

# Single-layer Graphene Sheets as Counter Electrodes for Fiber-Shaped Polymer Solar Cells

Dianyi Liu,<sup>1</sup> Yan Li,<sup>1</sup> Shuli Zhao,<sup>2</sup> Anyuan Cao,<sup>3</sup> Chaohua Zhang,<sup>2</sup> Zhiwei Liu,<sup>1</sup> Zuqiang Bian,<sup>1\*</sup>  
Zhongfan Liu,<sup>2</sup> Chunhui Huang<sup>1</sup>

<sup>1</sup> Beijing National Laboratory for Molecular Sciences, State Key Laboratory of Rare Earth Materials Chemistry and Applications, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China

<sup>2</sup> Center for Nanochemistry, Beijing National Laboratory for Molecular Sciences, State Key Laboratory for Structural Chemistry of Unstable and Stable Species, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China

<sup>3</sup> Department of Materials Science and Engineering, College of Engineering, Peking University, Beijing 100871, P. R. China

Corresponding author: [bianzq@pku.edu.cn](mailto:bianzq@pku.edu.cn)

## Supporting Information:

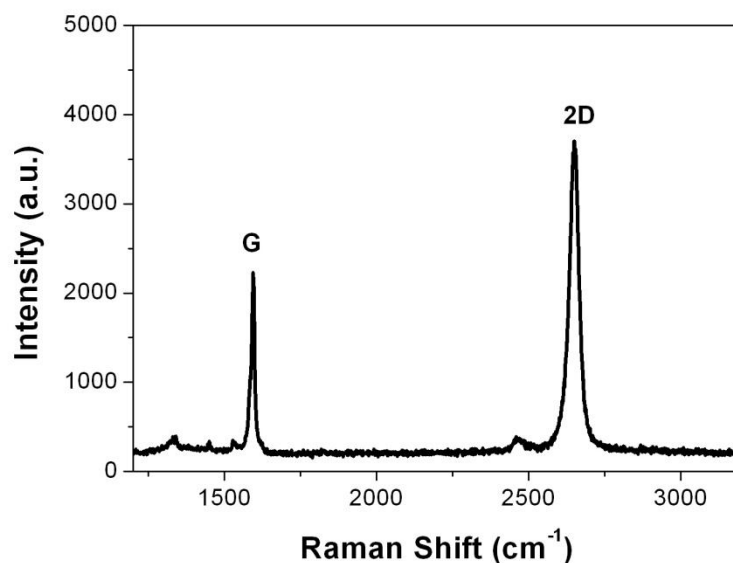


Figure S1. Raman spectrum of SLG grown on Cu foil by CVD process, showing representative G and 2D peaks with a  $I_{2D}/I_G$  intensity ratio of  $\sim 3.5$ .

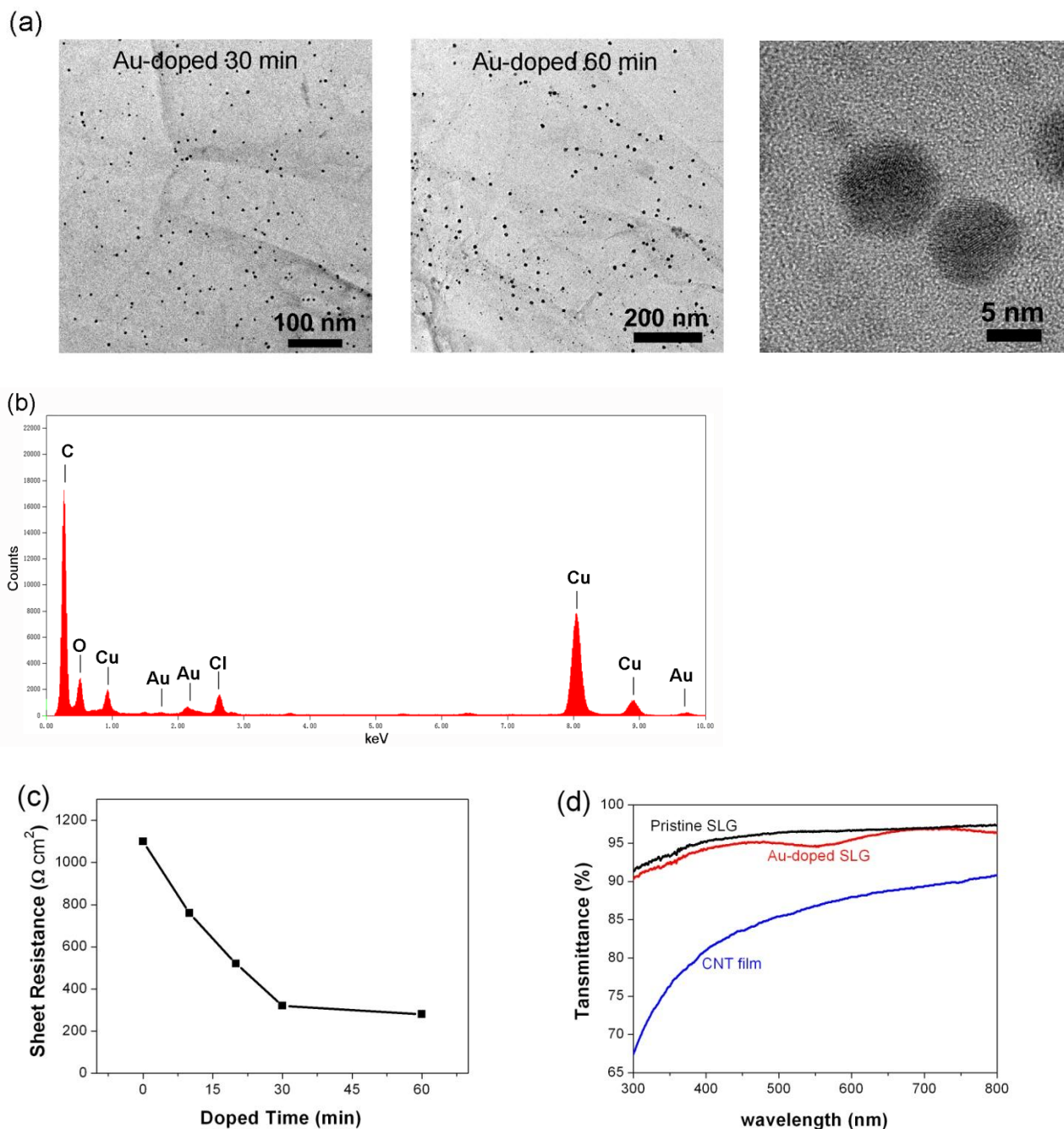


Figure S2. Properties of Au-doped of graphene sheets. (a) Transmission electron microscope (TEM) image of Au nanoparticles (dark-contrast dots) adhered on the surface of a SLG sheet with doped time of 30 min (left) and 60 min (middle), respectively. The right image shows the high resolution TEM of Au nanoparticles on the surface of SLG with 30 min doped time. (b) Energy dispersive spectroscopy (EDS) of the Au nanoparticles doped graphene layer. (c) Sheet resistance of the graphene layer after different doping periods (0-60 min). (d) Optical transmittance curves of the pristine, Au-doped graphene, and a carbon nanotube spiderweb film in the range of 300-800 nm.

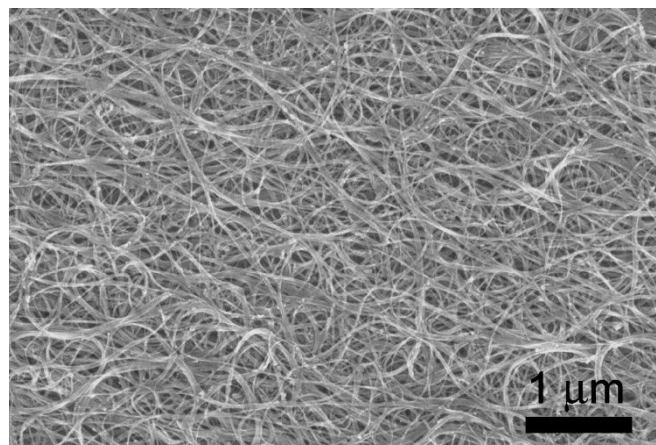


Figure S3. SEM image of a single-walled carbon nanotube film used in this work (Fig. 3b and Fig. S2d), showing a spiderweb-like structure.

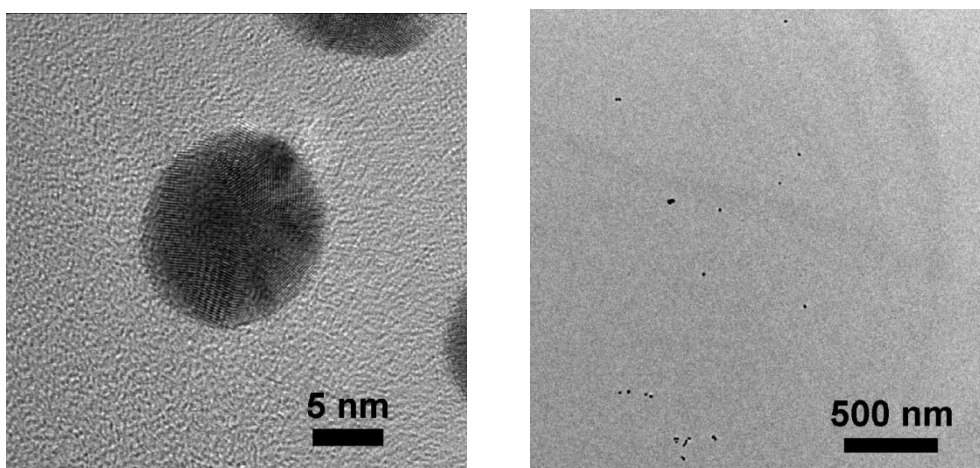


Figure S4. The high resolution TEM image of pre-synthesized Au nanoparticles (left), and the Au particles adhered onto graphene surface by physical adsorption (right).

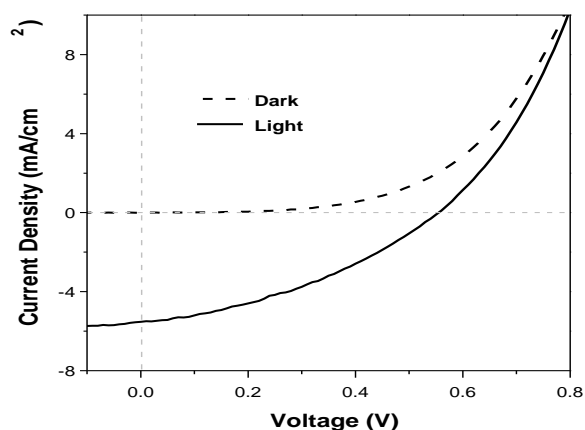


Figure S5. The  $J$ - $V$  curves of the control device using pre-synthesized Au nanoparticles adsorbed-graphene as the electrode.

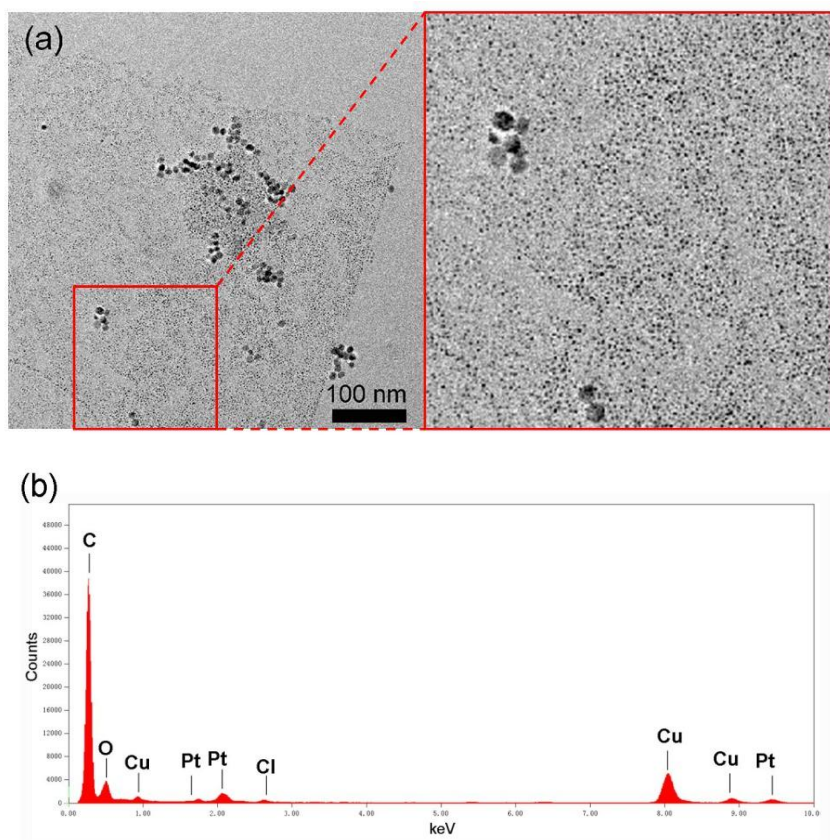


Figure S6. (a) TEM image of a Pt-doped graphene layer containing 2-4 nm Pt nanoparticles distributed uniformly and at high area density on the graphene surface. (b) EDS analysis of the Pt-doped graphene layer.

Table S1. Performances of FSCs with different electrode as described in Figure 3b.

Electrode	$V_{oc}$ [mV]	$J_{sc}$ [mA cm <sup>-2</sup> ]	FF [%]	PCE [%]
CNT Film	550	8.13	51.2	2.29
Au-Graphene	570	8.14	54.5	2.53
Pt-Graphene	550	7.91	51.6	2.24