

## **Electronic Supplementary Information**

### **Graphene-based gas sensor: metal decoration effect and application to a flexible device**

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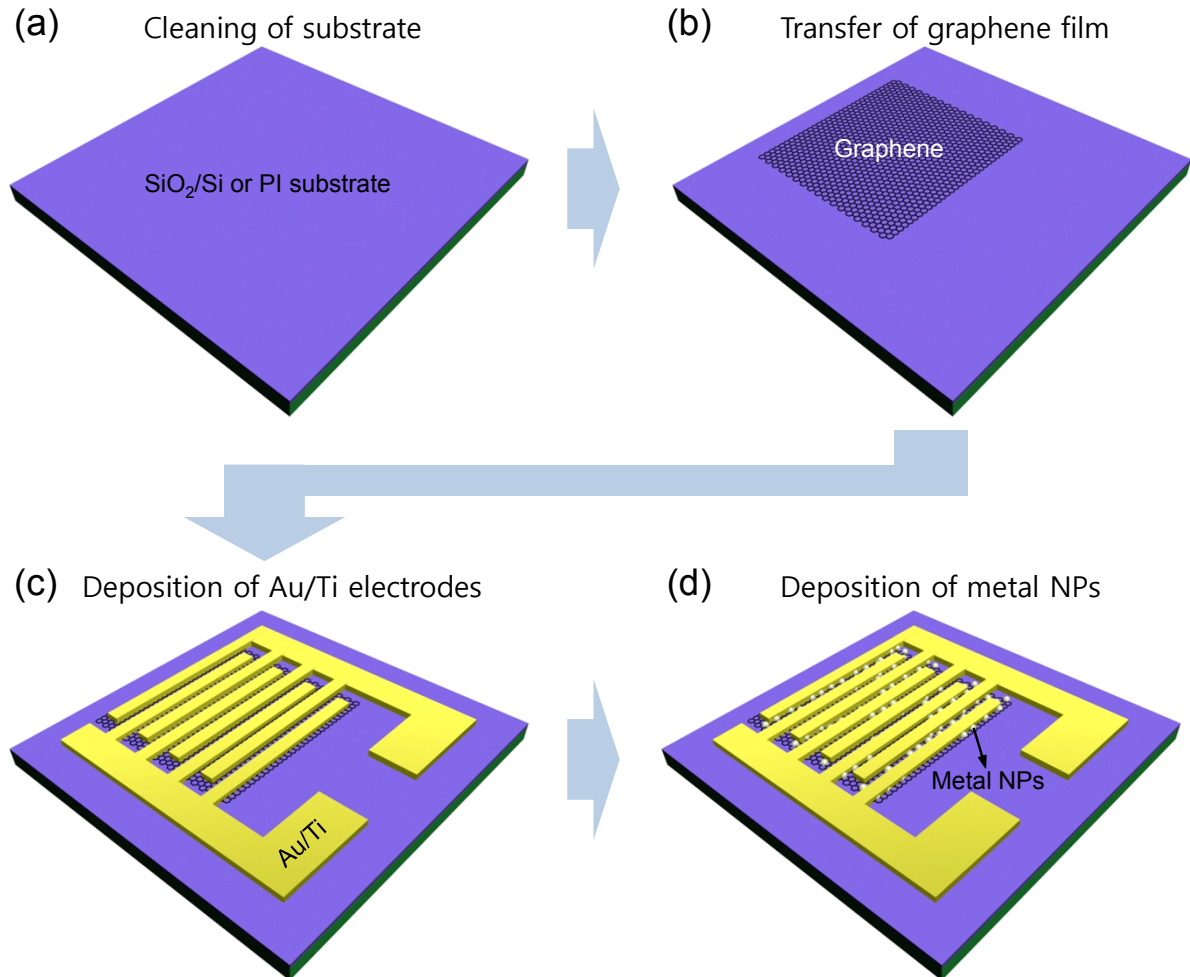
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## A. Fabrication process of graphene based gas sensor devices



**Fig. S1** Sequential process of graphene based gas sensor devices. (a) Cleaning process of substrate (hard SiO<sub>2</sub>/Si or flexible PI substrate). (b) Transfer process of graphene film grown on Ni film to the prepared substrates. (c) Deposition of Au/Ti (100/7 nm) electrodes using a shadow mask with IDE array structure. (d) Decoration process of metal NPs (Pd or Al NPs) on graphene film using a thermal evaporator.

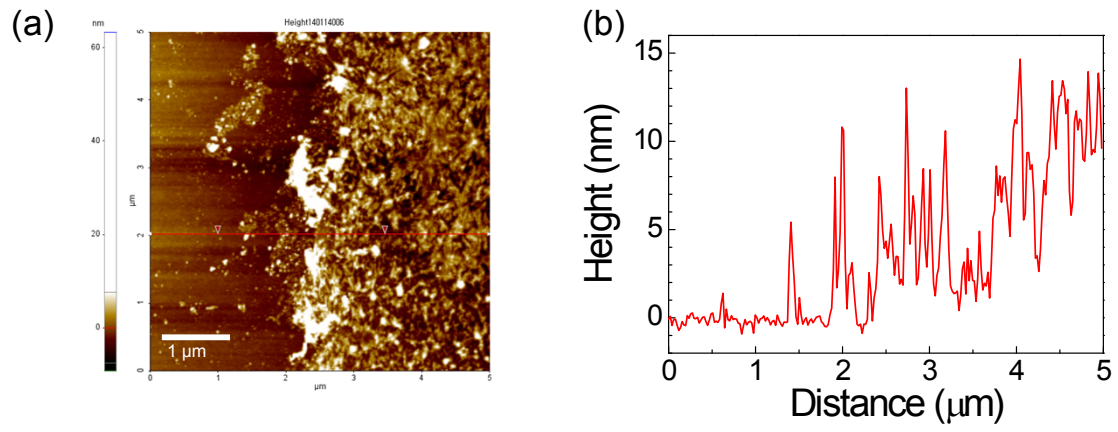
## B. 4-probe Hall measurement

**Table S1** Comparison of several electrical parameters extracted from Hall measurement of Graphene, Pd:Graphene, and Al:Graphene.

| Device      | Type | $\mu$<br>( $\text{cm}^2/\text{Vs}$ ) | $n$<br>( $1/\text{cm}^3$ ) | $\rho$<br>( $\Omega/\text{cm}$ ) | $R_s$<br>( $\Omega/\square$ ) | $R_H$<br>( $\text{cm}^3/\text{C}$ ) |
|-------------|------|--------------------------------------|----------------------------|----------------------------------|-------------------------------|-------------------------------------|
| Graphene    | p    | 400                                  | $2.94 \times 10^{19}$      | $5.31 \times 10^{-4}$            | 531                           | 0.213                               |
| Pd:Graphene | p    | 374                                  | $3.22 \times 10^{19}$      | $5.17 \times 10^{-4}$            | 517                           | 0.194                               |
| Al:Graphene | p    | 536                                  | $1.37 \times 10^{19}$      | $8.49 \times 10^{-4}$            | 849                           | 0.455                               |

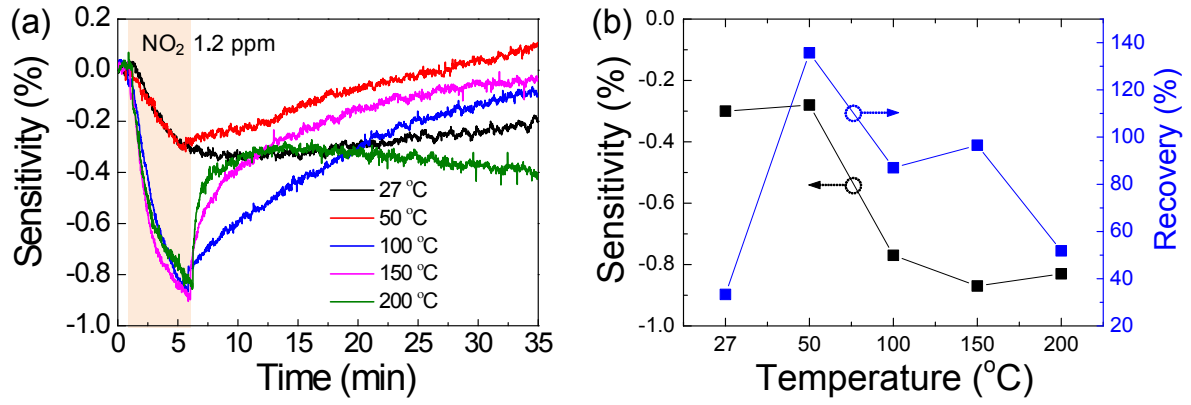
\*Type of carrier, mobility, carrier concentration, resistivity, sheet resistance, and hall coefficient are denoted as Type,  $\mu$ ,  $n$ ,  $\rho$ ,  $R_s$ , and  $R_H$ , respectively.

### C. AFM image and line profile of graphene film



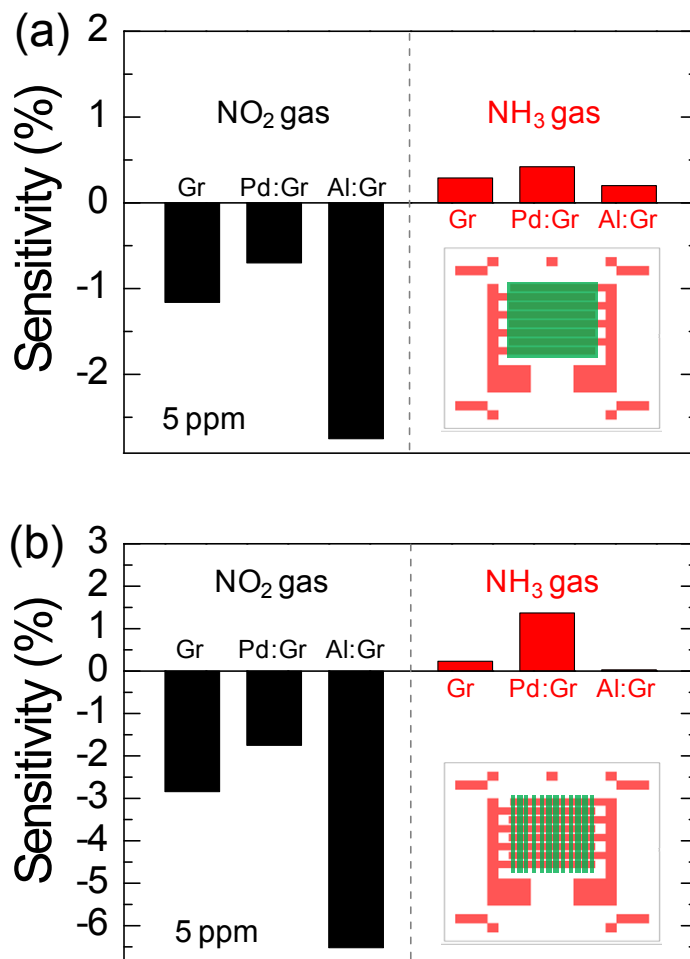
**Fig. S2** (a) AFM morphological image and (b) line profile of graphene film.

#### D. Operating temperature dependency of sensing characteristics



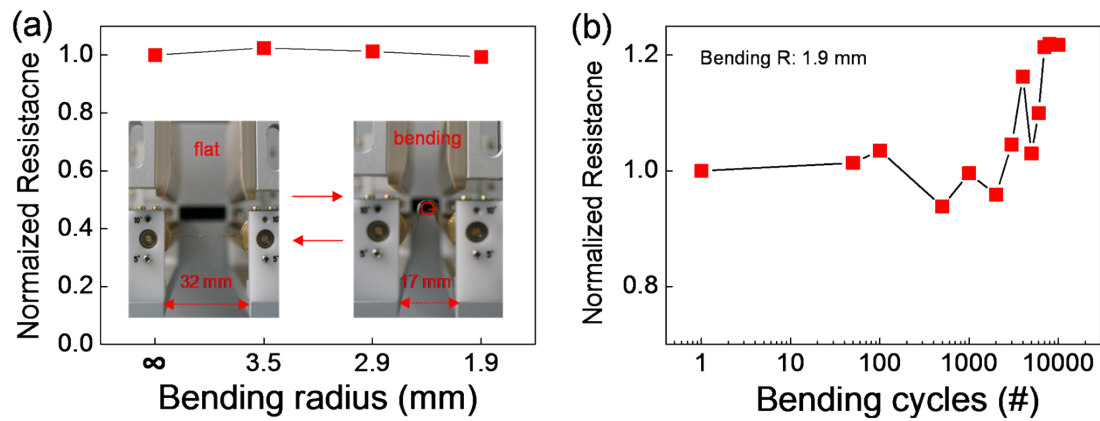
**Fig. S3** (a) Transient sensing characteristics of Graphene device under  $\text{NO}_2$  1.2 ppm at the operating temperature ranging from 27 to 200 °C. (b) Sensitivity and recovery characteristics of Graphene device as function of the operating temperature.

### E. Comparison of sensing performance for non-patterned and patterned graphene



**Fig. S4** Gas sensing performance of Graphene, Pd:Graphene, and Al:Graphene devices compared under 5 ppm gas concentration of NO<sub>2</sub> or NH<sub>3</sub> for (a) non-patterned and (b) patterned graphene. The insets of Fig. S4(a) and (b) are top view images of non-patterned and patterned graphene device, respectively.

## F. Bending performance of graphene based devices



**Fig. S5** (a) Resistance change as function of bending radius. (b) Resistance change as function of bending cycles.