Supporting Information

1. GO thin film thicknesses on different substrates

In this part, various thicknesses of GO thin films on two different substrates were carefully characterized. Due to the roughness of Ag nanoparticles, the thickness of GO thin film on Ag/Si substrate was determined by using the SEM cross section images. By contrast, GO thin films on the flat bare Si substrate were measured by AFM. Figure S1 shows the result of SEM and AFM measurements of GO thin films (~9 nm and ~40 nm) on two different substrates. Every sample was measured on 6 different positions to obtain an average thickness as shown in Table S1.

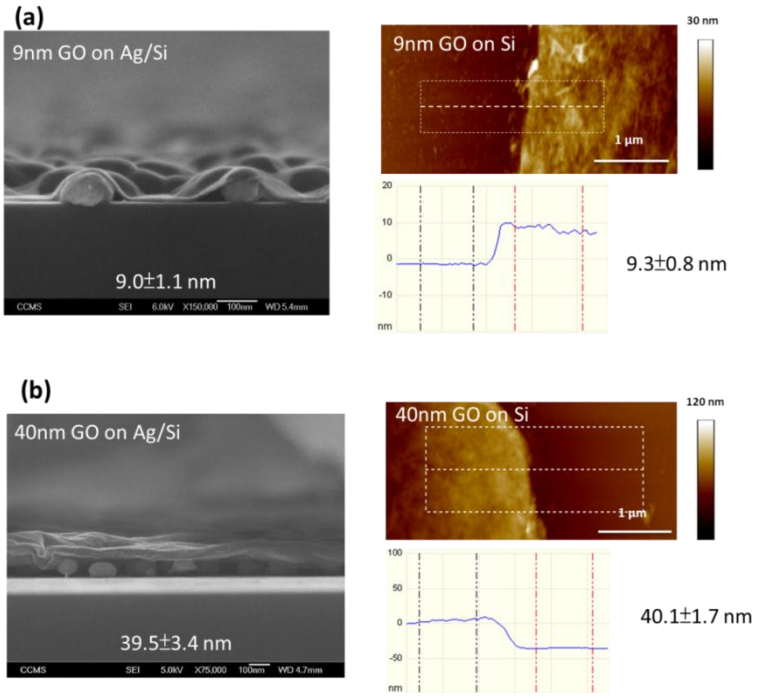

Figure S1. SEM and AFM images of (a) 9 nm and (b) 40 nm GO thin films on Ag/Si (left) and on Si substrates (right)

Table S1. Averaged GO thin film thickness on Ag/Si and bare Si substrate.

on Ag/Si (nm)	on Si (nm)
9.0±1.1	9.3±0.8
15.0±1.1	15.1±1.0
18.4±1.4	19.1±0.7
31.9±1.7	30.8±0.8
39.5±3.4	40.1±1.7

For the estimation of PL enhancement ratio, the PL intensity per unit volume (*I*) was used with definition according to Equation (1):

$$I = \frac{A}{t \times \pi r^2} \qquad (1)$$

where *A* represents the integrated intensity of PL spectrum, *t* is the averaged thickness of GO on each substrate and *r* is the beam radius of excitation laser which is about 0.5 mm.

2. Calculation of surface area difference between two different substrates

The maximum surface area difference of GO thin films on bare Si substrate and Ag NPs substrate can be describe as $4\pi r^2 - \pi r^2 = 3\pi r^2$ as shown in Figure S2. The particle size and the particle density are 80nm and 14.1 particles/μm^2 respectively, estimated from the SEM images. Therefore, the theoretical upper limit value, which corresponds to the volume ratio between the GO thin films conformally deposited on

the Ag NPs/Si substrate and on the flat Si substrate respectively, can be evaluated as

$$\frac{1 + 14.1 \times (3\pi \times 0.08^2)(\mu m^2)}{1(\mu m^2)} = 1.85$$

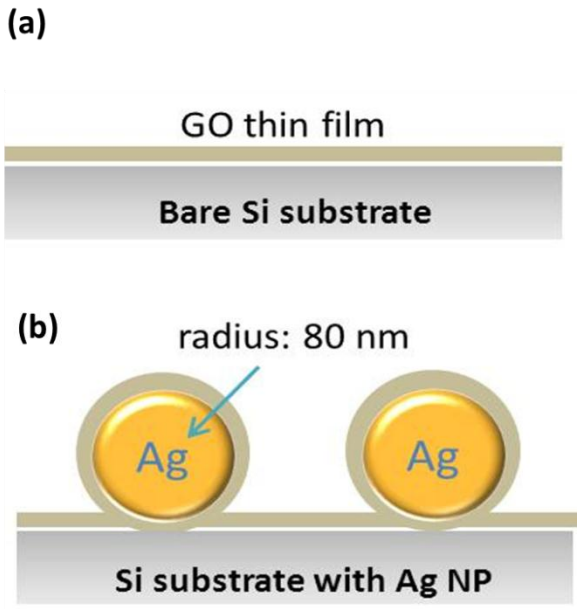

Figure S2. The schematic illustration of GO film covered on (a) bare Si substrate and (b) Ag NPs.

3. Deposition of Ag NPs by the solution-process technique

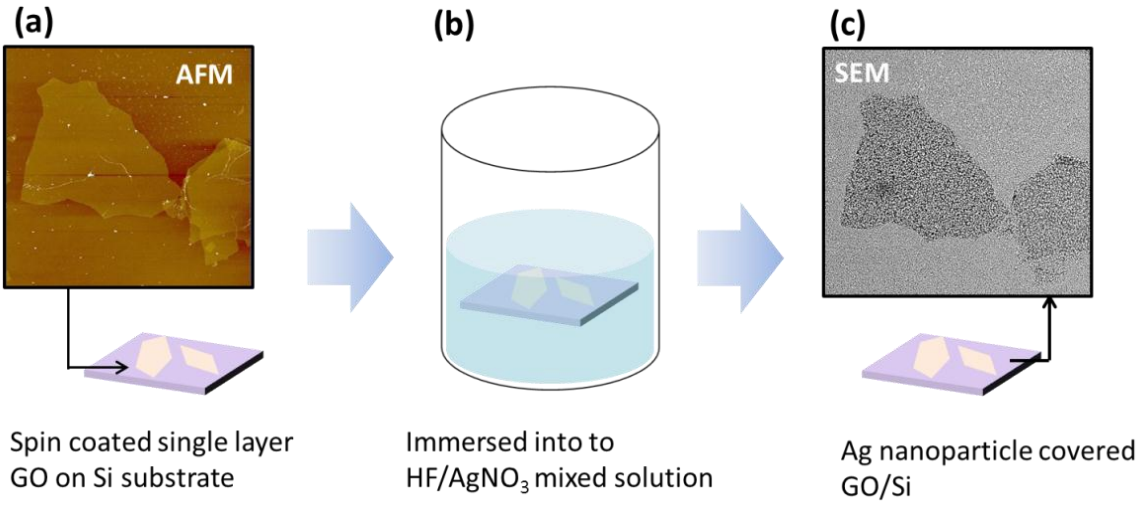

Figure S3. Fabrication processes of Ag NPs on the single layer GO sheets.

Single-layered and isolated GO was deposited onto a Si substrate from highly diluted GO solution (0.03mg/ml) with high spin coating rate (5000rpm) and the morphology was examined by AFM as shown in Figure S3(a). To decorate Ag NPs onto the single-layer GO sheets, a reaction in HF/$AgNO_3$ mixed solution was performed according to ref S1 and S2. The Si substrate consisting of the pre-coated single-layered GO sheets was immersed into a solution containing 4.6M HF and 8.3mM $AgNO_3$ (Figure S3(b)). Ag NPs can be formed onto the single-layer GO sheet and Si substrate according to following reactions:

$$Si + 2H_2O \rightarrow SiO_2 + 4H^+ + 4e_{Si}^- \qquad (1)$$

$$SiO_2 + 6HF \rightarrow H_2SiF_6 + 2H_2O \qquad (2)$$

$$Ag^+ + e_{Si}^- \rightarrow Ag^0 \qquad (3)$$

These redox reactions occurred because the energy level of Ag^+ reduction lies well below the Si valance band edge. Si atoms were oxidized to give out electrons as described in reaction (1) and the resulted SiO_2 was then etched by HF in reaction (2) to expose more Si for efficient electron supply. Ag NPs were simultaneously deposited onto surface by accepting electrons as shown in reaction (3). Figure S3(c) shows the SEM morphology of the single-layer GO sheet and Si substrate decorated with Ag NPs after immersion in mixed solution for 20 seconds. Ag NPs were

homogeneously distributed both on the GO sheet and Si substrate. The density of the Ag NPs formed on the GO sheet was slightly lower than that of the Ag NPs on the Si region. An even lower density of Ag NPs was observed in the double-layer region of the GO sheet, indicating that GO might also hinder the reduction process of Ag^{+}.

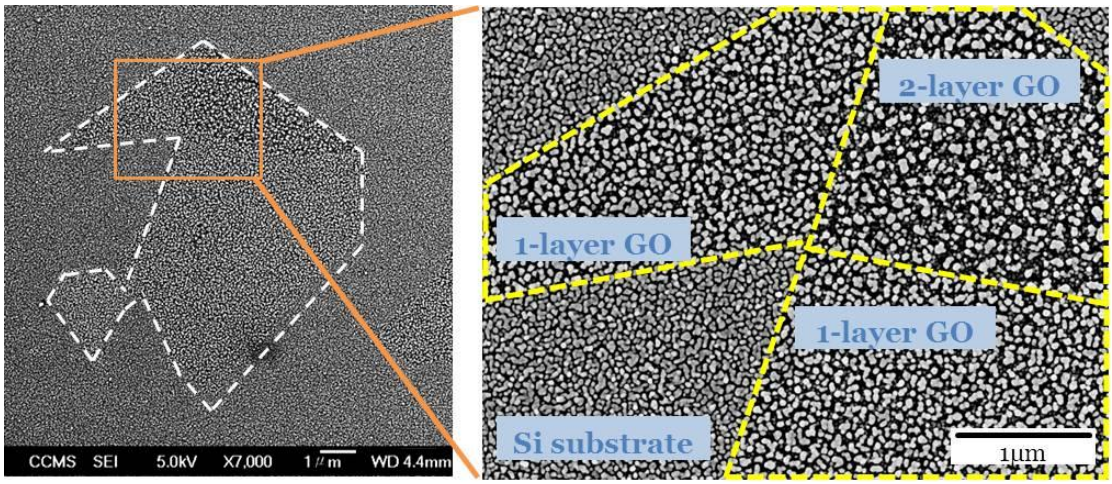

Figure S4. The SEM image of Ag NPs deposited on Si substrate and GO film with various densities.

To further verify the chemical compositions of GO, we performed the XPS measurement to analyze the composition of GO before and after HF treatment as shown in Figure S5. The two XPS spectra for the pristine GO and GO with HF treatment are nearly identical, indicating that the chemical compositions of GO does not change after HF treatment.

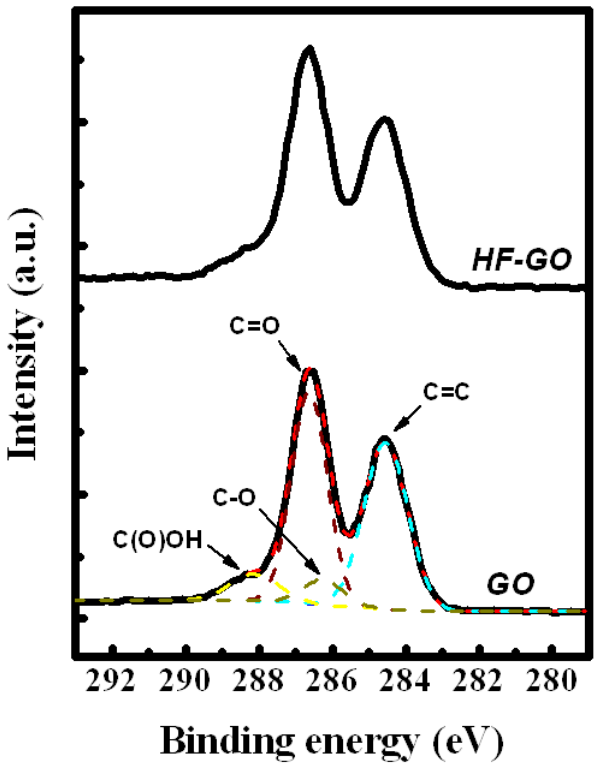

Figure S5. The XPS spectra for the pristine GO and GO with HF treatment

Reference

1. K. Peng, J. Hu, Y. Yan, Y. Wu, H. Fang, Y. Xu, S. T. Lee, J. Zhu, *Adv. Funct. Mater.* **2006**, *16*, 387–394

2. G. Lu, H. Li, C. Liusman, Z. Yin, S. Wu, H.Zhang, *Chem. Sci.*, **2011**, *2*, 1817-1821