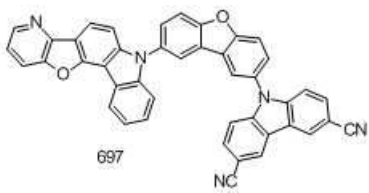
[0301]



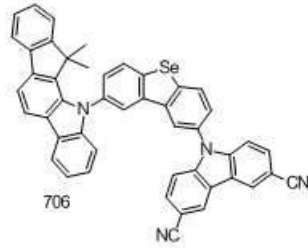
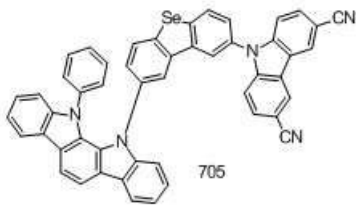
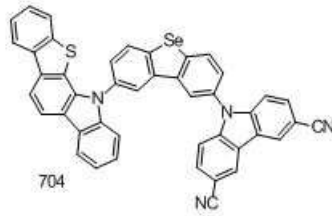
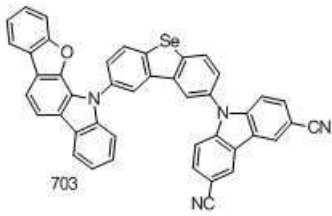
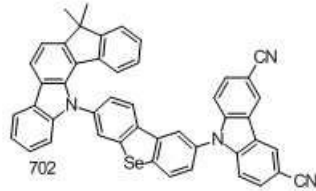
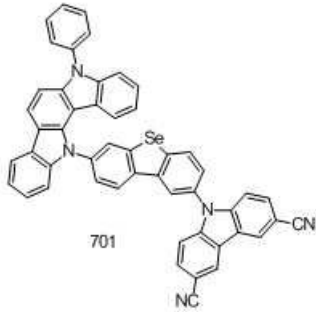
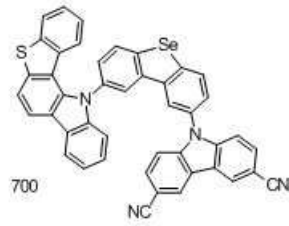
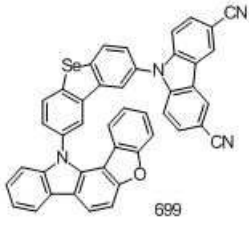
[0302]



[0303]

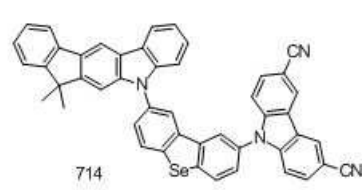
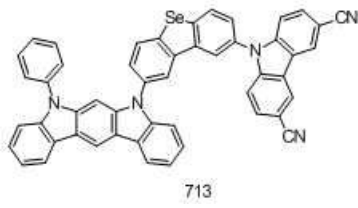
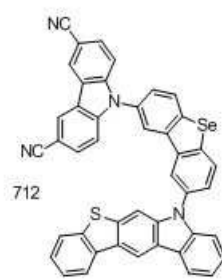
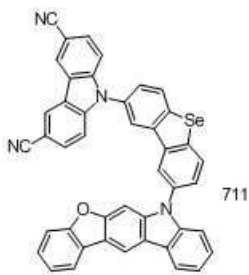
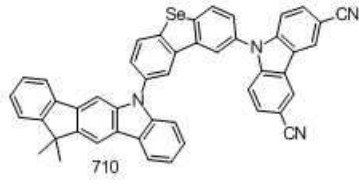
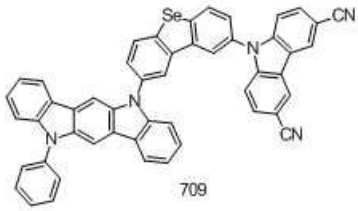
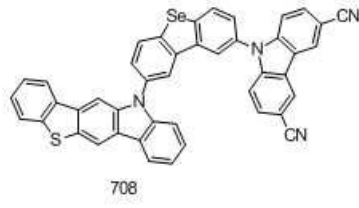
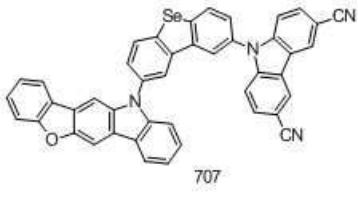


[0304]

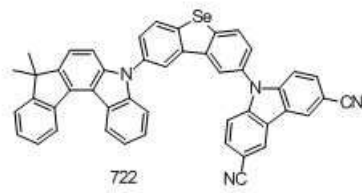
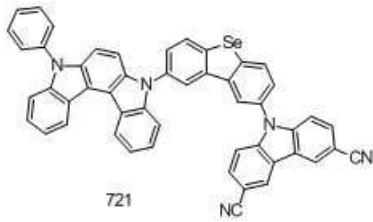
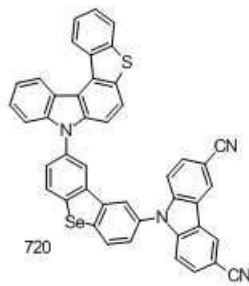
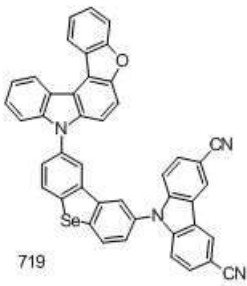
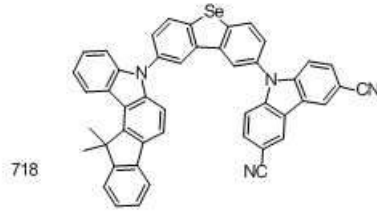
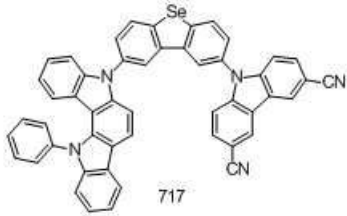
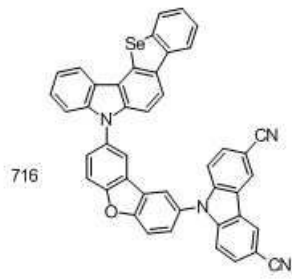
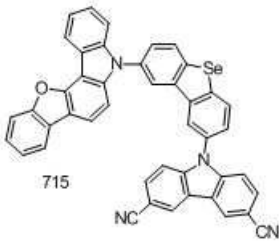


[0305]

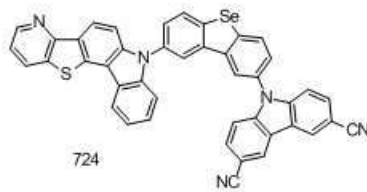
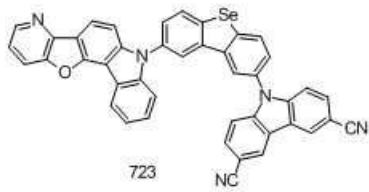




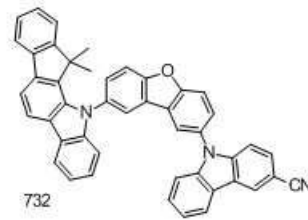
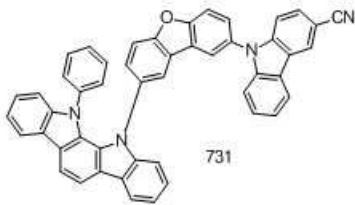
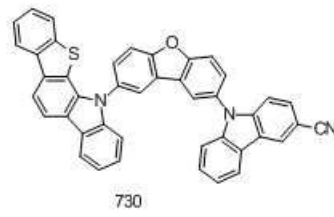
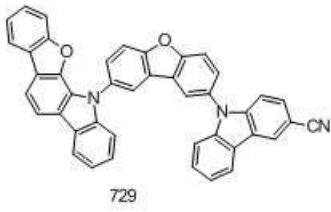
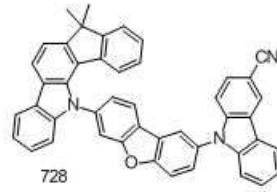
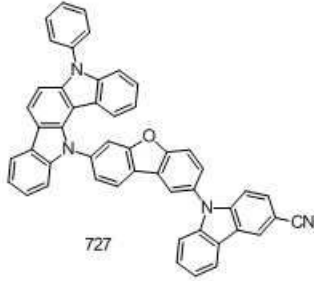
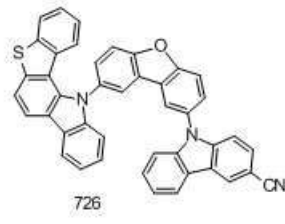
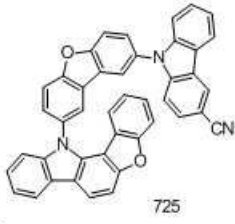
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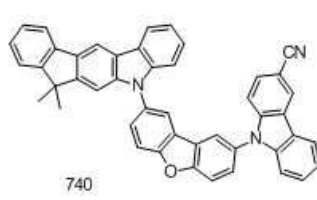
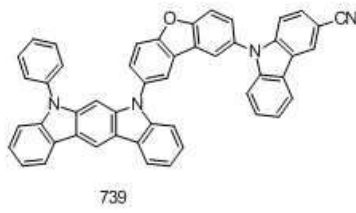
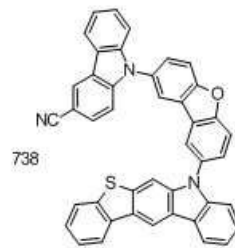
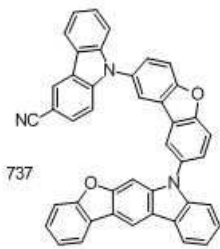
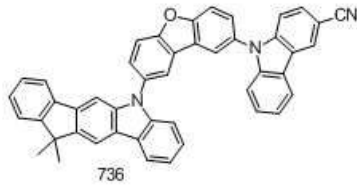
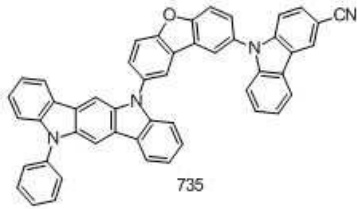
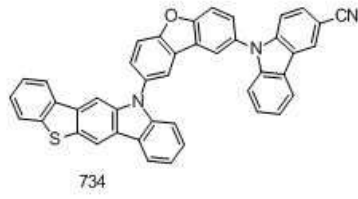
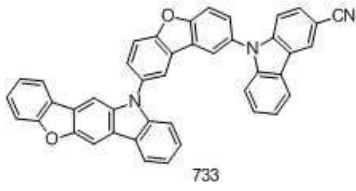
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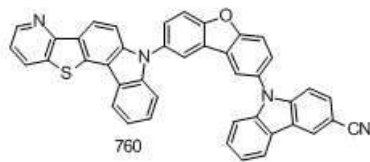
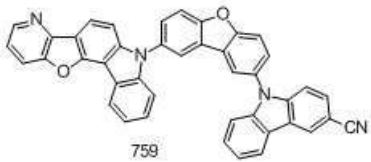
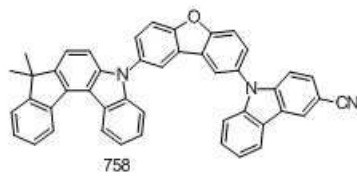
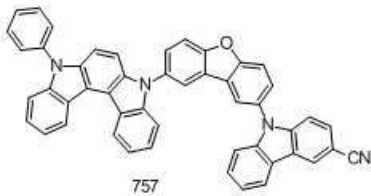
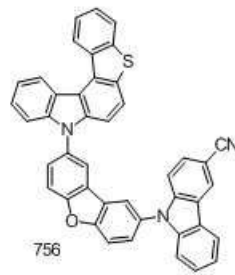
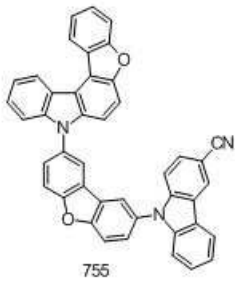
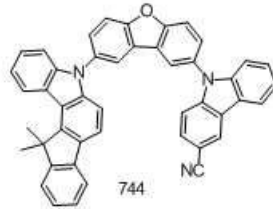
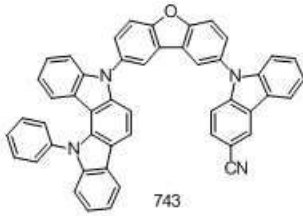
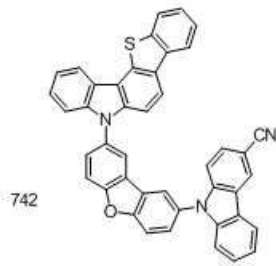
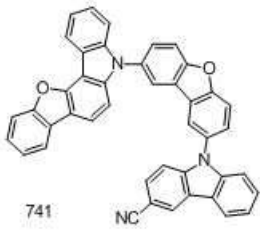
[0308]



[0309]

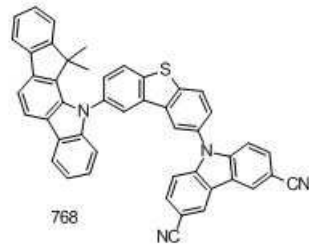
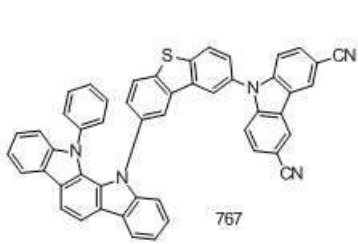
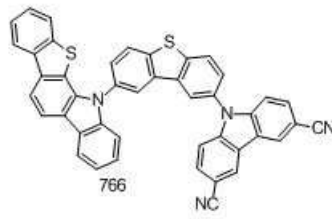
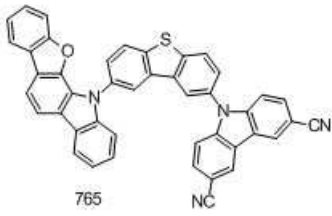
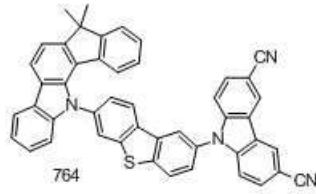
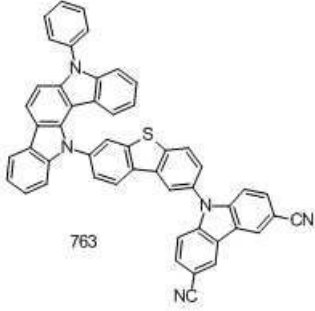
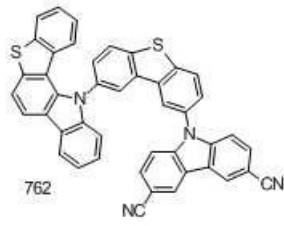
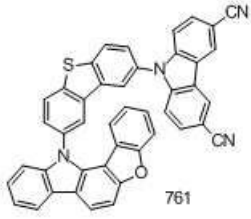


[0310]

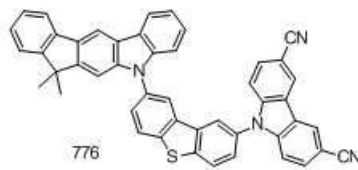
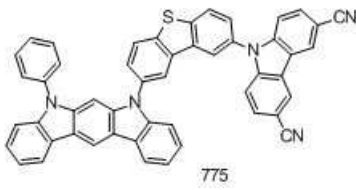
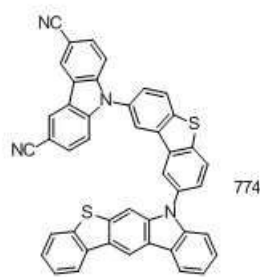
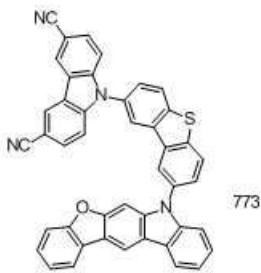
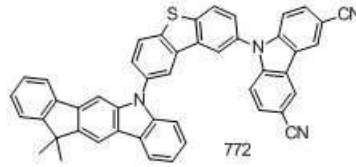
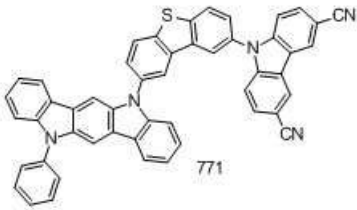
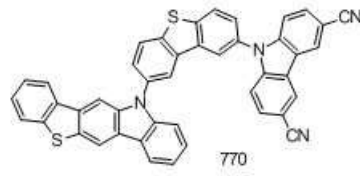
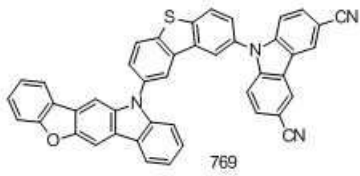


[0311]

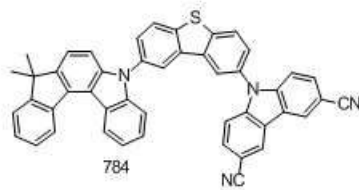
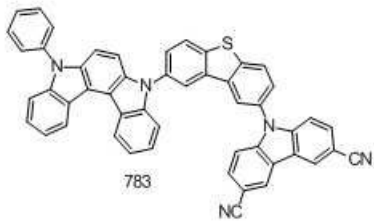
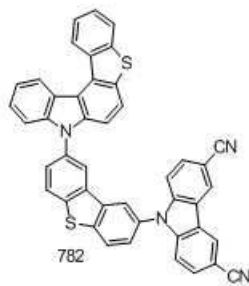
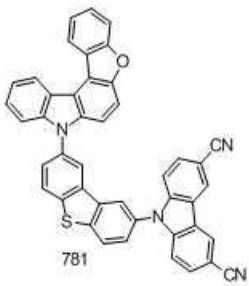
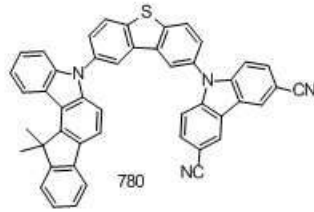
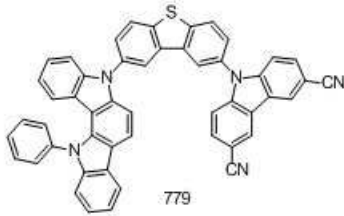
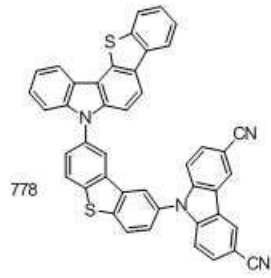
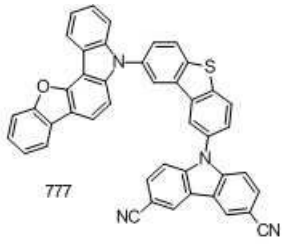
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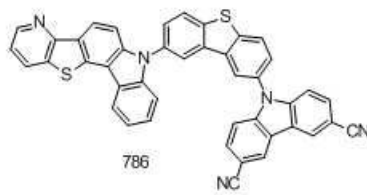
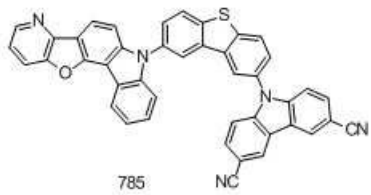
[0313]



[0314]

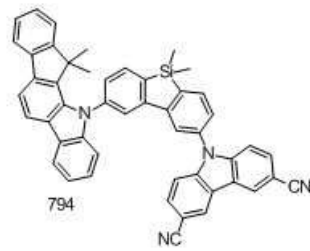
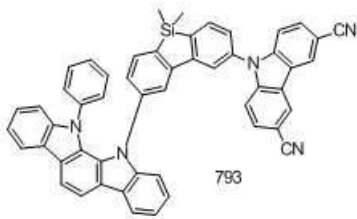
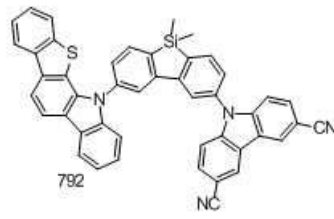
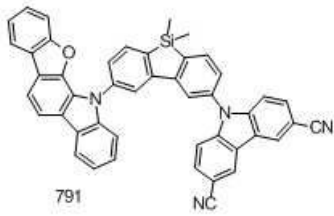
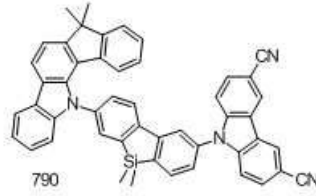
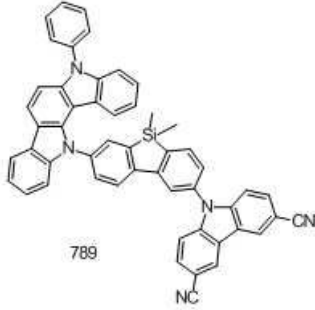
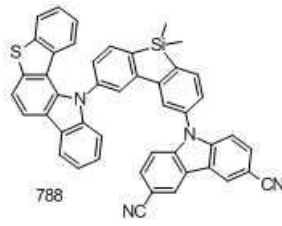
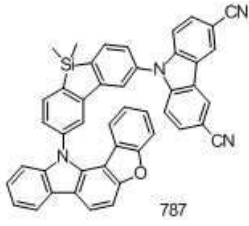


[0315]

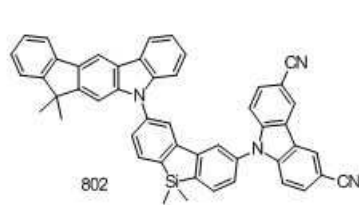
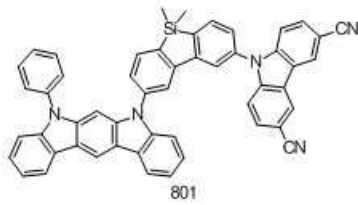
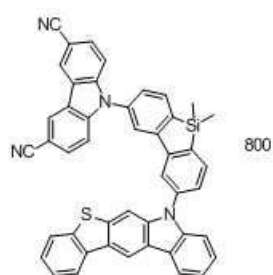
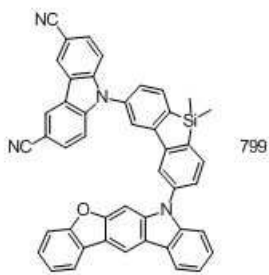
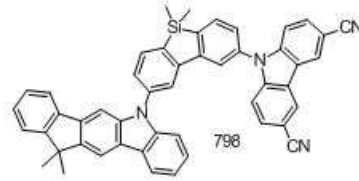
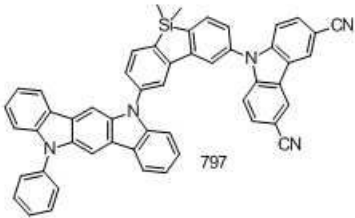
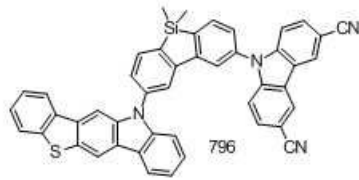
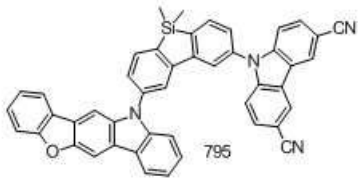


[0316]

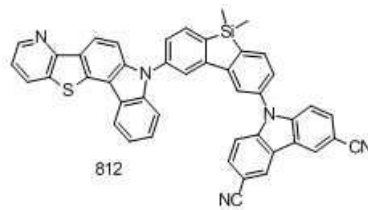
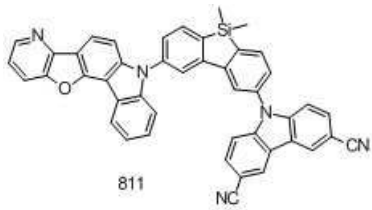
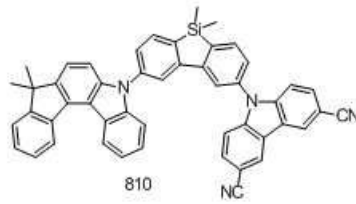
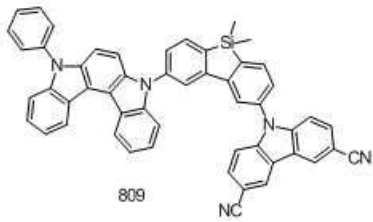
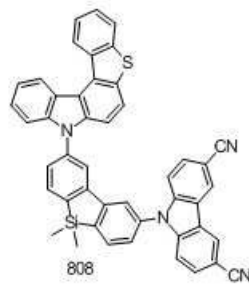
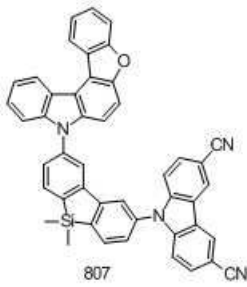
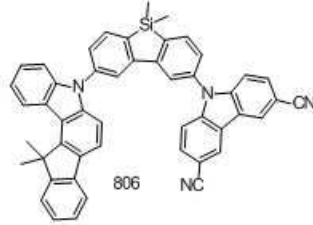
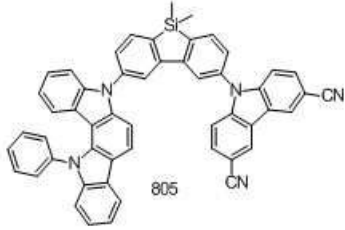
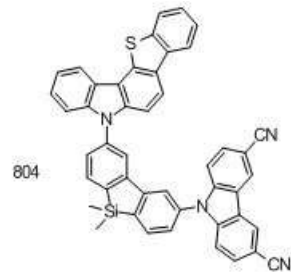
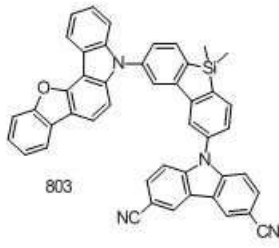




[0317]

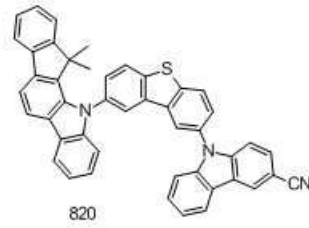
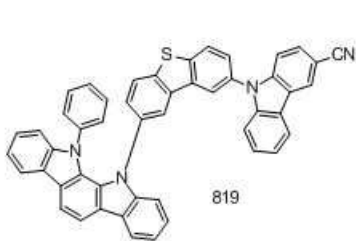
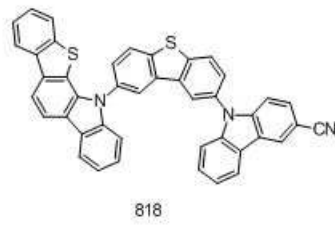
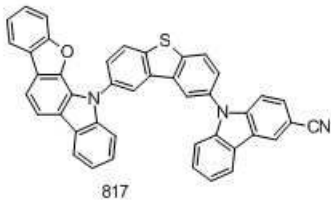
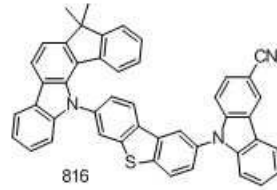
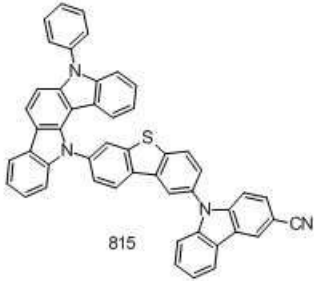
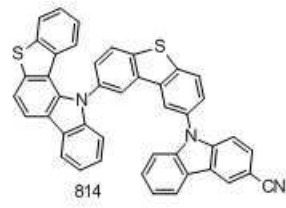


[0318]

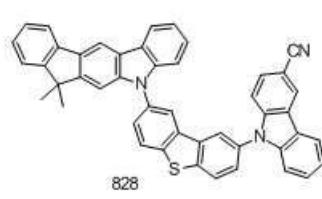
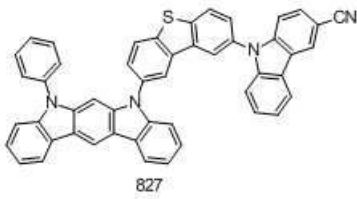
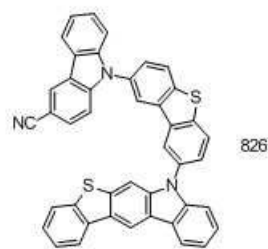
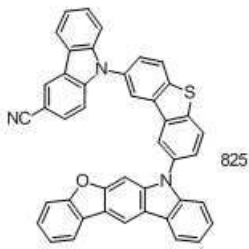
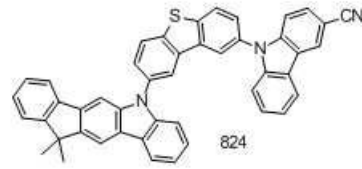
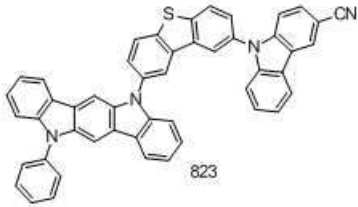
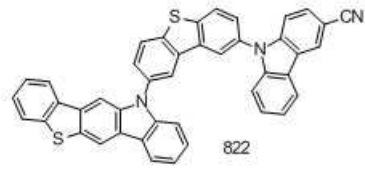
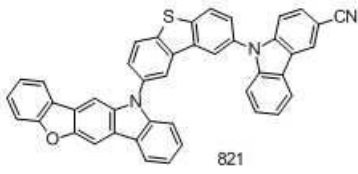


[0319]

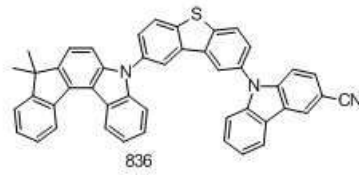
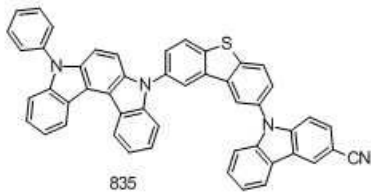
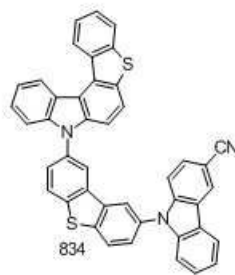
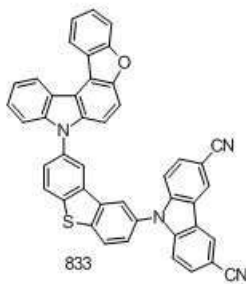
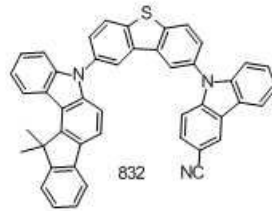
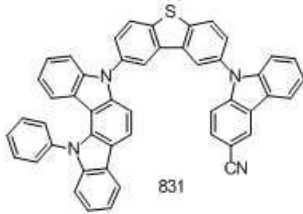
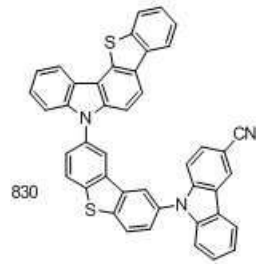
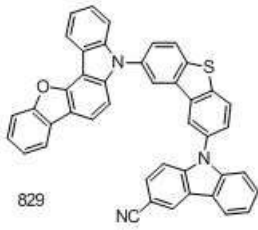
[0320]



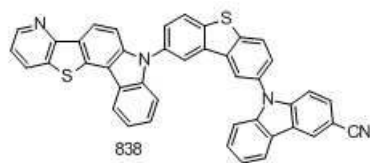
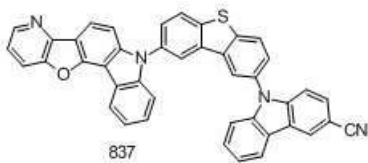
[0321]



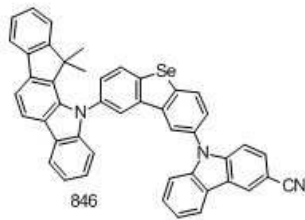
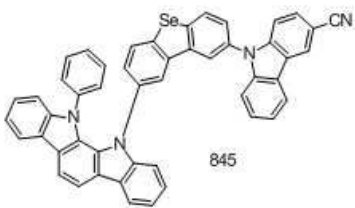
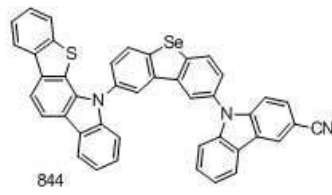
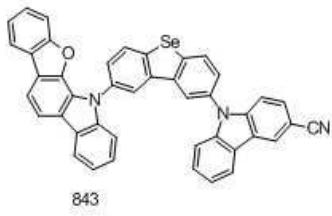
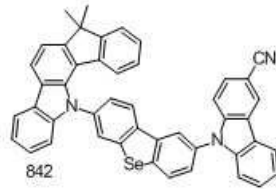
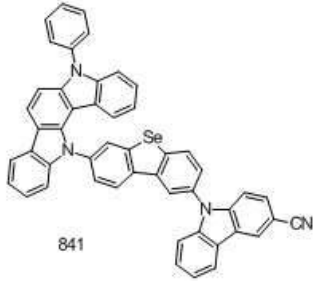
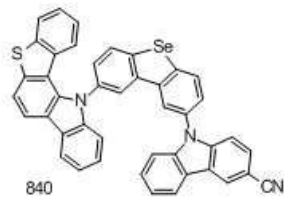
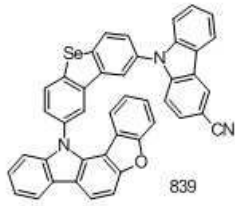
[0322]



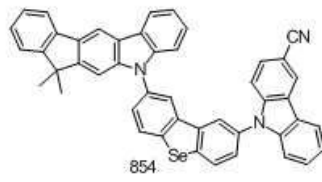
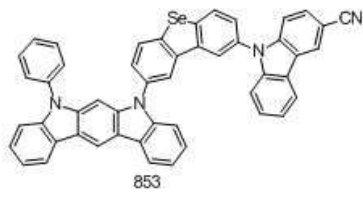
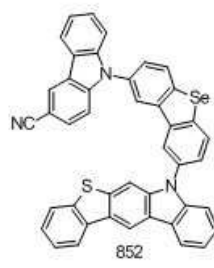
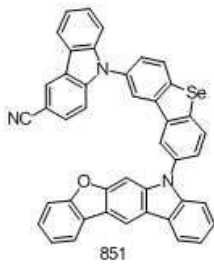
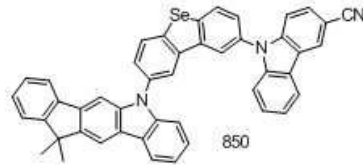
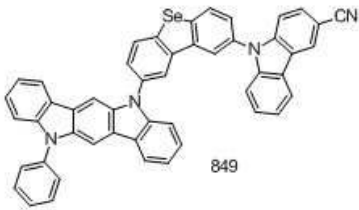
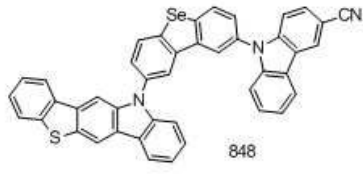
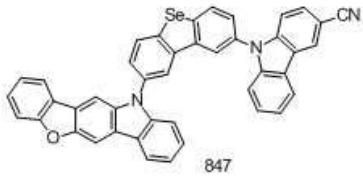
[0323]



[0324]

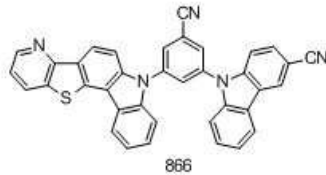
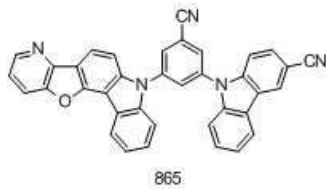
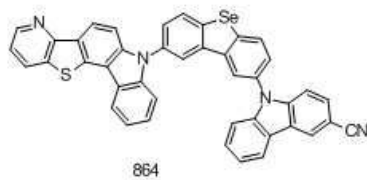
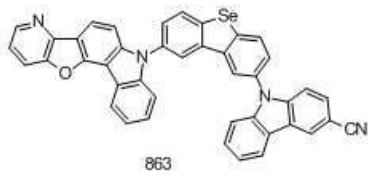
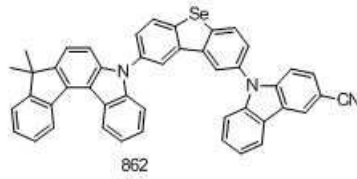
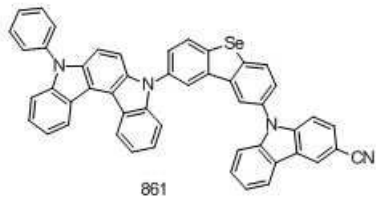
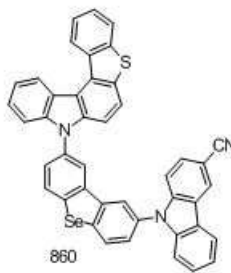
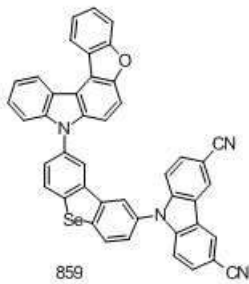
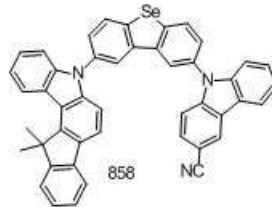
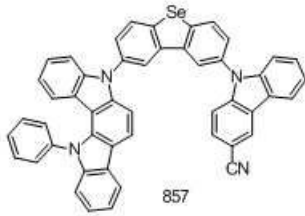
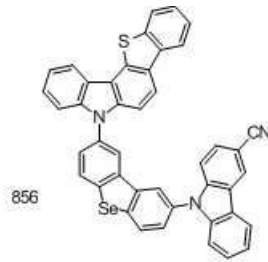
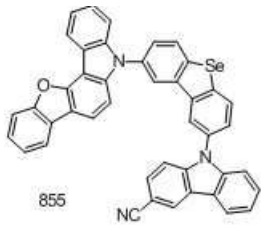


[0325]



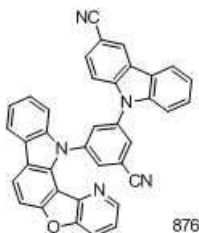
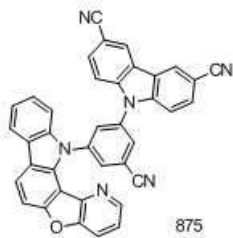
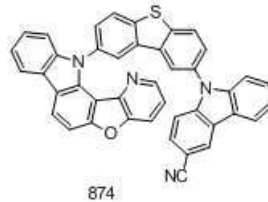
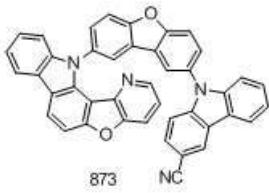
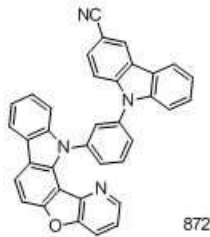
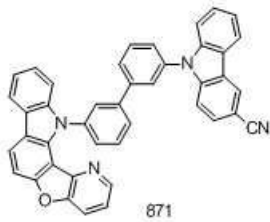
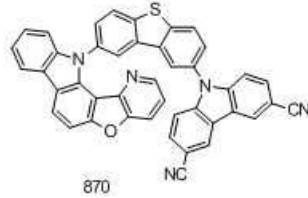
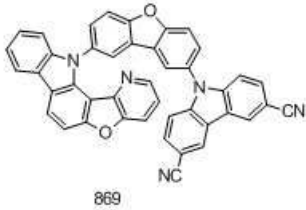
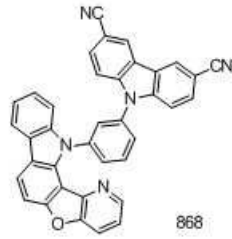
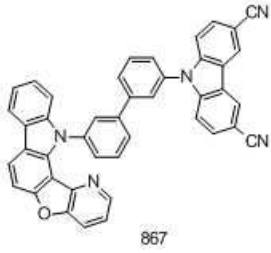
[0326]





[0327]

[0328]



[0329]

[0330]

[0331]

상기 화학식 1 중  $CY_1$ 은 하기 화학식 2로 표시된다. 따라서, 상기 화학식 1로 표시되는 축합환 화합물은 높은 삼중항 에너지를 유지함과 동시에 우수한 내열성을 지닌 특성을 가질 수 있다. 또한 전기적 특성 (예를 들면, HOMO, LUMO 에너지 레벨 등)이 정공 이동을 강화시킬 수 있도록 제어하기에 용이하다. 따라서, 상기 화학식 1로 표시되는 축합환 화합물은 전자 소자, 예를 들면, 유기 발광 소자용 재료(예를 들면, 발광층 중 호스트 재료, 공통층)으로서 적합한 삼중항( $T_1$ ) 에너지 레벨 및 HOMO/LUMO 에너지 레벨을 가질 수 있다.

[0332]

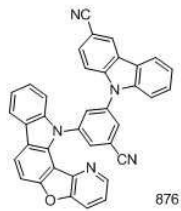
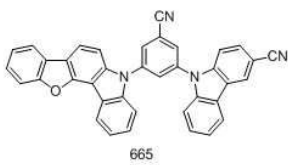
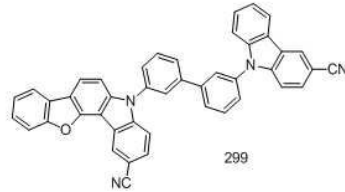
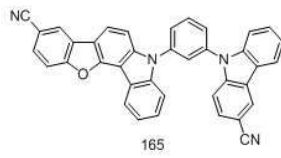
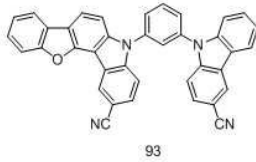
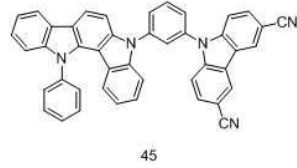
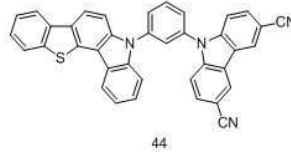
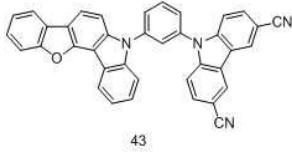
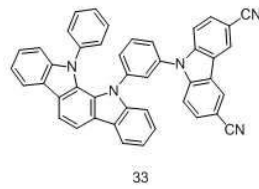
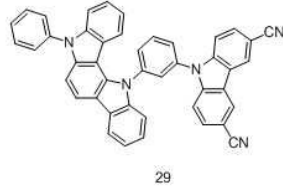
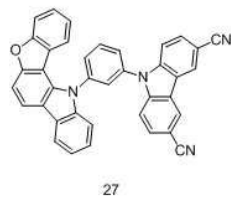
또한, 상기 화학식 1로 표시되는 축합환 화합물 중  $X_7$ ,  $X_8$ ,  $X_{14}$  및  $X_{21}$  내지  $X_{28}$  중 적어도 하나는, 반드시 C(CN)이다. 이로써, 상기 화학식 1로 표시되는 축합환 화합물의 전기적 특성(예를 들면, HOMO, LUMO 에너지 레벨 등)은 전하(예를 들면, 전자) 이동을 강화시킬 수 있도록 제어하기에 용이하고 우수한 내열성을 가질 수 있다.

[0333]

예를 들어, 상기 화합물 27, 29, 33, 43, 45, 93, 165, 299, 665, 876 및 A 내지 C에 대한 HOMO, LUMO,  $T_1$  및  $S_1$  에너지 레벨에 대하여 Gaussian 프로그램을 이용하여 시뮬레이션 평가한 결과는 하기 표 1과 같다:

표 1

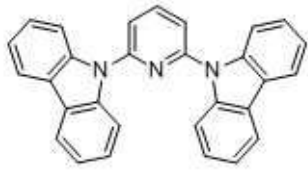
	HOMO (eV)	LUMO (eV)	T <sub>1</sub> (eV)	S <sub>1</sub> (eV)
화합물 27	-5.750	-1.768	2.991	3.612
화합물 29	-5.348	-1.662	2.967	3.360
화합물 33	-5.503	-1.658	2.904	3.295
화합물 43	-5.626	-1.717	2.998	3.550
화합물 44	-5.655	-1.730	2.961	3.573
화합물 45	-5.342	-1.682	2.949	3.317
화합물 93	-5.825	-1.463	2.978	3.783
화합물 165	-5.817	-1.447	2.992	3.821
화합물 299	-5.713	-1.651	2.978	3.585
화합물 665	-5.703	-2.131	2.839	3.032
화합물 876	-5.885	-1.971	2.936	3.300
화합물 A	-5.450	-1.080	3.160	3.330
화합물 B	-5.069	-0.770	2.967	3.356
화합물 C	-5.802	-1.703	3.080	3.430



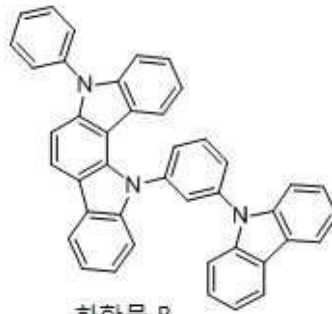
[0334]

[0335]

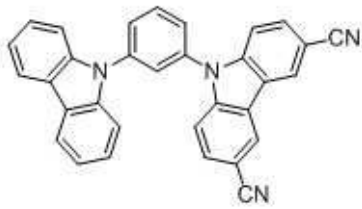
[0336]



화합물 A



화합물 B

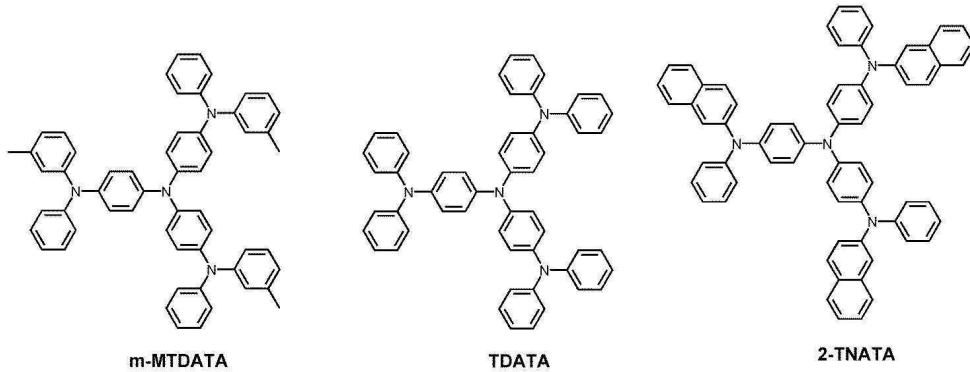


화합물 C

- [0337]
- [0338] 상기 표 1로부터 상기 화학식 1로 표시되는 축합환 화합물은 우수한 전기적 특성, 예를 들면, 높은  $T_1$  에너지 레벨을 가짐을 확인할 수 있다.
- [0339] 상기 화학식 1로 표시되는 축합환 화합물의 합성 방법은, 후술하는 합성예를 참조하여, 당업자가 인식할 수 있다.
- [0340] 상기 화학식 1로 표시되는 축합환 화합물은 유기 발광 소자의 유기층, 예를 들면, 상기 유기층 중 발광층 및/또는 전자/정공 수송 영역 재료로 사용하기 적합할 수 있는 바, 다른 측면에 따르면, 제1전극; 제2전극; 및 상기 제1전극과 상기 제2전극 사이에 개재되고 발광층을 포함한 유기층;을 포함하고, 상기 유기층은 상기 화학식 1로 표시되는 축합환 화합물을 적어도 1종 이상 포함한, 유기 발광 소자가 제공된다.
- [0341] 상기 유기 발광 소자는 상술한 바와 같은 화학식 1로 표시되는 축합환 화합물을 포함한 유기층을 구비함으로써, 고효율 및 장수명을 가질 수 있다.
- [0342] 예를 들어, 상기 화학식 1로 표시되는 축합환 화합물은 상기 발광층에 포함되어 있을 수 있다.
- [0343] 다른 예로서, 상기 화학식 1로 표시되는 축합환 화합물은 상기 발광층에 포함되어 있고, 상기 화학식 1로 표시되는 축합환 화합물은 지연 형광 재료일 수 있다.
- [0344] 일 구현예에 따르면, 상기 발광층은 호스트 및 도펀트를 포함(상기 호스트의 함량은 상기 도펀트의 함량보다 큼)하고, 상기 호스트는 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다. 호스트의 역할을 하는 상기 축합환 화합물은 지연 형광 방출 메커니즘에 의하여 도펀트로의 에너지를 전달할 수 있다. 상기 도펀트는 형광 도펀트 및 인광 도펀트 중 적어도 하나를 포함할 수 있다. 상기 도펀트는 공지된 임의의 도펀트 중에서 선택될 수 있다. 상기 호스트는 공지된 호스트 중에서 선택된 임의의 호스트를 더 포함할 수 있다.
- [0345] 또 다른 구현예에 따르면, 상기 발광층은 호스트 및 도펀트를 포함(상기 호스트의 함량은 상기 도펀트의 함량보다 큼)하고, 상기 도펀트는 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다. 도펀트의 역할을 하는 상기 축합환 화합물은 지연 형광 방출 메커니즘에 의하여 지연 형광을 방출할 수 있다. 상기 호스트는 공지된 임의의 도펀트 중에서 선택될 수 있다.
- [0346] 상기 발광층은 적색, 녹색 또는 청색광을 방출할 수 있다.
- [0347] 일 구현예에 따르면, 상기 발광층은 인광 도펀트를 포함한 청색 발광층일 수 있으나, 이에 한정되는 것은 아니다.

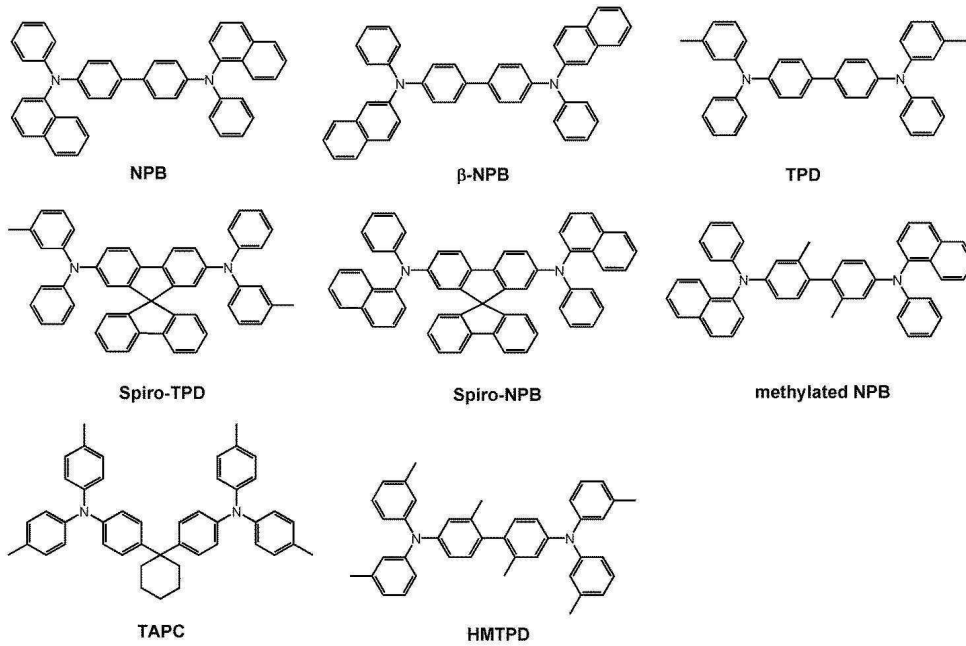
- [0348] 또 다른 예로서, 상기 화학식 1로 표시되는 축합환 화합물은 전자 수송 영역에 포함될 수 있다.
- [0349] 예를 들어, 상기 유기 발광 소자의 전자 수송 영역은 정공 저지층 및 전자 수송층 중 하나 이상을 포함하고, 상기 전자 저지층 및 전자 수송층 중 하나 이상은 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다.
- [0350] 일 구현예에 따르면, 상기 유기 발광 소자의 전자 수송 영역은 정공 전지층을 포함하고, 상기 정공 전지층에 상기 화학식 1로 표시되는 축합환 화합물이 포함될 수 있다. 상기 정공 저지층은 상기 발광층에 직접(directly) 접촉될 수 있다.
- [0351] 본 명세서 중 "(유기층이) 축합환 화합물을 1종 이상 포함한다"란, "(유기층이) 상기 화학식 1의 범주에 속하는 1종의 축합환 화합물 또는 상기 화학식 1의 범주에 속하는 서로 다른 2종 이상의 축합환 화합물을 포함할 수 있다"로 해석될 수 있다.
- [0352] 예를 들어, 상기 유기층은 상기 축합환 화합물로서, 상기 화합물 1만을 포함할 수 있다. 이 때, 상기 화합물 1은 상기 유기 발광 소자의 발광층에 존재할 수 있다. 또는, 상기 유기층은 상기 축합환 화합물로서, 상기 화합물 1과 화합물 2를 포함할 수 있다. 이 때, 상기 화합물 1과 화합물 2는 동일한 층에 존재(예를 들면, 상기 화합물 1과 화합물 2는 모두 발광층에 존재할 수 있음)하거나, 서로 다른 층(예를 들면, 상기 화합물 1은 발광층에 존재하고, 상기 화합물 2는 정공 저지층에 존재할 수 있음)에 존재할 수 있다.
- [0353] 상기 제1전극은 정공 주입 전극인 애노드이고 상기 제2전극은 전자 주입 전극인 캐소드이거나, 상기 제1전극은 전자 주입 전극인 캐소드이고 상기 제2전극은 정공 주입 전극인 애소드이다.
- [0354] 예를 들어, 상기 유기 발광 소자 중,
- [0355] 제1전극은 애노드이고, 상기 제2전극은 캐소드이고,
- [0356] 상기 유기층은, 상기 제1전극과 상기 발광층 사이에 개재된 정공 수송 영역 및 상기 발광층과 상기 제2전극 사이에 개재된 전자 수송 영역을 포함하고,
- [0357] 상기 정공 수송 영역은, 정공 주입층, 정공 수송층 및 전자 저지층 중에서 선택된 적어도 하나를 포함하고,
- [0358] 상기 전자 수송 영역은, 정공 저지층, 전자 수송층 및 전자 주입층 중에서 선택된 적어도 하나를 포함할 수 있다.
- [0359] 본 명세서 중 "유기층"은 유기 발광 소자 중 제1전극과 제2전극 사이에 개재된 단일 및/또는 복수의 층을 가리키는 용어이다. 상기 "유기층"은 유기 화합물뿐만 아니라, 금속을 포함한 유기금속 착체 등도 포함할 수 있다.
- [0360] 도 1은 본 발명의 일 구현예를 따르는 유기 발광 소자(10)의 단면도를 개략적으로 도시한 것이다. 이하, 도 1을 참조하여 본 발명의 일 구현예를 따르는 유기 발광 소자의 구조 및 제조 방법을 설명하면 다음과 같다. 유기 발광 소자(10)는 제1전극(11), 유기층(15) 및 제2전극(19)이 차례로 적층된 구조를 갖는다.
- [0361] 상기 제1전극(11) 하부 또는 제2전극(19) 상부에는 기판이 추가로 배치될 수 있다. 상기 기판으로는, 통상적인 유기 발광 소자에서 사용되는 기판을 사용할 수 있는데, 기계적 강도, 열안정성, 투명성, 표면 평활성, 취급용이성 및 방수성이 우수한 유리 기판 또는 투명 플라스틱 기판을 사용할 수 있다.
- [0362] 상기 제1전극(11)은 예를 들면, 기판 상부에, 제1전극용 물질을 증착법 또는 스퍼터링법 등을 이용하여 제공함으로써 형성될 수 있다. 상기 제1전극(11)은 애노드일 수 있다. 상기 제1전극용 물질은 정공 주입이 용이하도록 높은 일함수를 갖는 물질 중에서 선택될 수 있다. 상기 제1전극(11)은 반사형 전극, 반투과형 전극 또는 투과형 전극일 수 있다. 제1전극용 물질로는 산화인듐주석(ITO), 산화인듐아연(IZO), 산화주석(SnO<sub>2</sub>), 산화아연(ZnO) 등을 이용할 수 있다. 또는, 마그네슘(Mg), 알루미늄(Al), 알루미늄-리튬(Al-Li), 칼슘(Ca), 마그네슘-인듐(Mg-In), 마그네슘-은(Mg-Ag)등과 같은 금속을 이용할 수 있다.
- [0363] 상기 제1전극(11)은 단일층 또는 2 이상의 층을 포함한 다층 구조를 가질 수 있다. 예를 들어, 상기 제1전극(11)은 ITO/Ag/ITO의 3층 구조를 가질 수 있으나, 이에 한정되는 것은 아니다.
- [0364] 상기 제1전극(11) 상부로는 유기층(15)이 배치되어 있다.
- [0365] 상기 유기층(15)은 정공 수송 영역(hole transport region); 발광층(emission layer); 및 전자 수송 영역(electron transport region);을 포함할 수 있다.
- [0366] 상기 정공 수송 영역은 제1전극(11)과 발광층 사이에 배치될 수 있다.

- [0367] 상기 정공 수송 영역은 정공 주입층, 정공 수송층, 전자 저지층 및 버퍼층 중 적어도 하나를 포함할 수 있다.
- [0368] 상기 정공 수송 영역은 정공 주입층만을 포함하거나, 정공 수송층만을 포함할 수 있다. 또는, 상기 정공 수송 영역은, 제1전극(11)로부터 차례로 적층된, 정공 주입층/정공 수송층 또는 정공 주입층/정공 수송층/전자 저지층의 구조를 가질 수 있다.
- [0369] 정공 수송 영역이 정공 주입층을 포함할 경우, 정공 주입층(HIL)은 상기 제1전극(11) 상부에 진공증착법, 스핀 코팅법, 캐스트법, LB법 등과 같은 다양한 방법을 이용하여 형성될 수 있다.
- [0370] 진공 증착법에 의하여 정공 주입층을 형성하는 경우, 그 증착 조건은 정공 주입층 재료로 사용하는 화합물, 목적으로 하는 정공 주입층의 구조 및 열적 특성 등에 따라 다르지만, 예를 들면, 증착온도 약 100 내지 약 500℃, 진공도 약  $10^{-8}$  내지  $10^{-3}$  torr, 증착 속도 약 0.01 내지 약 100Å/sec의 범위에서 선택될 수 있으며, 이에 한정되는 것은 아니다.
- [0371] 스핀 코팅법에 의하여 정공 주입층을 형성하는 경우, 코팅 조건은 정공주입층 재료로 사용하는 화합물, 목적하는 하는 정공 주입층의 구조 및 열적 특성에 따라 상이하지만, 약 2000rpm 내지 약 5000rpm의 코팅 속도, 코팅 후 용매 제거를 위한 열처리 온도는 약 80℃ 내지 200℃의 온도 범위에서 선택될 수 있으며, 이에 한정되는 것은 아니다.
- [0372] 상기 정공 수송층 및 전자 저지층 형성 조건은 정공 주입층 형성 조건을 참조한다.
- [0373] 상기 정공 수송 영역은, 예를 들면, m-MTDATA, TDATA, 2-TNATA, NPB, β-NPB, TPD, Spiro-TPD, Spiro-NPB, methylated-NPB, TAPC, HMTPD, TCTA(4,4',4"-트리스(N-카바졸일)트리페닐아민(4,4',4"-tris(N-carbazolyl)triphenylamine)), Pani/DBSA (Polyaniline/Dodecylbenzenesulfonic acid:폴리아닐린/도데실벤젠술포산), PEDOT/PSS(Poly(3,4-ethylenedioxythiophene)/Poly(4-styrenesulfonate):폴리(3,4-에틸렌디옥시티오펜)/폴리(4-스티렌술포네이트)), Pani/CSA (Polyaniline/Camphor sulfonicacid:폴리아닐린/캄퍼술포산), PANI/PSS (Polyaniline)/Poly(4-styrenesulfonate):폴리아닐린/폴리(4-스티렌술포네이트)), 하기 화학식 201로 표시되는 화합물 및 하기 화학식 202로 표시되는 화합물 중 적어도 하나를 포함할 수 있다:



[0374]

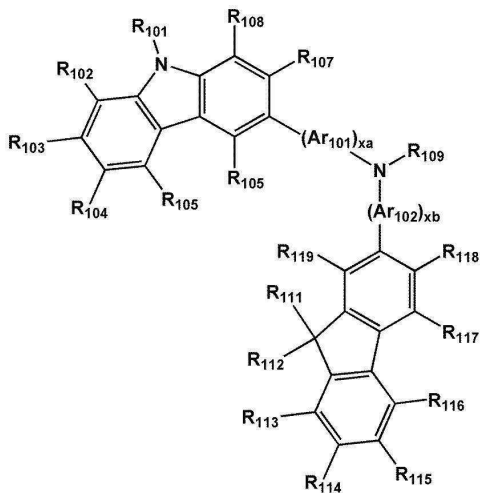




[0375]

[0376]

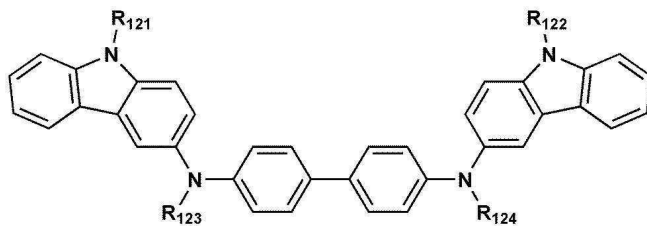
<화학식 201>



[0377]

[0378]

<화학식 202>



[0379]

[0380]

상기 화학식 201 중, Ar<sub>101</sub> 및 Ar<sub>102</sub>는 서로 독립적으로,

[0381]

페닐렌기, 펜타레닐렌기, 인데닐렌기, 나프틸렌기, 아줄레닐렌기, 헵탈레닐렌기, 아세나프틸렌기, 플루오레닐렌기, 페나레닐렌기, 페난트레닐렌기, 안트라세닐렌기, 플루오란테닐렌기, 트리페닐레닐렌기, 파이레닐렌기, 크라이세닐레닐렌기, 나프타세닐렌기, 피세닐렌기, 페릴레닐렌기 및 펜타세닐렌기; 및

[0382]

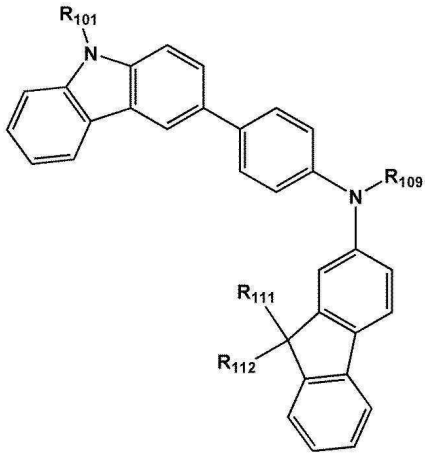
중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>2</sub>-C<sub>60</sub>알케닐기, C<sub>2</sub>-C<sub>60</sub>알키닐기, C<sub>1</sub>-C<sub>60</sub>알콕시기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시

클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>6</sub>-C<sub>60</sub>아릴옥시기, C<sub>6</sub>-C<sub>60</sub>아릴티오기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹 중에서 선택된 적어도 하나로 치환된, 페닐렌기, 펜타레닐렌기, 인데닐렌기, 나프틸렌기, 아줄레닐렌기, 헵탈레닐렌기, 아세나프틸렌기, 플루오레닐렌기, 페나레닐렌기, 페난트레닐렌기, 안트라세닐렌기, 플루오란테닐렌기, 트리페닐레닐렌기, 파이레닐렌기, 크라이세닐레닐렌기, 나프타세닐렌기, 피세닐렌기, 페틸레닐렌기 및 펜타세닐렌기;

- [0383] 중에서 선택될 수 있다.
- [0384] 상기 화학식 201 중, 상기 xa 및 xb는 서로 독립적으로 0 내지 5의 정수, 또는 0, 1 또는 2일 수 있다. 예를 들어, 상기 xa는 1이고, xb는 0일 수 있으나, 이에 한정되는 것은 아니다.
- [0385] 상기 화학식 201 및 202 중, 상기 R<sub>101</sub> 내지 R<sub>108</sub>, R<sub>111</sub> 내지 R<sub>119</sub> 및 R<sub>121</sub> 내지 R<sub>124</sub>는 서로 독립적으로,
- [0386] 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기(예를 들면, 메틸기, 에틸기, 프로필기, 부틸기, 펜틸기, 헥실기 등) 및 C<sub>1</sub>-C<sub>10</sub>알콕시기(예를 들면, 메톡시기, 에톡시기, 프로폭시기, 부톡시기, 펜톡시기 등);
- [0387] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염 및 인산기 또는 이의 염, 중 하나 이상으로 치환된, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기;
- [0388] 페닐기, 나프틸기, 안트라세닐기, 플루오레닐기 및 파이레닐기; 및
- [0389] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>10</sub>알킬기 및 C<sub>1</sub>-C<sub>10</sub>알콕시기 중 하나 이상으로 치환된, 페닐기, 나프틸기, 안트라세닐기, 플루오레닐기 및 파이레닐기;
- [0390] 중에서 선택될 수 있으나, 이에 한정되는 것은 아니다.
- [0391] 상기 화학식 201 중, R<sub>109</sub>는,
- [0392] 페닐기, 나프틸기, 안트라세닐기 및 피리디닐기; 및
- [0393] 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>20</sub>알킬기, C<sub>1</sub>-C<sub>20</sub>알콕시기, 페닐기, 나프틸기, 안트라세닐기 및 피리디닐기 중 하나 이상으로 치환된, 페닐기, 나프틸기, 안트라세닐기 및 피리디닐기;
- [0394] 중에서 선택될 수 있다.
- [0395] 일 구현예에 따르면, 상기 화학식 201로 표시되는 화합물은 하기 화학식 201A로 표시될 수 있으나, 이에 한정되는 것은 아니다:



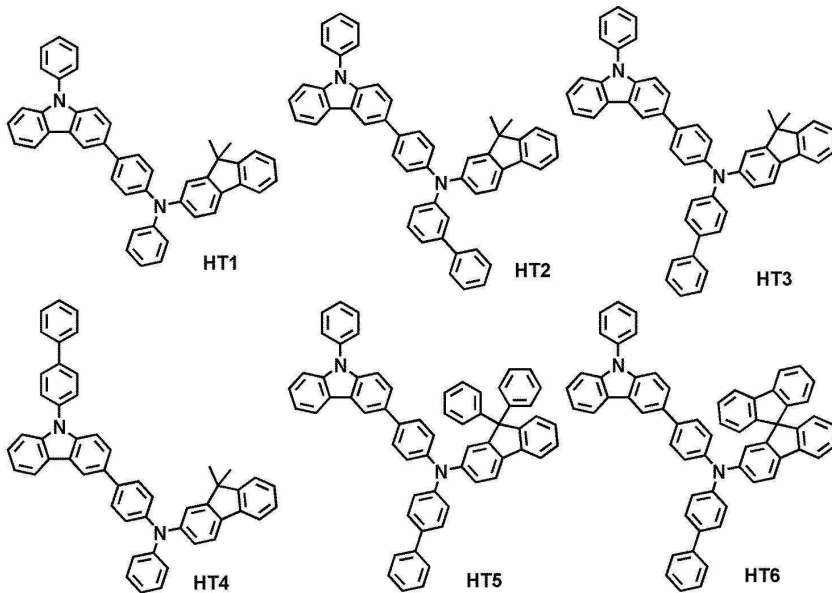
[0396] <화학식 201A>



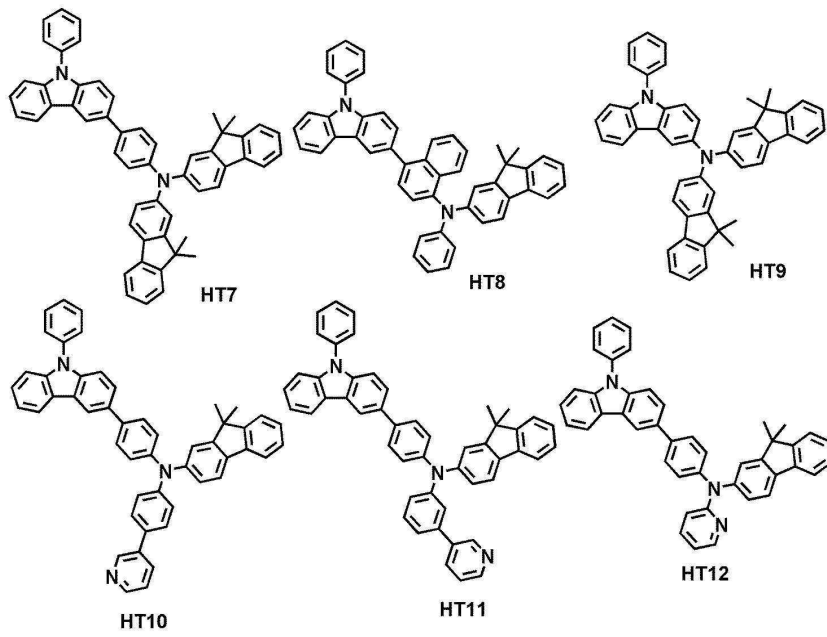
[0397]

[0398] 상기 화학식 201A 중, R<sub>101</sub>, R<sub>111</sub>, R<sub>112</sub> 및 R<sub>109</sub>에 대한 상세한 설명은 상술한 바를 참조한다.

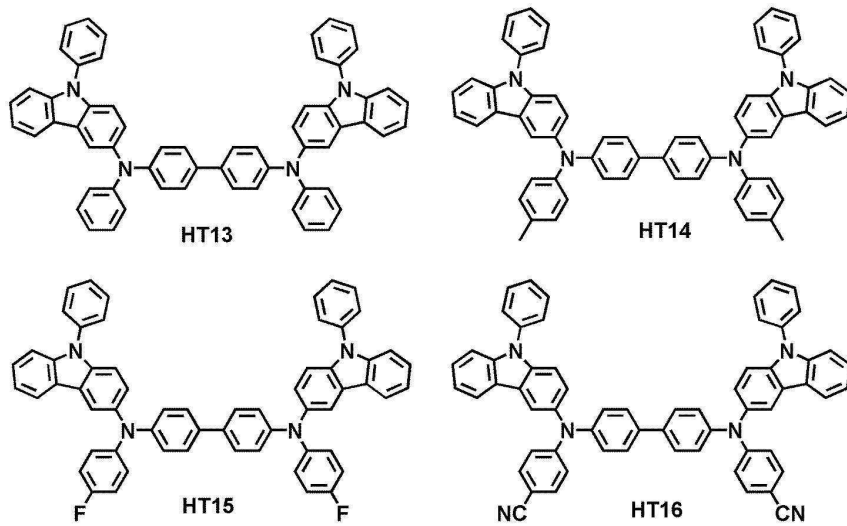
[0399] 예를 들어, 상기 화학식 201로 표시되는 화합물 및 상기 화학식 202로 표시되는 화합물은 하기 화합물 HT1 내지 HT20을 포함할 수 있으나, 이에 한정되는 것은 아니다:



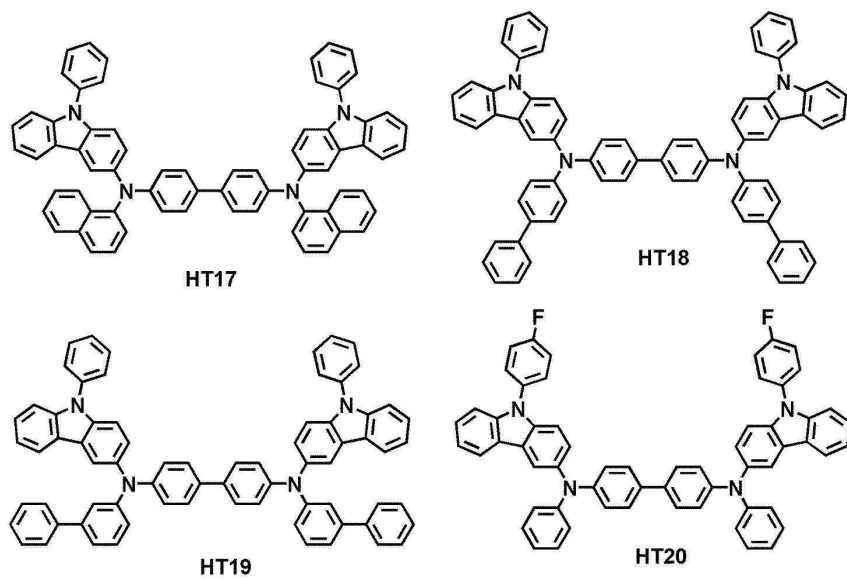
[0400]



[0401]



[0402]



[0403]

[0404]

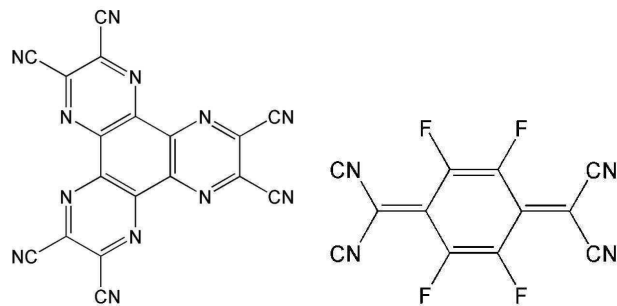
상기 정공 수송 영역의 두께는 약 100Å 내지 약 10000Å, 예를 들면, 약 100Å 내지 약 1000Å일 수 있다. 상기 정공 수송 영역이 정공 주입층 및 정공 수송층 중 적어도 하나를 포함한다면, 상기 정공 주입층의 두께는 약

100Å 내지 약 10000Å, 예를 들면, 약 100Å 내지 약 1000Å이고, 상기 정공 수송층의 두께는 약 50Å 내지 약 2000Å, 예를 들면 약 100Å 내지 약 1500Å일 수 있다. 상기 정공 수송 영역, 정공 주입층 및 정공 수송층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 정공 수송 특성을 얻을 수 있다.

[0405] 상기 정공 수송 영역은 상술한 바와 같은 물질 외에, 도전성 향상을 위하여 전하-생성 물질을 더 포함할 수 있다. 상기 전하-생성 물질은 상기 정공 수송 영역 내에 균일하게 또는 불균일하게 분산되어 있을 수 있다.

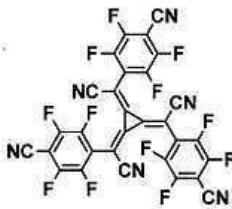
[0406] 상기 전하-생성 물질은 예를 들면, p-도펀트일 수 있다. 상기 p-도펀트는 퀴논 유도체, 금속 산화물 및 시아노기-함유 화합물 중 하나일 수 있으나, 이에 한정되는 것은 아니다. 예를 들어, 상기 p-도펀트의 비제한적인 예로는, 테트라시아이아노퀴논다이메테인(TCNQ) 및 2,3,5,6-테트라플루오로-테트라시아이아노-1,4-벤조퀴논다이메테인(F4-TCNQ) 등과 같은 퀴논 유도체; 텅스텐 산화물 및 몰리브덴 산화물 등과 같은 금속 산화물; 및 하기 화합물 HT-D1, HP-1 등과 같은 시아노기-함유 화합물 등을 들 수 있으나, 이에 한정되는 것은 아니다.

[0407] <화합물 HT-D1> <F4-TCNQ>



[0408]

[0409] <HP-1>



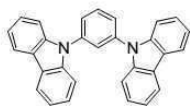
[0410]

[0411] 상기 정공 수송 영역은, 버퍼층을 더 포함할 수 있다.

[0412] 상기 버퍼층은 발광층에서 방출되는 광의 파장에 따른 광학적 공진 거리를 보상하여 효율을 증가시키는 역할을 할 수 있다.

[0413] 상기 정공 수송 영역 상부에 진공 증착법, 스핀 코팅법, 캐스트법, LB법 등과 같은 방법을 이용하여 발광층(EML)을 형성할 수 있다. 진공 증착법 및 스핀 코팅법에 의해 발광층을 형성하는 경우, 그 증착 조건 및 코팅 조건은 사용하는 화합물에 따라 다르지만, 일반적으로 정공 주입층의 형성과 거의 동일한 조건범위 중에서 선택될 수 있다.

[0414] 상기 정공 수송 영역은, 전자 저지층을 더 포함할 수 있다. 상기 전자 저지층은 공지의 물질, 예를 들면, mCP를 포함할 수 있으나, 이에 한정되는 것은 아니다.



mCP

[0415]

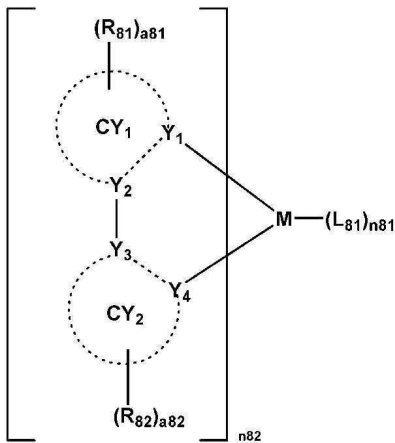
[0416] 상기 전자 저지층의 두께는 약 50Å 내지 약 1000Å, 예를 들면, 약 70Å 내지 약 500Å일 수 있다. 상기 전자 저지층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 전자 저지 특성을 얻을 수 있다.

[0417] 상기 유기 발광 소자가 풀 컬러 유기 발광 소자일 경우, 발광층은 적색 발광층, 녹색 발광층 및 청색 발광층으로 패터닝될 수 있다. 또는, 상기 발광층은 적색 발광층, 녹색 발광층 및/또는 청색 발광층이 적층된 구조를 가짐으로써, 백색광을 방출할 수 있는 등 다양한 변형예가 가능하다.

[0418] 상기 발광층은 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다. 예를 들어, 상기 발광층은 상기 화학식 1로 표시되는 축합환 화합물만을 포함할 수 있다. 또는, 상기 발광층은 호스트 및 도펀트를 포함하고, 상기 호스트는 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다. 또 다른 예에 따르면, 상기 발광층은 호스트 및 도펀트를 포함하고, 상기 도펀트는 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다.

[0419] 일 구현예에 따르면, 상기 발광층 중 도펀트는 인광 도펀트일 수 있고, 상기 인광 도펀트는 하기 화학식 81로 표시되는 유기금속 화합물을 포함할 수 있다:

[0420] <화학식 81>



[0421]

[0422] 상기 화학식 81 중,

[0423] M은 이리듐(Ir), 백금(Pt), 오스뮴(Os), 티탄(Ti), 지르코늄(Zr), 하프늄(Hf), 유로퓸(Eu), 테르븀(Tb) 및 톨륨(Tm) 중에서 선택되고,

[0424] Y<sub>1</sub> 내지 Y<sub>4</sub>는 서로 독립적으로, 탄소(C) 또는 질소(N)이고,

[0425] Y<sub>1</sub>과 Y<sub>2</sub>는 단일 결합 또는 이중 결합을 통하여 연결되어 있고, Y<sub>3</sub>와 Y<sub>4</sub>는 단일 결합 또는 이중 결합을 통하여 연결되어 있고,

[0426] CY<sub>1</sub> 및 CY<sub>2</sub>는 서로 독립적으로, 벤젠, 나프탈렌, 플루오렌, 스파이로-플루오렌, 인덴, 피롤, 티오펜, 퓨란(furan), 이미다졸, 피라졸, 티아졸, 이소티아졸, 옥사졸, 이소옥사졸(isooxazole), 피리딘, 피라진, 피리미딘, 피리다진, 퀴놀린, 이소퀴놀린, 벤조퀴놀린, 퀴놀살린, 퀴놀린, 카바졸, 벤조이미다졸, 벤조퓨란(benzofuran), 벤조티오펜, 이소벤조티오펜, 벤조옥사졸, 이소벤조옥사졸, 트리아졸, 테트라졸, 옥사디아졸, 트리아진, 디벤조퓨란(dibenzofuran) 또는 디벤조티오펜이고, CY<sub>1</sub>과 CY<sub>2</sub>는 선택적으로(optionally), 단일 결합 또는 유기 연결기(organic linking group)를 통하여 서로 결합되고,

[0427] R<sub>81</sub> 및 R<sub>82</sub>는 서로 독립적으로, 수소, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카르복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, -SF<sub>5</sub>, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환 또는 비치환된 C<sub>2</sub>-C<sub>60</sub>알키닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환 또는 비치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환 또는 비치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환 또는 비치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환 또는 비치환된 1가 비-방향족 축합다환 그룹, 치환 또는 비치환된 1가 비-방향족 헤테로축합다환 그룹, -N(Q<sub>1</sub>)(Q<sub>2</sub>), -Si(Q<sub>3</sub>)(Q<sub>4</sub>)(Q<sub>5</sub>) 및 -B(Q<sub>6</sub>)(Q<sub>7</sub>) 중에서 선택되고,

[0428] a81 및 a82는 서로 독립적으로, 1 내지 5의 정수 중에서 선택되고,

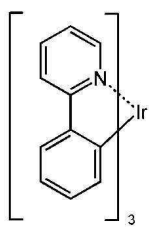
[0429] n81은 0 내지 4의 정수 중에서 선택되고,

[0430] n82는 1, 2 또는 3이고,

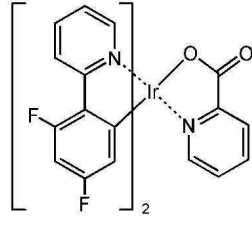
[0431] L<sub>81</sub>은 1가 유기 리간드, 2가 유기 리간드 또는 3가 유기 리간드이다.

[0432] 상기 R<sub>81</sub> 및 R<sub>82</sub>에 대한 설명은 본 명세서 중 R<sub>11</sub>에 대한 설명을 참조한다.

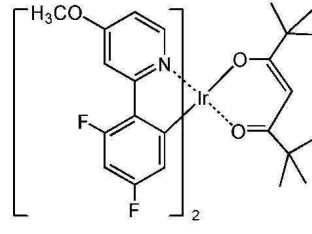
[0433] 상기 인광 도펀트는 하기 화합물 PD1 내지 PD7 및 FIr<sub>6</sub> 중 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다:



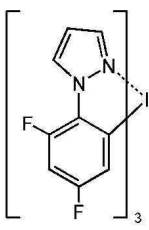
PD1



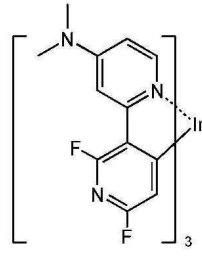
PD2



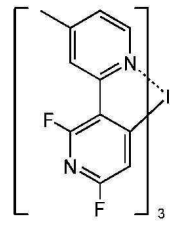
PD3



PD4



PD5

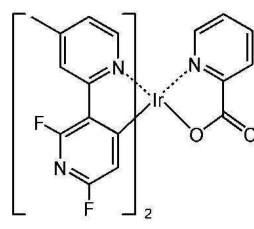


PD6

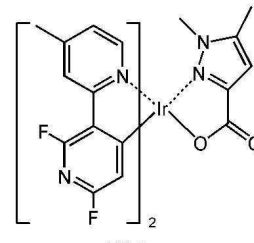
[0434]



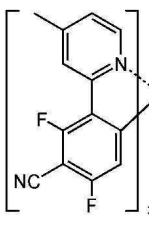
PD7



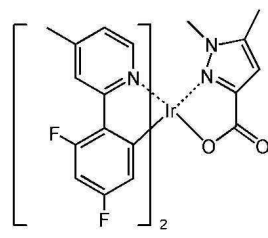
PD8



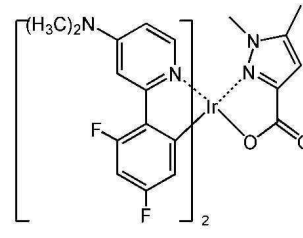
PD9



PD10

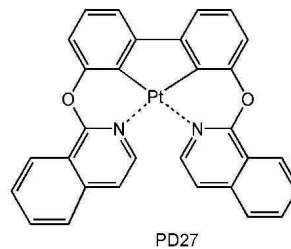
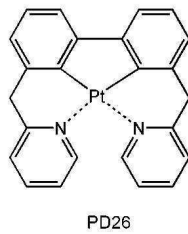
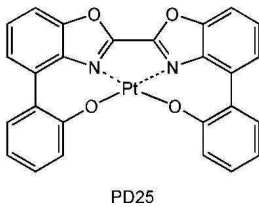
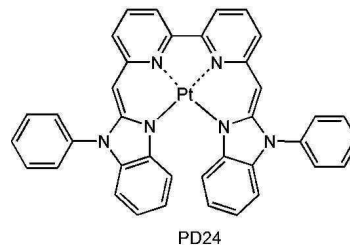
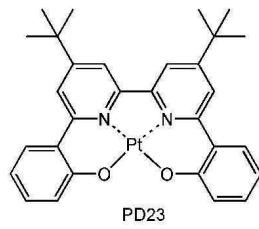
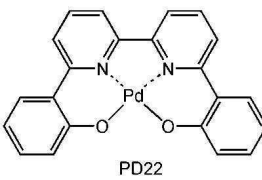
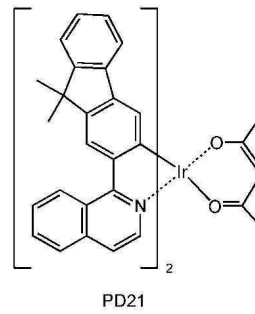
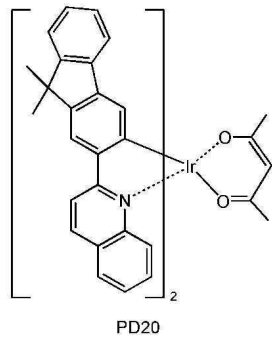
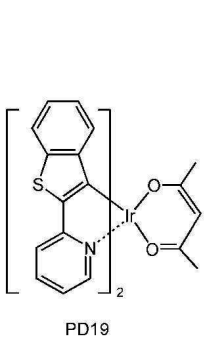
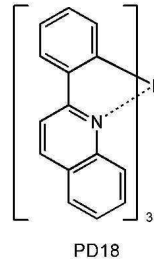
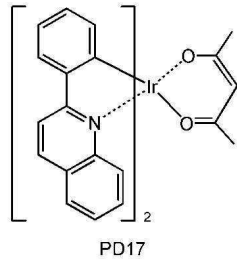
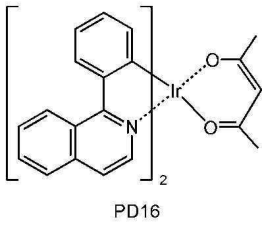
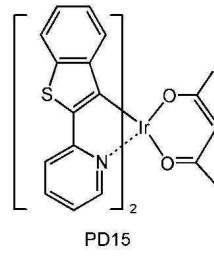
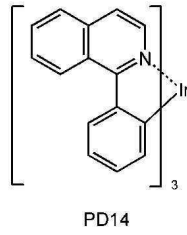
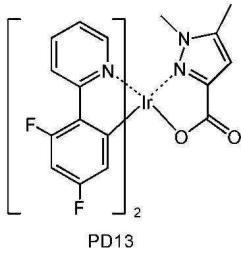


PD11



PD12

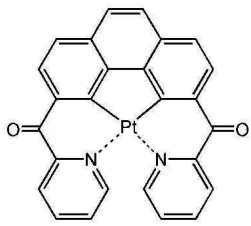
[0435]



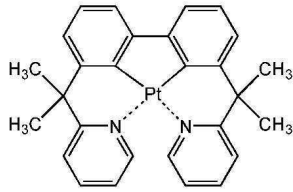
[0436]

[0437]

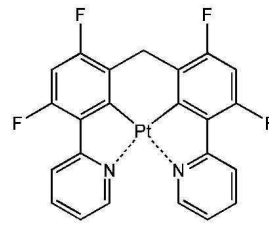
[0438]



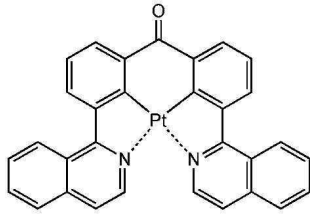
PD28



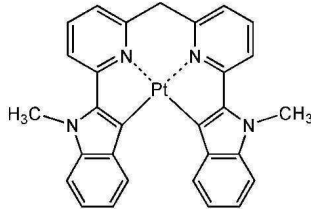
PD29



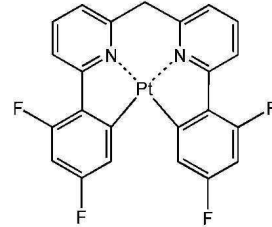
PD30



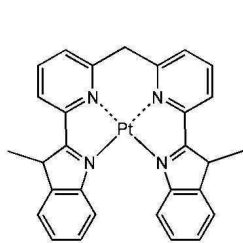
PD31



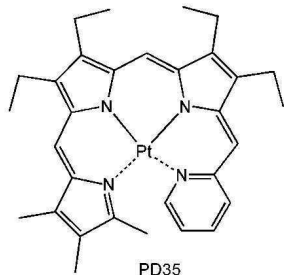
PD32



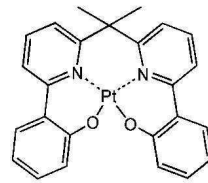
PD33



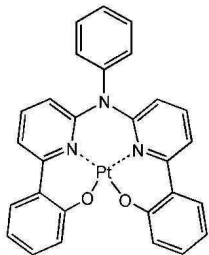
PD34



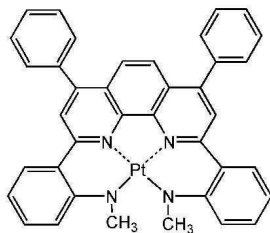
PD35



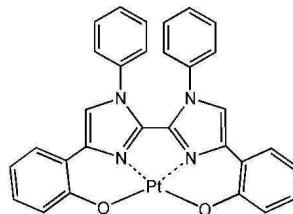
PD36



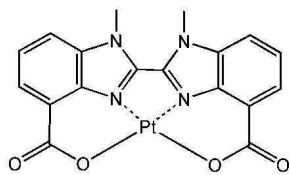
PD37



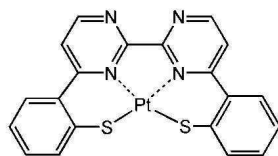
PD38



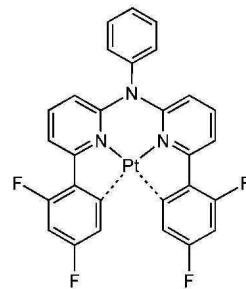
PD39



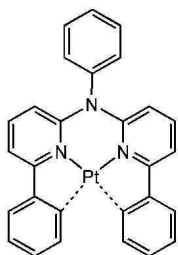
PD40



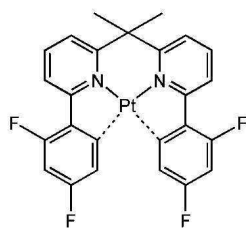
PD41



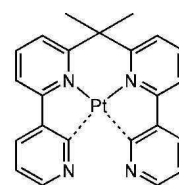
PD42



PD43



PD44



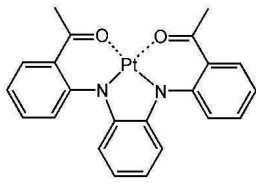
PD45

[0439]

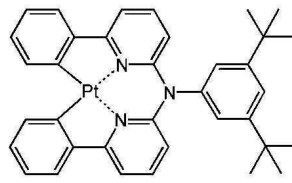
[0440]

[0441]

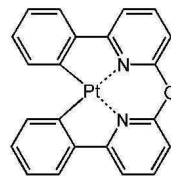




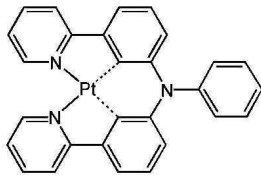
PD46



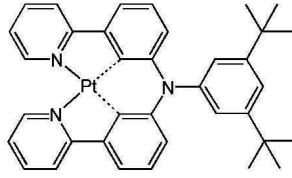
PD47



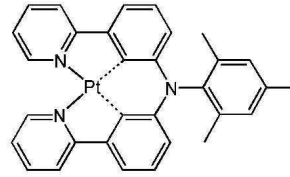
PD48



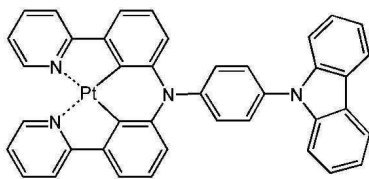
PD49



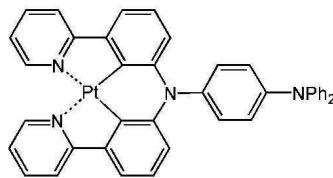
PD50



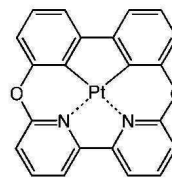
PD51



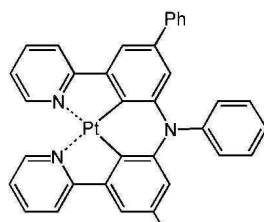
PD52



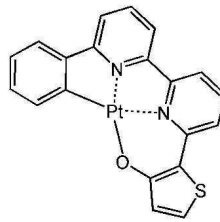
PD53



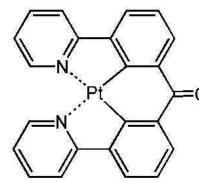
PD54



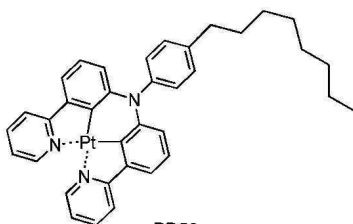
PD55



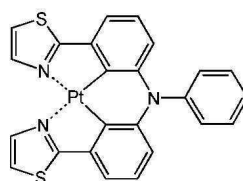
PD56



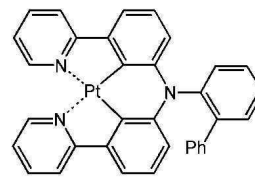
PD57



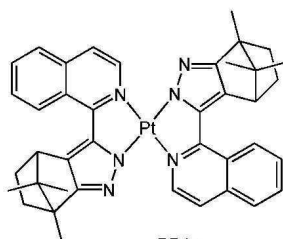
PD58



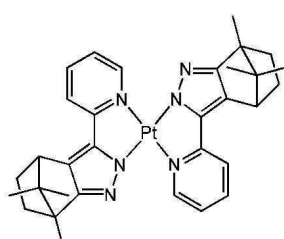
PD59



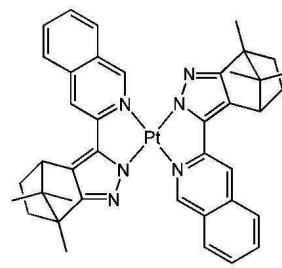
PD60



PD61



PD62



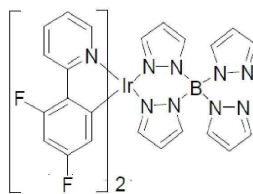
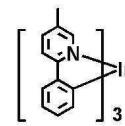
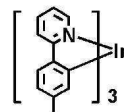
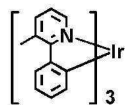
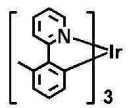
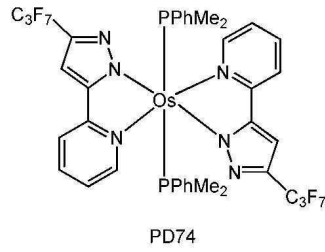
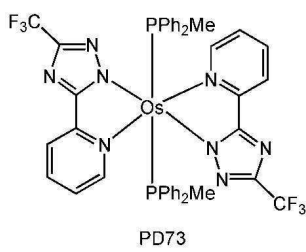
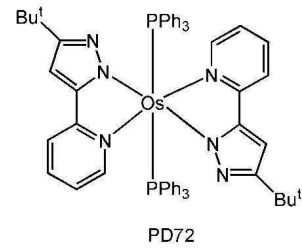
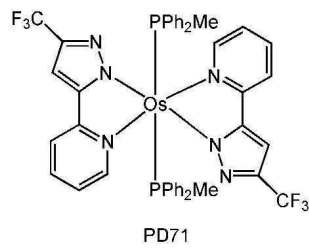
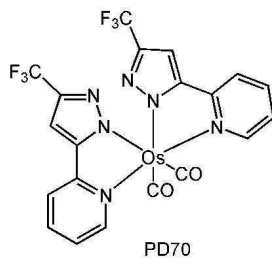
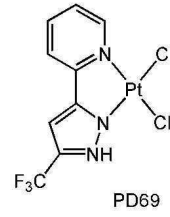
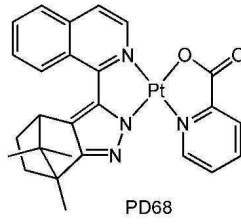
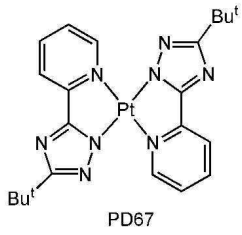
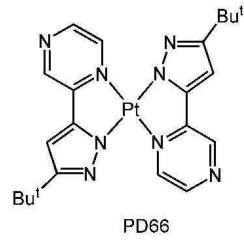
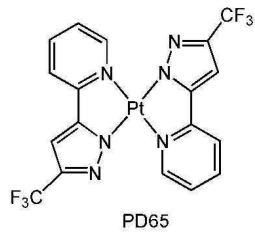
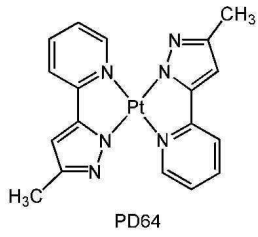
PD63

[0442]

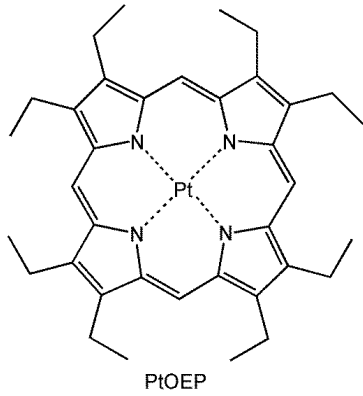
[0443]

[0444]





[0449] 또는, 상기 인광 도펀트는 하기 PtOEP를 포함할 수 있다:



[0450]

[0451]

상기 발광층이 호스트 및 도펀트를 포함할 경우, 도펀트의 함량은 통상적으로 호스트 약 100 중량부를 기준으로 하여 약 0.01 내지 약 20 중량부의 범위에서 선택될 수 있으며, 이에 한정되는 것은 아니다.

[0452]

상기 발광층의 두께는 약 100Å 내지 약 1000Å, 예를 들면 약 200Å 내지 약 600Å일 수 있다. 상기 발광층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 우수한 발광 특성을 나타낼 수 있다.

[0453]

다음으로 발광층 상부에 전자 수송 영역이 배치된다.

[0454]

전자 수송 영역은 정공 저지층, 전자 수송층 및 전자 주입층 중 적어도 하나를 포함할 수 있다.

[0455]

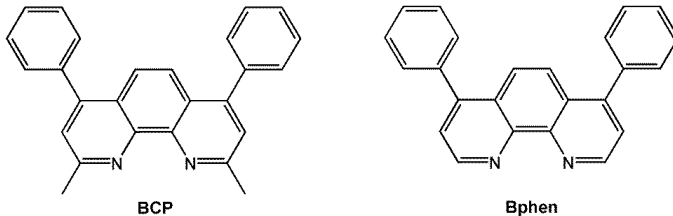
예를 들어, 전자 수송 영역은 정공 저지층/전자 수송층/전자 주입층 또는 전자 수송층/전자 주입층의 구조를 가질 수 있으나, 이에 한정되는 것은 아니다. 상기 전자 수송층은 단일층 또는 2 이상의 서로 다른 물질을 포함한 다층 구조를 가질 수 있다.

[0456]

상기 전자 수송 영역의 정공 저지층, 전자 수송층 및 전자 주입층의 형성 조건은 정공 주입층의 형성 조건을 참조한다.

[0457]

상기 전자 수송 영역이 정공 저지층을 포함할 경우, 상기 정공 저지층은 예를 들면, 하기 BCP 및 Bphen 중 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다.



[0458]

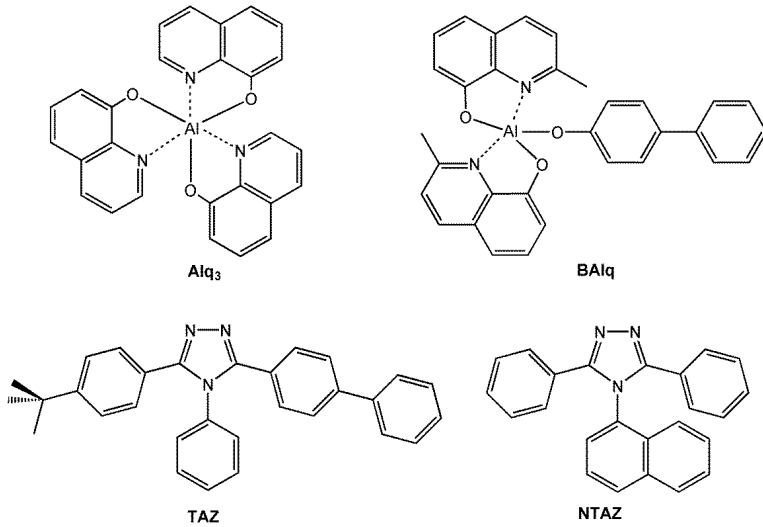
[0459]

또는, 상기 정공 저지층은 상기 화학식 1로 표시되는 축합환 화합물을 포함할 수 있다.

[0460]

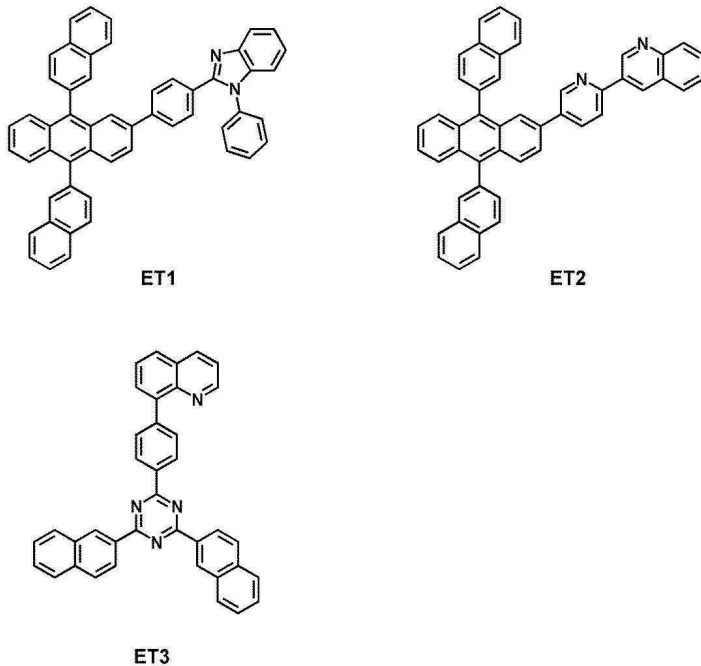
상기 정공 저지층의 두께는 약 20Å 내지 약 1000Å, 예를 들면 약 30Å 내지 약 300Å일 수 있다. 상기 정공 저지층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 우수한 정공 저지 특성을 얻을 수 있다.

[0461] 상기 전자 수송층은 상기 BCP, Bphen 및 하기 Alq<sub>3</sub>, Balq, TAZ 및 NTAZ 중 적어도 하나를 더 포함할 수 있다.



[0462]

[0463] 또는, 상기 전자 수송층은 하기 화합물 ET1, ET2 및 ET3 중 적어도 하나를 포함할 수 있으나, 이에 한정되는 것은 아니다.



[0464]

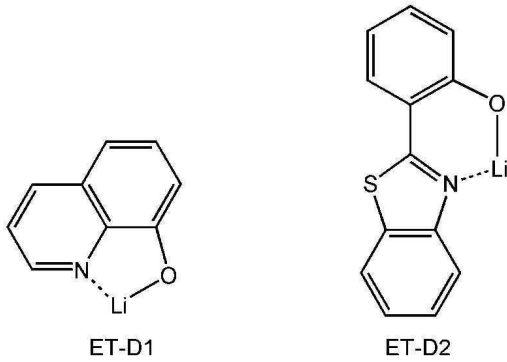
[0465] 상기 전자 수송층의 두께는 약 100Å 내지 약 1000Å, 예를 들면 약 150Å 내지 약 500Å일 수 있다. 상기 전자 수송층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 전자 수송 특성을 얻을 수 있다.

[0466]

상기 전자 수송층은 상술한 바와 같은 물질 외에, 금속-함유 물질을 더 포함할 수 있다.

[0467]

상기 금속-함유 물질은 Li 착체를 포함할 수 있다. 상기 Li 착체는, 예를 들면, 하기 화합물 ET-D1(리튬 퀴놀레이트, LiQ) 또는 ET-D2을 포함할 수 있다.



- [0468]
- [0469] 또한 전자 수송 영역은, 제2전극(19)으로부터 전자의 주입을 용이하게 하는 전자 주입층(EIL)을 포함할 수 있다.
- [0470] 상기 전자 주입층은, LiQ, LiF, NaCl, CsF, Li<sub>2</sub>O 및 BaO 중에서 선택된 적어도 하나를 포함할 수 있다.
- [0471] 상기 전자 주입층의 두께는 약 1Å 내지 약 100Å, 약 3Å 내지 약 90Å일 수 있다. 상기 전자 주입층의 두께가 전술한 바와 같은 범위를 만족할 경우, 실질적인 구동 전압 상승없이 만족스러운 정도의 전자 주입 특성을 얻을 수 있다.
- [0472] 상기 유기층(15) 상부로는 제2전극(19)이 구비되어 있다. 상기 제2전극(19)은 캐소드일 수 있다. 상기 제2전극(19)용 물질로는 상대적으로 낮은 일함수를 가지는 금속, 합금, 전기전도성 화합물 및 이들의 조합을 사용할 수 있다. 구체적인 예로서는 리튬(Li), 마그네슘(Mg), 알루미늄(Al), 알루미늄-리튬(Al-Li), 칼슘(Ca), 마그네슘-인듐(Mg-In), 마그네슘-은(Mg-Ag) 등을 제2전극(19) 형성용 물질로 사용할 수 있다. 또는, 전면 발광 소자를 얻기 위하여 ITO, IZO를 이용하여 투과형 제2전극(19)을 형성할 수 있는 등, 다양한 변형이 가능하다.
- [0473] 이상, 상기 유기 발광 소자를 도 1을 참조하여 설명하였으나, 이에 한정되는 것은 아니다.
- [0474] 본 명세서 중 C<sub>1</sub>-C<sub>60</sub>알킬기는 탄소수 1 내지 60의 선형 또는 분지형 지방족 탄화수소 1가(monovalent) 그룹을 의미하며, 구체적인 예에는, 메틸기, 에틸기, 프로필기, 이소부틸기, sec-부틸기, ter-부틸기, 펜틸기, iso-아밀기, 헥실기 등이 포함된다. 본 명세서 중 C<sub>1</sub>-C<sub>60</sub>알킬렌기는 상기 C<sub>1</sub>-C<sub>60</sub>알킬기와 동일한 구조를 갖는 2가(divalent) 그룹을 의미한다.
- [0475] 본 명세서 중 C<sub>1</sub>-C<sub>60</sub>알콕시기는 -OA<sub>101</sub>(여기서, A<sub>101</sub>은 상기 C<sub>1</sub>-C<sub>60</sub>알킬기임)의 화학식을 갖는 1가 그룹을 의미하며, 이의 구체적인 예에는, 메톡시기, 에톡시기, 이소프로필옥시기 등이 포함된다.
- [0476] 본 명세서 중 C<sub>2</sub>-C<sub>60</sub>알케닐기는 상기 C<sub>2</sub>-C<sub>60</sub>알킬기의 중간 또는 말단에 하나 이상의 탄소 이중 결합을 포함한 구조를 가지며, 이의 구체적인 예에는, 에테닐기, 프로페닐기, 부테닐기 등이 포함된다. 본 명세서 중 C<sub>2</sub>-C<sub>60</sub>알케닐렌기는 상기 C<sub>2</sub>-C<sub>60</sub>알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0477] 본 명세서 중 C<sub>2</sub>-C<sub>60</sub>알키닐기는 상기 C<sub>2</sub>-C<sub>60</sub>알킬기의 중간 또는 말단에 하나 이상의 탄소 삼중 결합을 포함한 구조를 가지며, 이의 구체적인 예에는, 에티닐기(ethynyl), 프로피닐기(propynyl), 등이 포함된다. 본 명세서 중 C<sub>2</sub>-C<sub>60</sub>알키닐렌기는 상기 C<sub>2</sub>-C<sub>60</sub>알키닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0478] 본 명세서 중 C<sub>3</sub>-C<sub>10</sub>시클로알킬기는 탄소수 3 내지 10의 1가 포화 탄화수소 모노시클릭 그룹을 의미하며, 이의 구체예는 시클로프로필기, 시클로부틸기, 시클로펜틸기, 시클로헥실기, 시클로헵틸기 등을 포함한다. 본 명세서 중 C<sub>3</sub>-C<sub>10</sub>시클로알킬렌기는 상기 C<sub>3</sub>-C<sub>10</sub>시클로알킬기와 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0479] 본 명세서 중 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리형성 원자로서 포함한 탄소수 1 내지 10의 1가 모노시클릭 그룹을 의미하며, 이의 구체예는 테트라히드로퓨라닐기(tetrahydrofuranyl), 테트라히드로티오펜기 등을 포함한다. 본 명세서 중 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬렌기는 상기 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기와 동일한 구조를 갖는 2가 그룹을 의미한다.

- [0480] 본 명세서 중 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기는 탄소수 3 내지 10의 1가 모노시클릭 그룹으로서, 고리 내에 적어도 하나의 이중 결합을 가지나, 방향족성(aromaticity)을 갖지 않는 그룹을 의미하며, 이의 구체예는 시클로펜테닐기, 시클로헥세닐기, 시클로헵테닐기 등을 포함한다. 본 명세서 중 C<sub>3</sub>-C<sub>10</sub>시클로알케닐렌기는 상기 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0481] 본 명세서 중 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기는 N, O, P, Si 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함한 탄소수 1 내지 10의 1가 모노시클릭 그룹으로서, 고리 내에 적어도 하나의 이중 결합을 갖는다. 상기 C<sub>2</sub>-C<sub>10</sub>헤테로시클로알케닐기의 구체예는, 2,3-히드로푸라닐기, 2,3-히드로티오펜닐기 등을 포함한다. 본 명세서 중 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐렌기는 상기 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기와 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0482] 본 명세서 중 C<sub>6</sub>-C<sub>60</sub>아릴기는 탄소 원자수 6 내지 60개의 카보사이클릭 방향족 시스템을 갖는 1가(monovalent) 그룹을 의미하며, C<sub>6</sub>-C<sub>60</sub>아릴렌기는 탄소 원자수 6 내지 60개의 카보사이클릭 방향족 시스템을 갖는 2가(divalent) 그룹을 의미한다. 상기 C<sub>6</sub>-C<sub>60</sub>아릴기의 구체예는, 페닐기, 나프틸기, 안트라세닐기, 페난트레닐기, 파이레닐기, 크라이세닐기 등을 포함한다. 상기 C<sub>6</sub>-C<sub>60</sub>아릴기 및 C<sub>6</sub>-C<sub>60</sub>아릴렌기가 2 이상의 고리를 포함할 경우, 2 이상의 고리들은 서로 융합될 수 있다.
- [0483] 본 명세서 중 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기는 N, O, P 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함하고 탄소수 1 내지 60개의 카보사이클릭 방향족 시스템을 갖는 1가 그룹을 의미하고, C<sub>1</sub>-C<sub>60</sub>헤테로아릴렌기는 N, O, P 및 S 중에서 선택된 적어도 하나의 헤테로 원자를 고리-형성 원자로서 포함하고 탄소수 1 내지 60개의 카보사이클릭 방향족 시스템을 갖는 2가 그룹을 의미한다. 상기 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기의 구체예는, 피리디닐기, 피리미디닐기, 피라지닐기, 피리다지닐기, 트리아지닐기, 퀴놀리닐기, 이소퀴놀리닐기 등을 포함한다. 상기 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기 및 C<sub>1</sub>-C<sub>60</sub>헤테로아릴렌기가 2 이상의 고리를 포함할 경우, 2 이상의 고리들은 서로 융합될 수 있다.
- [0484] 본 명세서 중 C<sub>6</sub>-C<sub>60</sub>아릴옥시기는 -OA<sub>102</sub>(여기서, A<sub>102</sub>는 상기 C<sub>6</sub>-C<sub>60</sub>아릴기임)를 가리키고, 상기 C<sub>6</sub>-C<sub>60</sub>아릴티오기(arylthio)는 -SA<sub>103</sub>(여기서, A<sub>103</sub>은 상기 C<sub>6</sub>-C<sub>60</sub>아릴기임)를 가리킨다.
- [0485] 본 명세서 중 1가 비-방향족 축합다환 그룹(non-aromatic condensed polycyclic group)은 2 이상의 고리가 서로 축합되어 있고, 고리 형성 원자로서 탄소만을 포함(예를 들어, 탄소수는 8 내지 60일 수 있음)하고, 분자 전체가 비-방향족성(non-aromaticity)을 갖는 1가 그룹을 의미한다. 상기 비-방향족 축합다환 그룹의 구체예는 플루오레닐기 등을 포함한다. 본 명세서 중 2가 비-방향족 축합다환 그룹은 상기 1가 비-방향족 축합다환 그룹과 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0486] 본 명세서 중 1가 비-방향족 헤테로축합다환 그룹(non-aromatic condensed heteropolycyclic group)은 2 이상의 고리가 서로 축합되어 있고, 고리 형성 원자로서 탄소(예를 들어, 탄소수는 1 내지 60일 수 있음) 외에 N, O, P, Si 및 S 중에서 선택된 헤테로 원자를 포함하고, 분자 전체가 비-방향족성(non-aromaticity)을 갖는 1가 그룹을 의미한다. 상기 1가 비-방향족 헤테로축합다환 그룹은, 카바졸일기 등을 포함한다. 본 명세서 중 2가 비-방향족 헤테로축합다환 그룹은 상기 1가 비-방향족 헤테로축합다환 그룹과 동일한 구조를 갖는 2가 그룹을 의미한다.
- [0487] 상기 화학식 1 중 상기 치환된 C<sub>1</sub>-C<sub>60</sub>알킬기, 치환된 C<sub>2</sub>-C<sub>60</sub>알케닐기, 치환된 C<sub>2</sub>-C<sub>60</sub>알키닐기, 치환된 C<sub>1</sub>-C<sub>60</sub>알콕시기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알킬기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, 치환된 C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, 치환된 C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴옥시기, 치환된 C<sub>6</sub>-C<sub>60</sub>아릴티오기, 치환된 C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 치환된 1가 비-방향족 축합다환 그룹 및 치환된 1가 비-방향족 헤테로축합다환 그룹 중 적어도 하나의 치환기는, 중수소, -F, -Cl, -Br, -I, 히드록실기, 시아노기, 니트로기, 아미노기, 아미디노기, 히드라진기, 히드라존기, 카복실산기 또는 이의 염, 술폰산기 또는 이의 염, 인산기 또는 이의 염, C<sub>1</sub>-C<sub>60</sub>알킬기, C<sub>2</sub>-C<sub>60</sub>알케닐기, C<sub>2</sub>-C<sub>60</sub>알키닐기, C<sub>1</sub>-C<sub>60</sub>알콕시기, C<sub>3</sub>-C<sub>10</sub>시클로알킬기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알킬기, C<sub>3</sub>-C<sub>10</sub>시클로알케닐기, C<sub>1</sub>-C<sub>10</sub>헤테로시클로알케닐기, C<sub>6</sub>-C<sub>60</sub>아릴기, C<sub>6</sub>-C<sub>60</sub>아릴옥시기, C<sub>6</sub>-C<sub>60</sub>아릴티오기, C<sub>1</sub>-C<sub>60</sub>헤테로아릴기, 1가 비-방향

족 축합다환 그룹, 1가 비-방향족 헤테로축합다환 그룹 및  $-Si(Q_{31})(Q_{32})(Q_{33})$  중에서 선택되고,

[0488] 상기  $Q_1$  내지  $Q_3$ ,  $Q_{11}$  내지  $Q_{13}$ ,  $Q_{21}$  내지  $Q_{23}$  및  $Q_{31}$  내지  $Q_{33}$ 은 서로 독립적으로, 수소,  $C_1-C_{60}$ 알킬기,  $C_1-C_{60}$ 알콕시기,  $C_3-C_{10}$ 시클로알킬기,  $C_1-C_{10}$ 헤테로시클로알킬기,  $C_3-C_{10}$ 시클로알케닐기,  $C_1-C_{10}$ 헤테로시클로알케닐기,  $C_6-C_{60}$ 아릴기,  $C_1-C_{60}$ 헤테로아릴기, 1가 비-방향족 축합다환 그룹 및 1가 비-방향족 헤테로축합다환 그룹 중에서 선택된다.

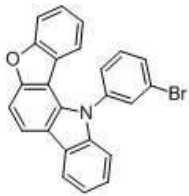
[0489] 본 명세서 중 \* 및 \*'은 다른 설명이 없는 한, 해당 화학식 중 이웃한 원자와의 결합 사이트이다.

[0490] 이하, 합성에 및 실시예를 들어, 본 발명의 일 구현예를 따르는 화합물 및 유기 발광 소자에 대하여 보다 구체적으로 설명하나, 본 발명이 하기의 합성에 및 실시예로 한정되는 것은 아니다. 하기 합성에 중 "'A' 대신 'B'를 사용하였다"란 표현 중 'B'의 사용량과 'A'의 사용량은 몰당량 기준으로 동일하다.

[0491] [실시예]

[0492] **합성예 1: 화합물 27의 합성**

[0493] (1) 중간체 1의 합성

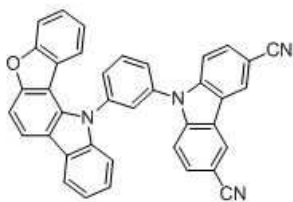


중간체 1

[0494]

[0495] 잘 건조된 500ml 둥근 바닥 플라스트(RBF)에 NaH(60% in mineral oil) (3g, 73.46 mmol)을 넣고, DMF 200ml를 가한 후 질소 하에서 온도 0도로 교반하였다. 12H-벤조퓨로[3,2-a]카바졸(18g, 69.96 mmol)를 100ml DMF에 녹여 천천히 가하였다. 이후 온도를 실온으로 올려서 3시간 교반하였다. 1-브로모-3-플루오로벤젠 (19.6g, 112 mmol)을 반응에 천천히 가한 후, 반응 온도를 150도로 올려서 22시간 교반하였다. MC를 이용하여 추출하고,  $MgSO_4$ 로 건조한 후, 용매를 감압 농축하였다. 실리카젤을 얇게 층진하여 뜨거운 톨루엔에 녹인 용액을 필터하고 여액을 감압 농축하였다. MC/메탄올 조건에서 침전물을 형성하고, 종이로 여과하였다. 얻어진 고체를 진공 오븐에서 건조함으로써 중간체 1(21g, 수율 73%)을 얻었다.

[0496] (2) 화합물 27의 합성



27

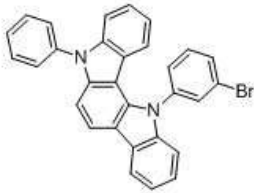
[0497]

[0498] 중간체 1 (15g, 35 mmol), 9H-카바졸-3,6-다이카보니트릴(7.2g, 33 mmol), CuI(3.2g, 16.5 mmol),  $K_2CO_3$  (9.1g, 66 mmol)과 1,10-페난트롤린 (6g, 33 mmol)을 250ml RBF에 넣고, DMF를 150 ml 가해준 후, 165도로 24시간 교반하였다. 반응 혼합물을 식힌 후, 물과 메탄올을 섞은 용액에 부어서 침전물을 형성하고 종이로 하였다. 얻어진 고체를 메탄올로 씻어주고 진공오븐에서 건조하였다. 뜨거운 MC에 고체를 녹인 후 얇게 층진한 실리카 필터를 통과시키고 여액을 농축한 후 에틸 아세테이트로 재결정함으로써 화합물 27 (10.5g, 수율 58%)을 얻었다.

[0499] MALDI-TOF Mass (계산치: 548.59 g/mol, 측정치: 548.28 g/mol)

[0500] **합성예 2: 화합물 29의 합성**

[0501] (1) 중간체 2의 합성

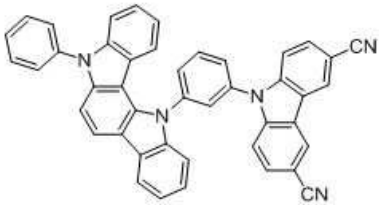


중간체 2

[0502]

[0503] 5-페닐-5,12-디하이드로인돌로[3,2-a]카바졸 (15g, 45 mmol), 3-브로모아이오도벤젠 (15.3g, 54 mmol), CuI(4.3g, 22.6 mmol), K<sub>2</sub>CO<sub>3</sub> (12.5g, 90 mmol)과 1,10-페난트린 (9.7g, 54 mmol)을 250ml RBF에 넣고, DMF를 180 ml 가해준 후, 165도로 24시간 교반하였다. 반응 혼합물을 식힌 후, 물로 씻어주고 MC로 추출하였다. MgSO<sub>4</sub>로 건조시킨 후, 감압 증류하고, 실리카 컬럼 크로마토그래피(MC:Hexane=1:4)를 진행하여 중간체 2 (12.8g, 수율 58%)를 얻었다.

[0504] (2) 화합물 29의 합성



29

[0505]

[0506] 화합물 29 합성시 중간체 1 대신, 중간체 2를 사용하였다는 점을 제외하고는, 상기 합성에 1의 화합물 27의 합성과 동일한 방법을 이용하여 화합물 29(수율 42%)를 합성하였다.

[0507] MALDI-TOF Mass (계산치: 623.70 g/mol, 측정치: 623.42 g/mol)

[0508] **합성예 3: 화합물 33의 합성**

[0509] (1) 중간체 3의 합성

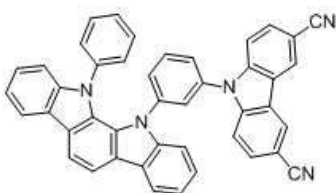


중간체 3

[0510]

[0511] 중간체 3 합성시 5-페닐-5,12-디하이드로인돌로[3,2-a]카바졸 대신, 11-페닐-11,12-디하이드로인돌로[2,3-a]카바졸을 사용하였다는 점을 제외하고는, 상기 합성예 2의 중간체 2의 합성과 동일한 방법을 이용하여 중간체 3 (수율 22%)을 합성하였다.

[0512] (2) 화합물 33의 합성



33

[0513]

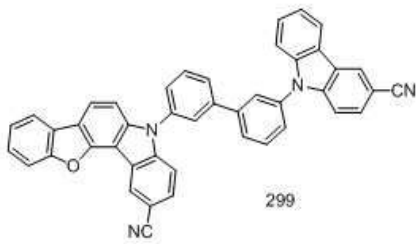








[0551] **합성예 9: 화합물 299의 합성**

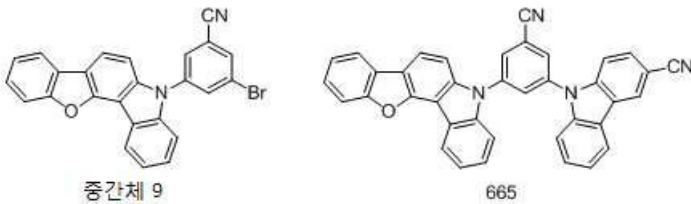


[0552]

[0553] 중간체 7 (12g, 27.4 mmol), 9-(3-(4,4,5,5-테트라메틸-1,3,2-디옥사보로란-2-닐)페닐)-9H-카바졸-3-카보니트릴(10.8g, 27.4 mmol), Pd(PPh<sub>3</sub>)<sub>4</sub> (6.3g, 5.5 mmol), K<sub>2</sub>CO<sub>3</sub> (11.4g, 82 mmol) 을 250ml RBF에 넣고, 물 41ml와 THF 95 ml 가해준 후, 90도로 21시간 교반하였다. 반응 혼합물을 식힌 후, 메탄올에 부어서 침전물을 형성하고 종이를 여과하였다. 뜨거운 MC에 고체를 녹인 후 상기 용액을 얇게 충전한 실리카 필터를 통과시키고 여액을 농축한 후 에틸 아세테이트로 재결정함으로써, 화합물 299 (6.9g, 수율 40%)를 얻었다.

[0554] MALDI-TOF Mass (계산치: 624.69 g/mol, 측정치: 624.27 g/mol)

[0555] **합성예 10: 화합물 665의 합성**



[0556]

[0557] (1) 중간체 9의 합성

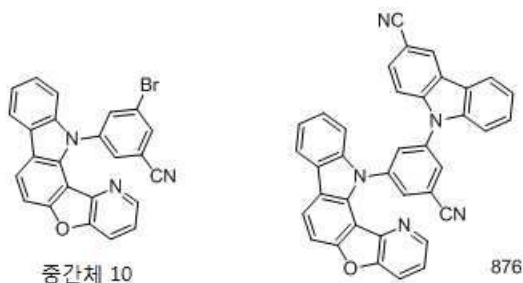
[0558] 중간체 9 합성시 12H-벤조퓨로[3,2-a]카바졸 대신, 5H-벤조퓨로[3,2-c]카바졸을 사용하고, 1-브로모-3-플루오로벤젠 대신 3-브로모-5-플루오로벤조니트릴 사용하였다는 점을 제외하고는, 상기 합성예 1의 중간체 1의 합성과 동일한 방법을 이용하여 중간체 9(수율 71%)를 합성하였다.

[0559] (2) 화합물 665의 합성

[0560] 화합물 665 합성시 중간체 1 대신, 중간체 9를 사용하고, 9H-카바졸-3,6-다이카보니트릴 대신 9H-카바졸-3-카보니트릴을 사용하였다는 점을 제외하고는, 상기 합성예 1의 화합물 27의 합성과 동일한 방법을 이용하여 화합물 665(수율 62%) 를 합성하였다.

[0561] MALDI-TOF Mass (계산치: 548.59 g/mol, 측정치: 548.18g/mol)

[0562] **합성예 11: 화합물 876의 합성**



[0563]

[0564] (1) 중간체 10의 합성

[0565] 중간체 10 합성시 12H-벤조퓨로[3,2-a]카바졸 대신, 12H-피리도[2'.3':4,5]퓨로[3,2-a]카바졸을 사용하고, 1-브로모-3-플루오로벤젠 대신 3-브로모-5-플루오로벤조니트릴 사용하였다는 점을 제외하고는, 상기 합성예 1의

중간체 1의 합성과 동일한 방법을 이용하여 중간체 10(수율 59%)을 합성하였다.

[0566] (2) 화합물 876의 합성

[0567] 화합물 876 합성시 중간체 1 대신, 중간체 10을 사용하였고, 9H-카바졸-3,6-다이카보니트릴 대신 9H-카바졸-3-카보니트릴을 사용하였다는 점을 제외하고는, 상기 합성에 1의 화합물 27의 합성과 동일한 방법을 이용하여 화합물 876(수율 63%)을 합성하였다.

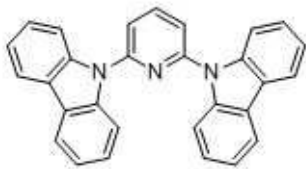
[0568] MALDI-TOF Mass (계산치: 549.58g/mol, 측정치: 549.18g/mol)

[0569] **평가예 1: 열적 특성 평가**

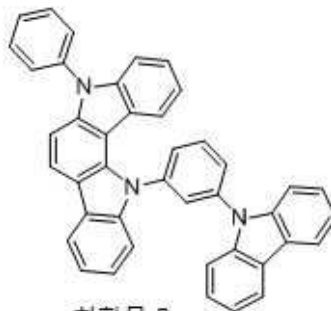
[0570] 상기 화합물 27, 29, 43, 44, 화합물 A, 화합물 B 및 화합물 C에 대하여 TGA(Thermo Gravimetric Analysis) 및 DSC(Differential Scanning Calorimetry)를 이용하여 열분석 (N<sub>2</sub> 분위기, 온도 구간: 상온에서 800℃까지(10℃/min)-TGA, 상온에서 400℃까지-DSC, Pan Type: Pt Pan in 일회용 Al Pan(TGA), 일회용 Al pan(DSC))을 수행하여 그 결과를 표 2에 정리하였다.

**표 2**

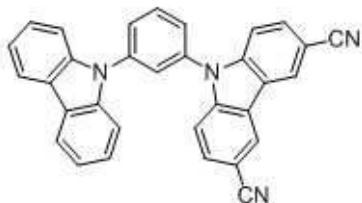
화합물 No.	Tg(℃)
27	159
29	185
43	166
44	177
화합물 A	72
화합물 B	130
화합물 C	128



화합물 A



화합물 B



화합물 C

[0572] 표 2에 따르면, 상기 화합물 27, 29, 43 및 44는 화합물 A, 화합물 B 및 화합물 C에 비하여 우수한 열안정성을 가짐을 확인할 수 있다.

[0574] **실시예 1**

[0575] 1500 Å 두께의 ITO (Indium tin oxide)전극(제1전극, 애노드)이 형성된 유리 기판을 증류수 초음파로 세척하였

다. 증류수 세척이 끝나면 이소프로필 알코올, 아세톤, 메탄올 등의 용제로 초음파 세척을 하고 건조시킨 후 플라즈마 세정기로 이송 시킨 다음 산소 플라즈마를 이용하여 상기 기판을 5분간 세정 한 후 진공 증착기로 상기 기판을 이송하였다.

[0576] 상기 유리 기판의 ITO 전극 상에 화합물 HT3와 화합물 HP-1를 공증착하여 100 Å 두께의 정공 주입층을 형성한 다음, 상기 정공 주입층 상에 화합물 HT3를 증착하여 1300 Å 두께의 정공 수송층을 형성하고, 상기 정공 수송층 상에 mCP를 증착하여 150 Å 두께의 전자 저지층을 형성하여, 정공 수송 영역을 형성하였다.

[0577] 상기 정공 수송 영역 상에 화합물 27(호스트) 및 FIr6(도펀트, 10wt%)를 공증착하여 300 Å 두께의 발광층을 형성하였다.

[0578] 상기 발광층 상에 상기 화합물 1을 진공 증착하여 100Å 두께의 정공 저지층을 형성하고, 상기 정공 저지층 상에 화합물 ET3와 Liq를 함께 진공 증착하여 250Å 두께의 전자 수송층을 형성한 다음, 상기 전자 수송층 상에 Liq를 증착하여 5 Å 두께의 전자 주입층을 형성하고, 상기 전자 주입층 상에 1000Å 두께의 Al 제2전극(캐소드)를 형성함으로써, 유기 발광 소자를 제작하였다.

[0579] **실시예 2 내지 6과 비교예 1 내지 2**

[0580] 발광층 형성시 발광층 호스트 재료로서 화합물 27 대신 표 3에 기재된 화합물을 사용하였다는 점을 제외하고는, 상기 실시예 1과 동일한 방법을 이용하여 유기 발광 소자를 제작하였다.

[0581] **평가예 4: 유기 발광 소자의 특성 평가**

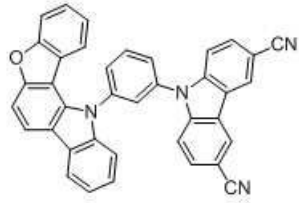
[0582] 상기 실시예 1 내지 6 및 비교예 1 내지 2에서 제조된 각각의 유기 발광 소자에 대하여 효율 및 수명(T<sub>95</sub>)을 Keithley SMU 236 및 휘도계 PR650를 이용하여 평가하였다. 표 3 중, 실시예 1 내지 6 및 비교예 1 내지 2의 효율은, 화합물 A의 유기 발광 소자의 효율을 "100"으로 나타내었을 때, 이에 대한 상대값으로 환산하여 나타내었다.

[0583] 한편, 표 3 중 수명(T<sub>80</sub>)은, 500nit 하의 초기 휘도를 100%라 할 때, 구동 후 휘도가 80%가 되는데 걸리는 시간(hr)을 측정한 것이다. 표 3 중 실시예 1 내지 6 및 비교예 1 내지 2의 수명(T<sub>80</sub>)은, 화합물 A의 유기 발광 소자의 수명(T<sub>80</sub>)을 "100"으로 나타내었을 때, 이에 대한 상대값으로 환산하여 나타내었다.

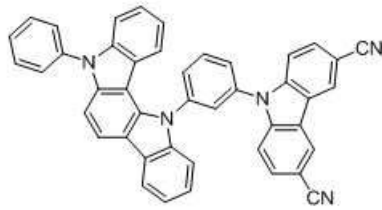
**표 3**

[0584]

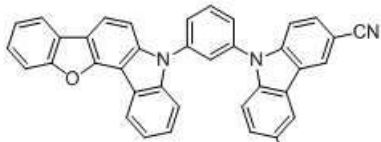
	발광층 호스트 재료	효율 (cd/A) (상대값)	T <sub>80</sub> (hr) (상대값)
실시예 1	화합물 27	108	389
실시예 2	화합물 29	170	204
실시예 3	화합물 43	134	351
실시예 4	화합물 44	133	189
실시예 5	화합물 93	120	250
실시예 6	화합물 299	155	275
비교예 1	화합물 A	100	100
비교예 2	화합물 B	124	243



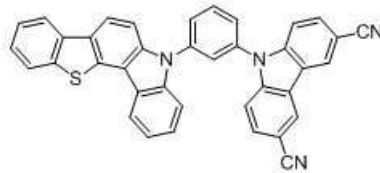
27



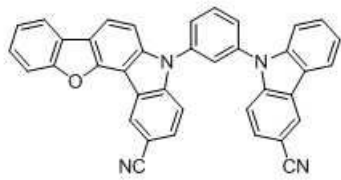
29



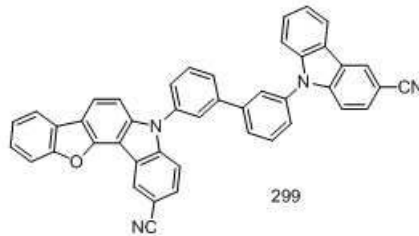
43



44

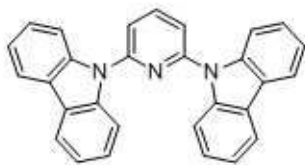


93

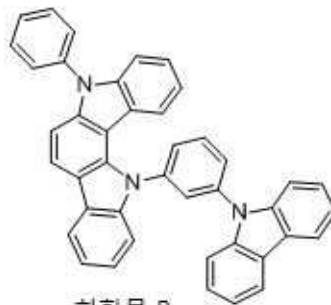


299

[0585]



화합물 A



화합물 B

[0586]

[0587]

상기 표 3로부터, 실시예 1 내지 5의 유기 발광 소자는 비교예 1 및 2의 유기 발광 소자에 비하여, 고효율 및 장수명을 모두 가짐을 확인할 수 있다.

**부호의 설명**

[0588]

10: 유기 발광 소자

11: 제1전극

15: 유기층

19: 제2전극

도면

도면1

