Supporting Information

Multilayer-graphene nanosheet (MLGNS) film deposited on a ceramic substrate without catalyst for constructing electrochemiluminescence imaging platform

Jiannan Wang, Pengxiang Shang, Jiangyan Zhong, Shan Lin, and Yuwu Chi*

MOE Key Laboratory for Analytical Science of Food Safety and Biology, Fujian Provincial Key Laboratory of Analysis and Detection for Food Safety, and College of Chemistry, Fuzhou University, Fuzhou, Fujian, 350108, P. R China. *E-mail: y.w.chi@fzu.edu.cn. Fax/phone: +86-591-22866137.

Experimental

Materials

Ethanol, concentrated H_2SO_4, concentrated HNO_3 and HF were purchased from Sinopharm Chemical Reagents Co., Ltd. (China). Acetone and hexachloroplatinic acid hexahydrate ($H_2PtCl_6 \cdot 6H_2O$, Pt% ≥ 37.5%) were obtained from Shanghai Aladdin Biochemical Technology Co., Ltd. (China). High purity argon (≥99.999%) was provided by Fuzhou Huaxinda Industrial Gas Co., Ltd. All chemicals were of analytical reagent grade or higher purity and were used without further purification unless otherwise noted.

Instrumentation

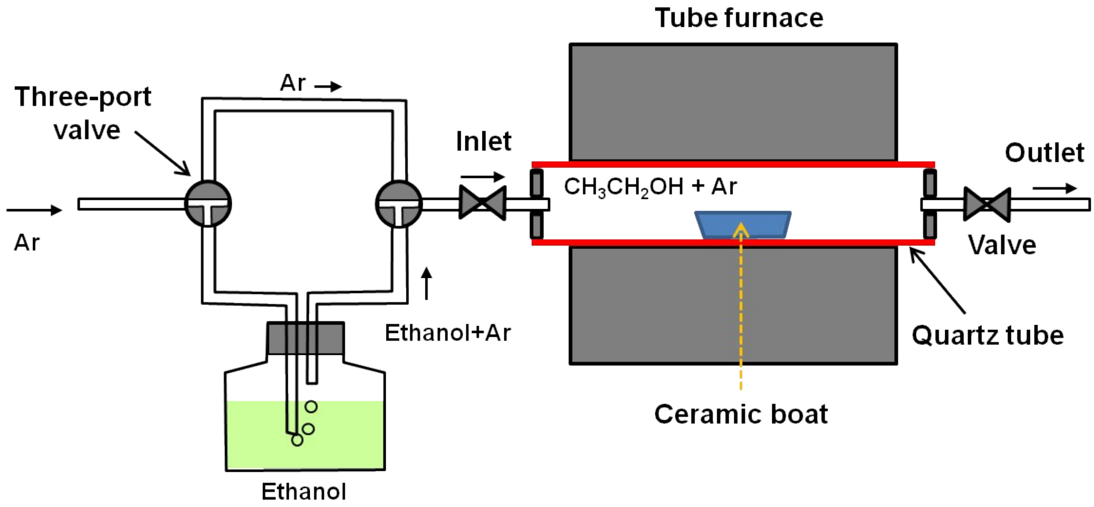
A GSL-1400X quartz tube furnace (Hefei Ke Jing Materials Technology Co., Ltd., China) was used for chemical vapor deposition (CVD) preparing multilayer-graphene nanosheet (MLGNS) film. A FEI Tecnai G2 F20S-TWIN transmission electronic microscope (TEM) at operation voltage of 200 KV, a FEI Nova NanoSEM 230 scanning electron microscope (SEM), a ThermoScientific Verios G4 UC SEM, and a Veeco NanoScope IIIa multimode atomic force microscope (AFM) were operated to characterize the morphologies of the prepared MLGNS film. A Hitachi HT7700 transmission electron microscope at an accelerating voltage of 100 kV (Japan) was utilized to characterize the morphology of Pt nanoparticles (Pt NPs). A Rigaku D/max-3C diffractometer using Cu Ka radiation (Japan) was used to measure XRD patterns. A Thermo Scientific ESCALAB 250 system was adopted to record X-ray photoelectron spectra (XPS). A Renishaw 1000 microspectrometer with excitation wavelength of 632.8 nm) was used to measure Raman spectra of samples. A RTS-9 4-Point Probes Resistivity Measurement System was used for measuring the square resistance of MLGNS film. A UV-5DL (5 W, 355nm) and a YLP-20 (20 W, 1064 nm) Fiber Laser Marking Systems (Shenzhen Dapeng Laser Technology Co., Ltd., China) were respectively used to cut ceramic and fabricate circuits on ceramic supported MLGNS for electrocehniluminescence (ECL) imaging sensing. An electrochemical workstation (CHI660C, CH Instruments, USA) was used to record cyclic voltammograms with a three-electrode system (the MLGNS working electrode, a Pt counter electrode, and a Ag/AgCl(3 M KCl), and was used to apply DC potential for ECL imaging platform with a two-electrode mode.

Fabrication of MLGNS film/ceramic substrate blocks and electrodes

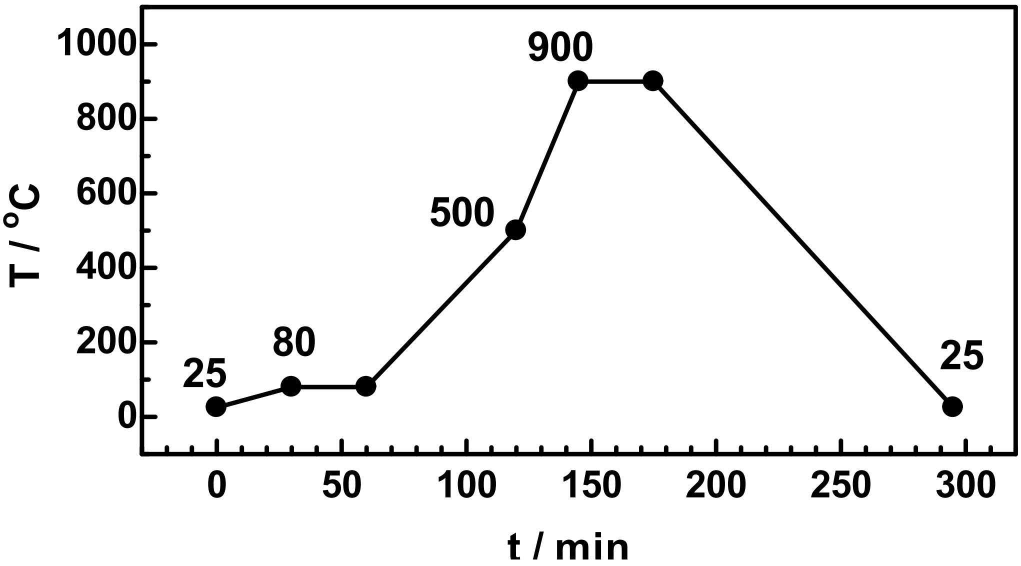
First, the ceramic boat deposited with MLGNS film was cut into MLGNS film/ceramic substrate blocks with different sizes by the 355-nm UV laser beam for further uses. Then, MLGNS film/ceramic substrate blocks were fabricated by the 1064-m laser beam into electroconductive film, electrodes and electrode arrays with necessary circuits for electroconductivity measurement, electrochemical investigation and ECL imaging, respectively.

Treatment of MLGNS film electrodes

After fabrication, the MLGNS film electrodes and MLGNS electrode arrays were simply cleaned by wiping them with alcoholic cotton for three time before use. No further chemical or electrochemical treatments, such as being soaked in NaOH, oxidized in concentrated HNO_3, or electrochemically activated by applying positive potentials, were carried out for the MLGNS film electrode or electrode arrays, since the obtained MLGNS film were both chemically and electrochemically stable, and the electrochemical and ECL performances of the electrodes, such as reversibility, redox currents, and ECL imaging were satisfied by the simple cleaning treatment with alcohol.



(A)



(B)

Figure S1. (A) Schematic diagram of a device for preparing graphene sheets by CVD under normal pressure; (B) Temperature programming for CVD preparation of MLGNS

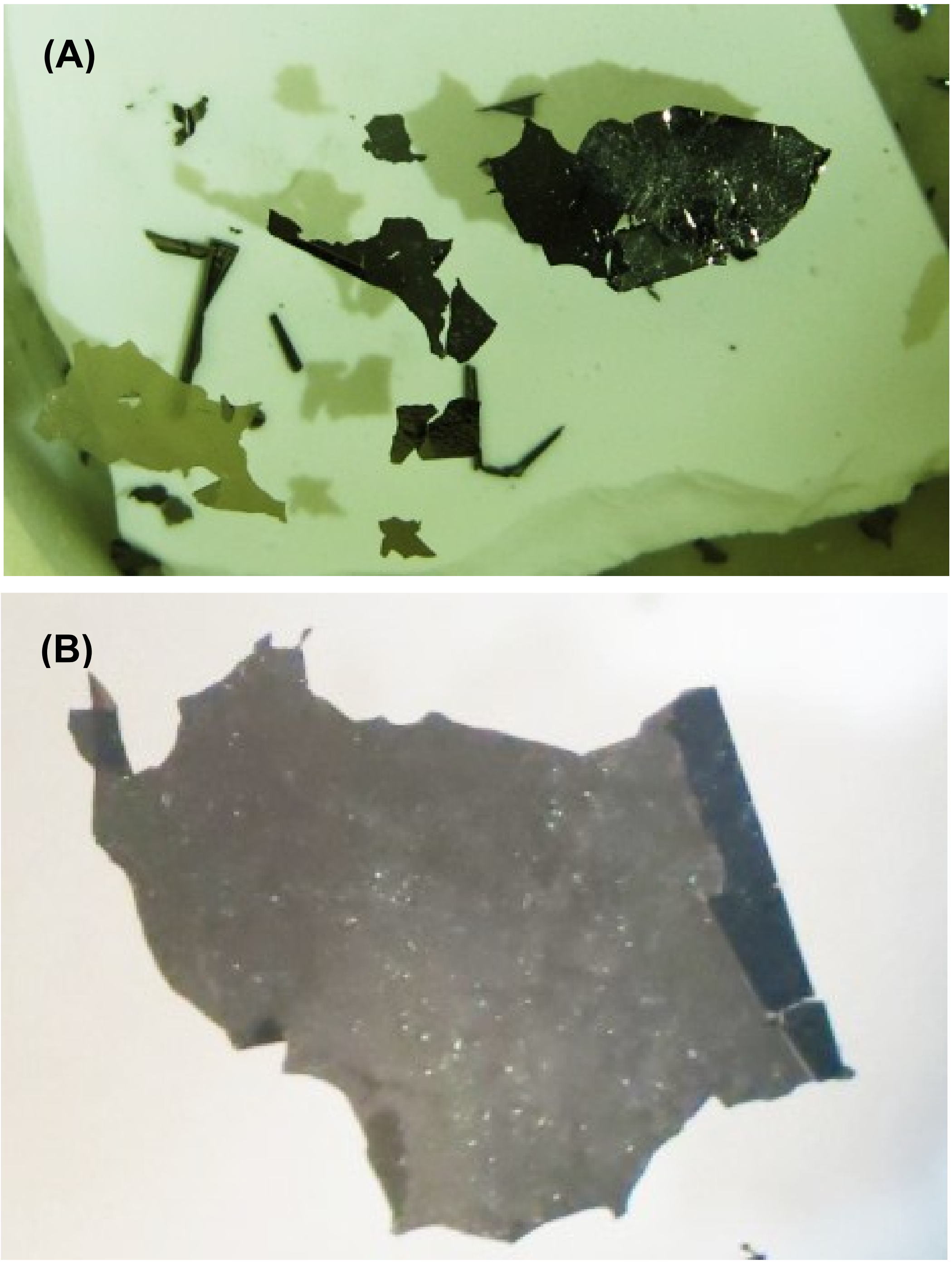


Figure S2. Photos of MLGNS/ceramic chip immersed in HF for 12 h (A) and typical MLGNS film peeled off from ceramic substrate (B).

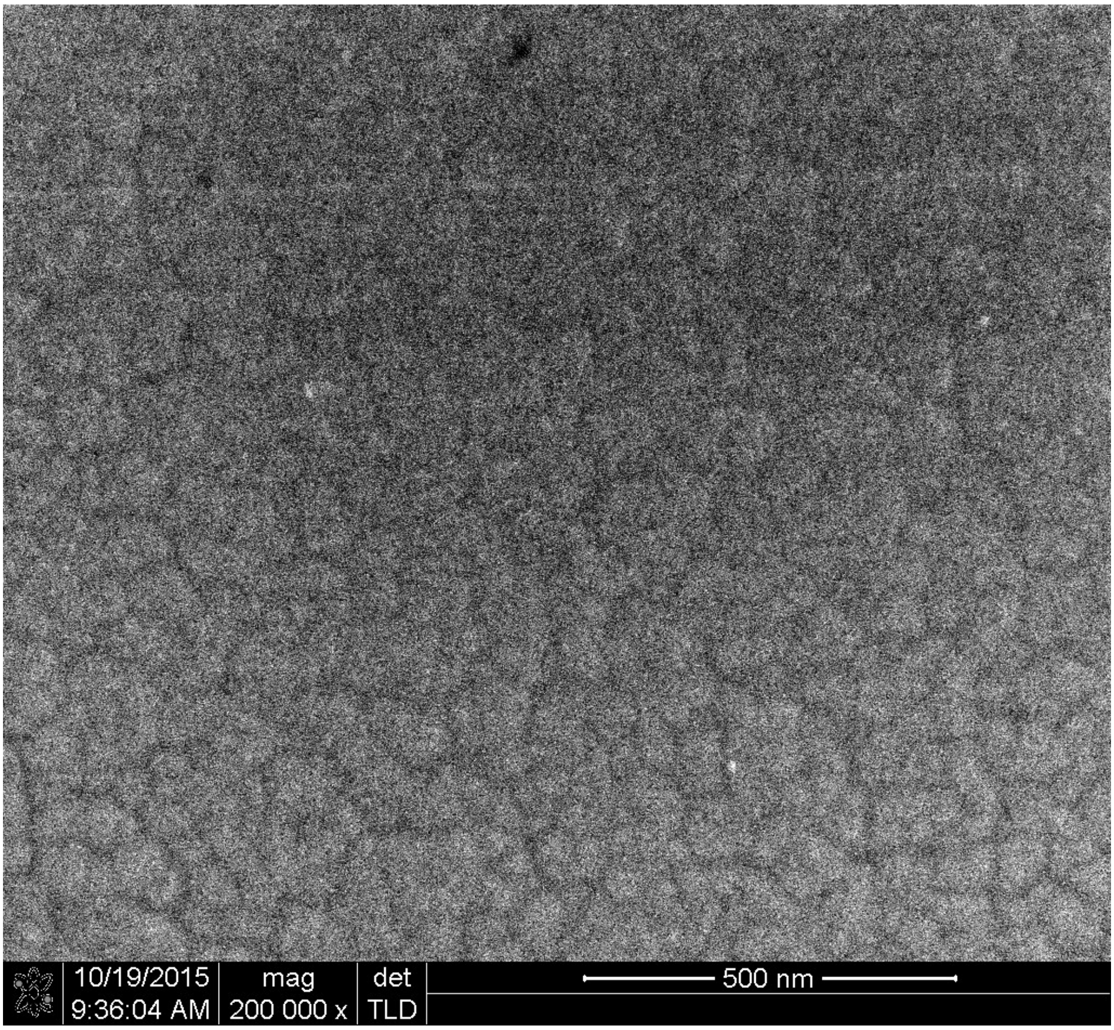


Figure S3. High-resolution SEM image of peeled MLGNS film put on a Si wafer

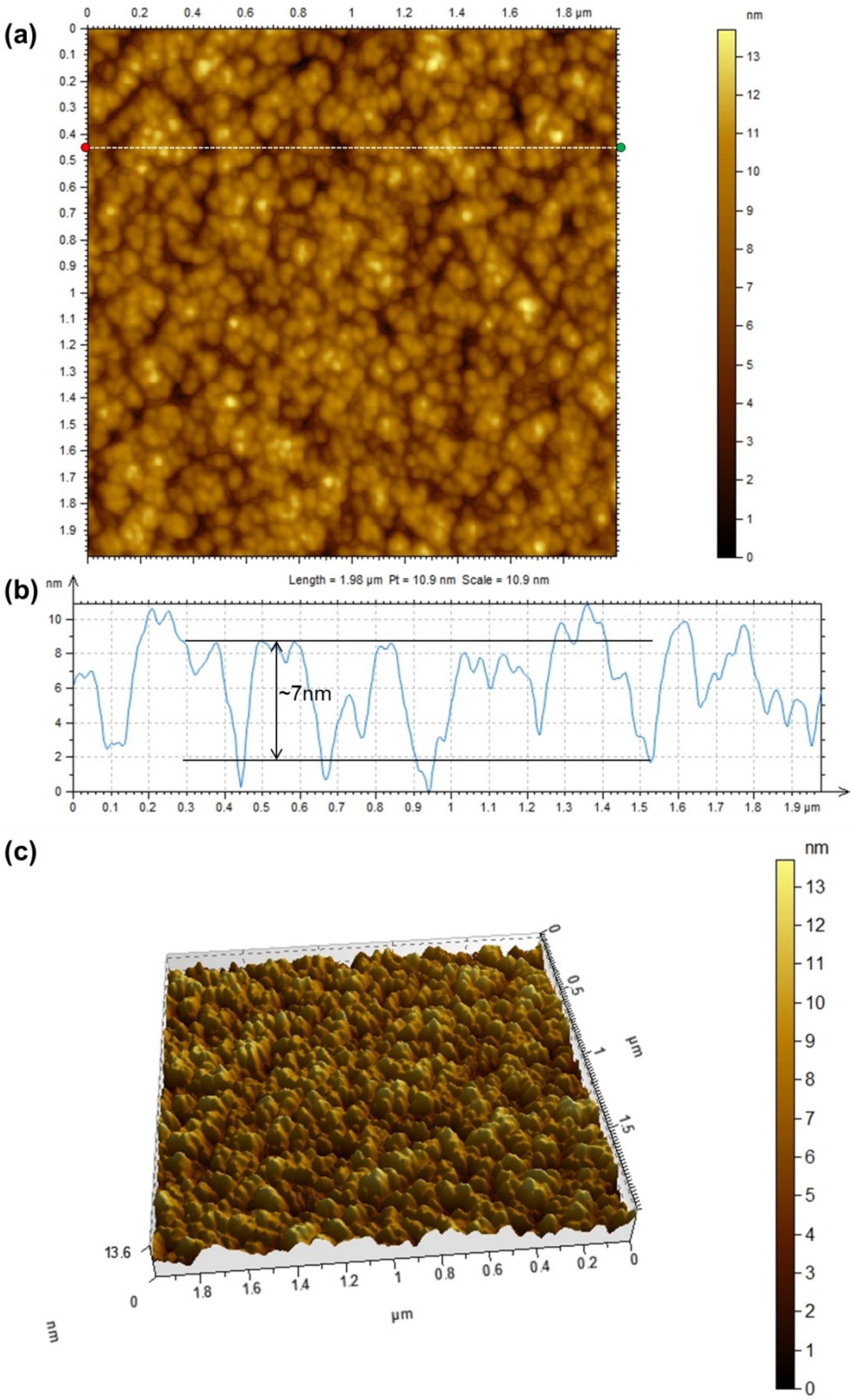


Figure S4. AFM image of the peeled MLGNS film put on a Si wafer (a); the height profile along white dash line in (b); and 3D AFM map (c).

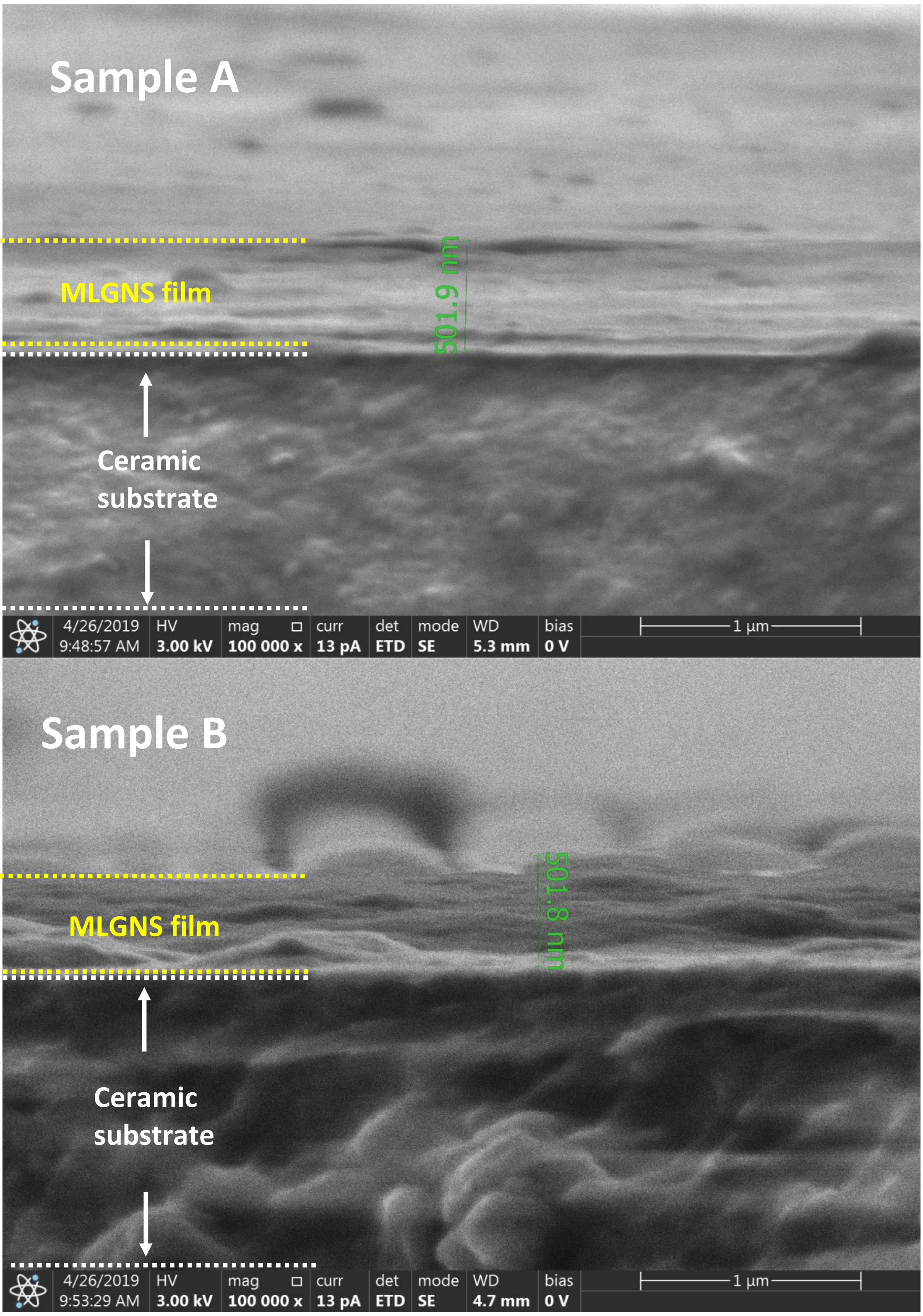


Figure S5. SEM images obtained for the fracture surfaces of MLGNS film/ ceramic substrate blocks.

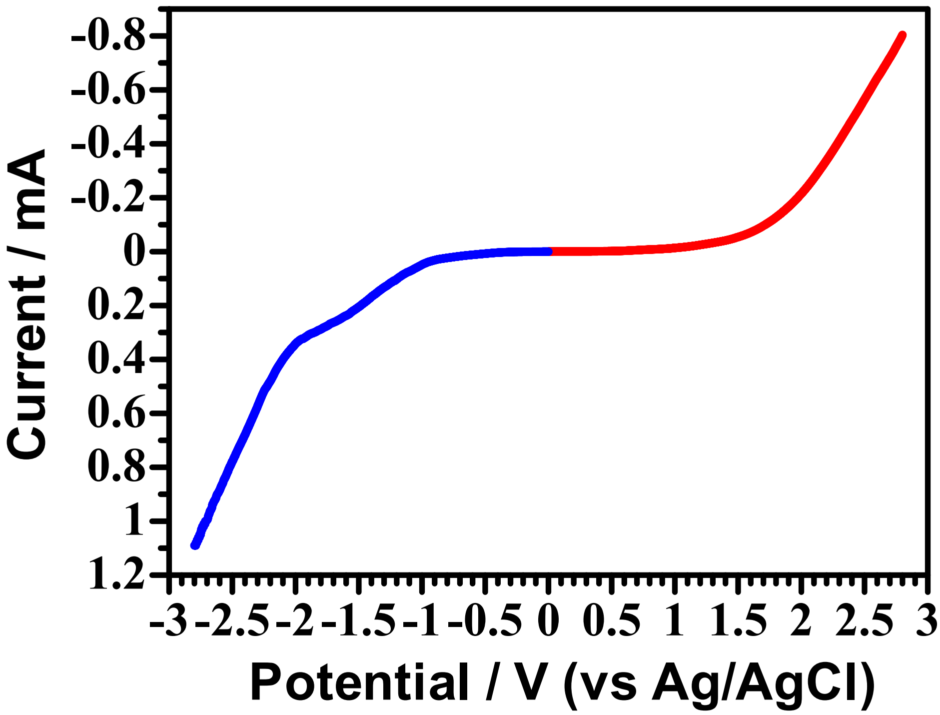


Figure S6. The potential window of MLGNS film electrode in Na_2SO_4 (0.1 M).

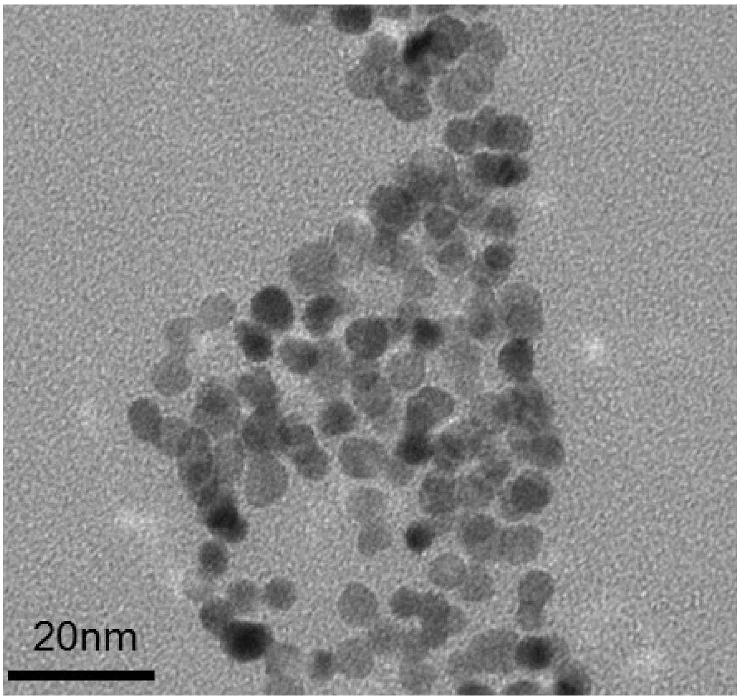


Figure S7. TEM image obtained for platinum nanoparticles (PtNPs).