

Supporting information

S1. Parallel process under the same condition without using ILs

Control experiment under the same condition without using ILs was done.

Figure S1 show the TEM result of the prepared sample without using ILs. Comparing with Figure 8b, the loading amount of Ag nanoparticle on RGO without using ILs is much lower. Besides, its size distribution is much worse and many of the nanoparticles aggregate with each other, suggesting that ILs play an important role in the production process.

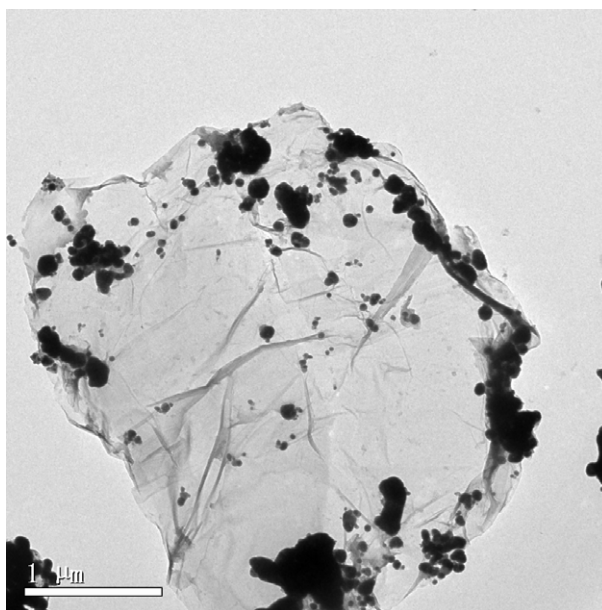


Figure S1 TEM image of prepared Ag-RGO without using ILs

From the results of antibacterial tests (Table S1), we can find that the antibacterial activity of Ag-RGO without using ILs is much lower than that prepared with ILs, suggesting that the size distribution and location of Ag on RGO will have a great effect on the disinfection ability of Ag-RGO.

Table S1. Antibacterial activity tests of Ag-RGO prepared with and without using ILs

Sample	Bacterial Culture	0 min colony counting	24h colony counting	disinfection rate (%)
Ag-RGO	Colibacillus	9.8×10^4	2.7×10^2	99.7
Ag-RGO prepared without using ILs	Colibacillus	1.0×10^5	3.1×10^3	96.9

All in all, it is found that ILs can be used as a good solvent for the synthesis of Ag-RGO with better morphology and improved properties.

S2 Control experiment of Ag-RGO prepared with different ratio of Ag and RGO

Control experiment under the same condition with different ratio of Ag and RGO was done. 150 mg of AgNO_3 was added to a mixture of 1 mL [BMIM] $[\text{PF}_6]$ and 9 mL water. The above mixture was stirred for 2 h to form part A. On the other hand, 100 mg of GO was added to 50 mL water. The mixture was sonicated for 30 min followed by high-speed stirring for further 1 h. 100 mg ascorbic acid and 1 mL ammonium hydroxide was added to the GO solution to get part B. Subsequently, part A and part B were mixed. The mixture was put into an autoclave and heated at 160 °C for 4 h. After cooling to room temperature naturally, the product was isolated by centrifugation, washed with pure water and ethanol several times, and dried at 90 °C for 12 h. The prepared sample is named as Ag-RGO-b.

From the result of SERS spectra (Figure S2), it is found that both of Ag-RGO and Ag-RGO-b show SERS enhancement, suggesting that Ag nanoparticles on RGO play an important role in SERS enhancement. However, the enhancement factor of Ag-RGO is a little better than that of Ag-RGO-b.

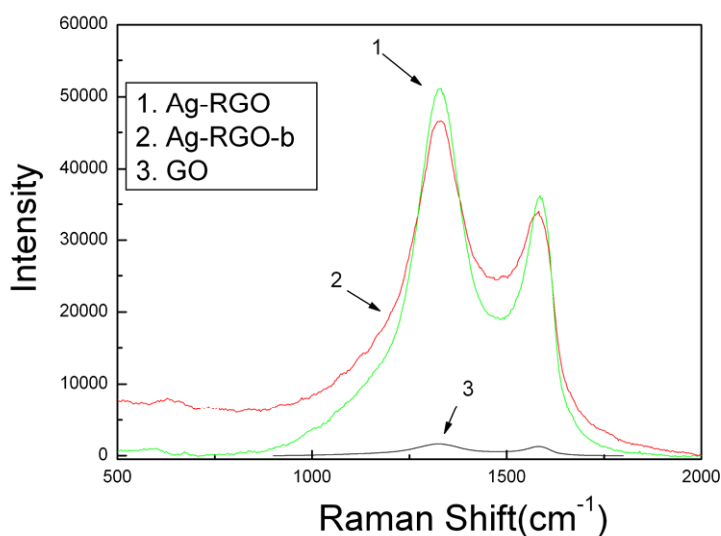


Figure S2 SERS spectra of Ag-RGO and Ag-RGO-b

From the results of antibacterial tests (Table S2), we can find that both of Ag-RGO and Ag-RGO-b show the antibacterial activity. Besides, it is found that the disinfection ability of Ag-RGO is a bit better than that of Ag-RGO-b, suggesting that the ratio of Ag and RGO will have an effect on its antibacterial activity.

Table S2. Antibacterial activity tests of Ag-RGO and Ag-RGO-b

Sample	Bacterial Culture	0 min colony counting	24h colony counting	disinfection rate (%)
Ag-RGO	Colibacillus	9.8×10^4	2.7×10^2	99.7
Ag-RGO-b	Colibacillus	9.7×10^4	1.0×10^3	99.0

S3 SERS spectrum of Ag nanoparticles

Control experiment under the same condition without adding RGO was done to get pure Ag nanoparticles.

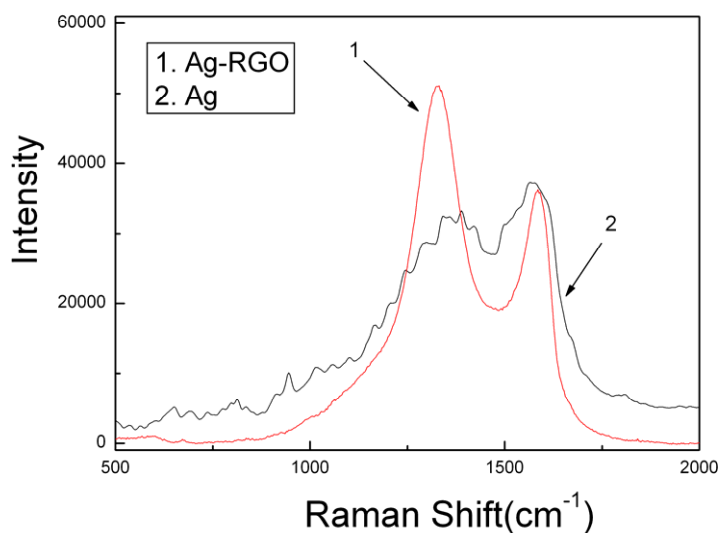


Figure S3 SERS spectra of Ag and Ag-RGO

From the result of SERS analysis (Figure S3), it is found that both of Ag-RGO and Ag show SERS enhancement, suggesting that Ag plays the main role in this phenomenon. However, the SERS enhancement of pure Ag is much lower than that of Ag-RGO. Besides, the spectrum of Ag-RGO is much smoother. These results suggest that there may exist chemical bonding between Ag and RGO [1]. We speculate that Ag nanoparticles may coordinate to O atoms bound to the RGO surface, bridging between two carbons and serving as a binding site for the Ag nanoclusters in the form of $C(=O)CO(Ag)$. The resulted interaction between Ag and RGO was strong enough to ensure the nanoparticles remain attached even after chemical cleaning and ultrasonication.

Reference

1. R.V. Hull, L. Li, Y.C. Xing, C.C. Chusuei, *Chem. Mater.* 2006, 18, 1780-1788.