Supporting Information

Polyethyleneimine-mediated seed growth approach for synthesis of silver-shell silica-core nanocomposites and their application as a versatile SERS platform

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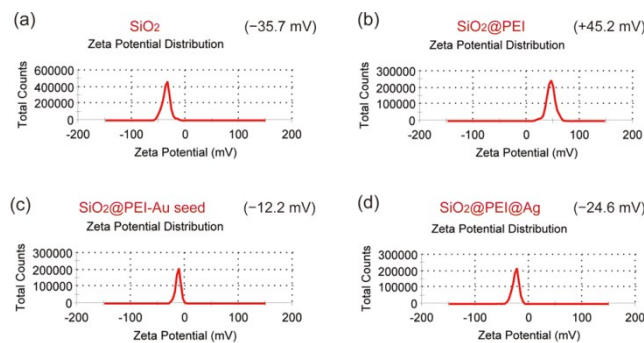
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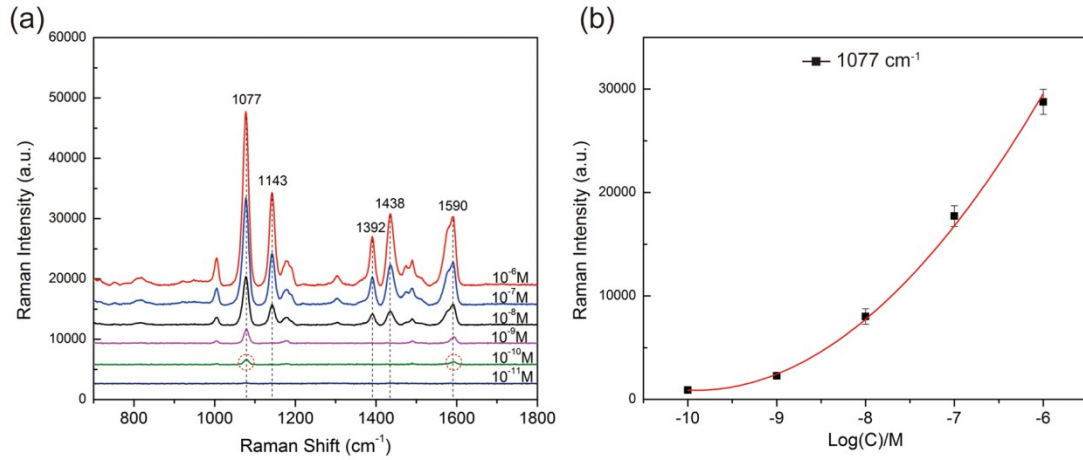[c]Henan University of Chinese Medicine, Zhengzhou, Henan 450008, PR China.

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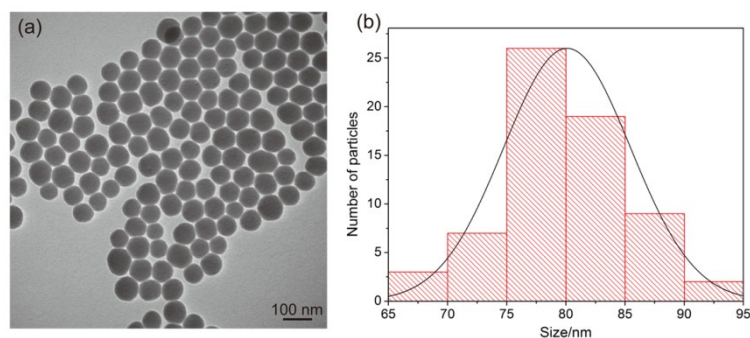
Fig. S1 (a) TEM images of SiO_2 NPs, and (b) the statistical histogram of the corresponding nanoparticle size.

Fig. S2 Zeta potentials of (a) SiO_2, (b) $SiO_2@PEI$, (c) $SiO_2@PEI$-Au seed, and (d) $SiO_2@PEI@Ag$ NPs in aqueous solution.

Fig. S3 (a) The SERS spectra of PATP measured with different concentrations on the SiO_2@PEI@Ag NPs. (b) The intensity−concentration calibration curve for PATP at a concentration range of 1.0×10^{-6} to 1.0×10^{-10} M by using SERS intensity at 1077 cm^{-1}. The error bars represent the standard deviations from 5 measurements.

S4 EF calculation:

To quantify the enhancement ability of the SiO_2@PEI@Ag NPs, the enhancement factor (EF) was calculated as the ratio of photons scattered by the SERS substrate and the normal substrate. EF was estimated according to the following equation:

EF=(I_{SERS}/I_{bulk})(N_{bulk}/N_{SERS}), whereas N_{bulk} and N_{SERS} is the number of molecules contributed to the Raman and SERS signal, respectively, and I_{SERS} and I_{bulk} is the respective signal intensity of the related peaks. However, intrinsic EF is difficult to estimate because several variables, such as adsorbed molecules and laser scattering volume, are difficult to obtain. In our experiment, all the other parameters, including the laser diameter, laser power, exposure time, and microscopic magnification, were identical. The chemical droplets were of the same volume, and the number of detected PATP molecules was proportional to its concentration. Therefore, the EF was roughly estimated by comparing the intensity of the Raman peak in the SERS spectrum with that in the normal Raman spectrum according to the equation EF = (I_{SERS}/I_{RS}) × (C_{RS}/C_{SERS}), where I_{SERS} and I_{RS} are the vibration intensities in the SERS and normal Raman spectra of PATP molecules, and C_{RS} and C_{SERS} are the concentrations of the PATP molecules in the SERS and reference samples, respectively.

The peak at 1077 cm^{-1} from the PATP Raman spectrum (Fig. S4) was chosen for analysis, and the intensities for peaks (a) and (d) were 1249 and 8157 a.u., respectively. The PATP concentrations for peaks (a) and (d) were 10^{-1} M and 10^{-8} M, respectively. Therefore, the EF of the SiO_2@PEI@Ag NPs was roughly estimated to be 6.53×10^{7}.
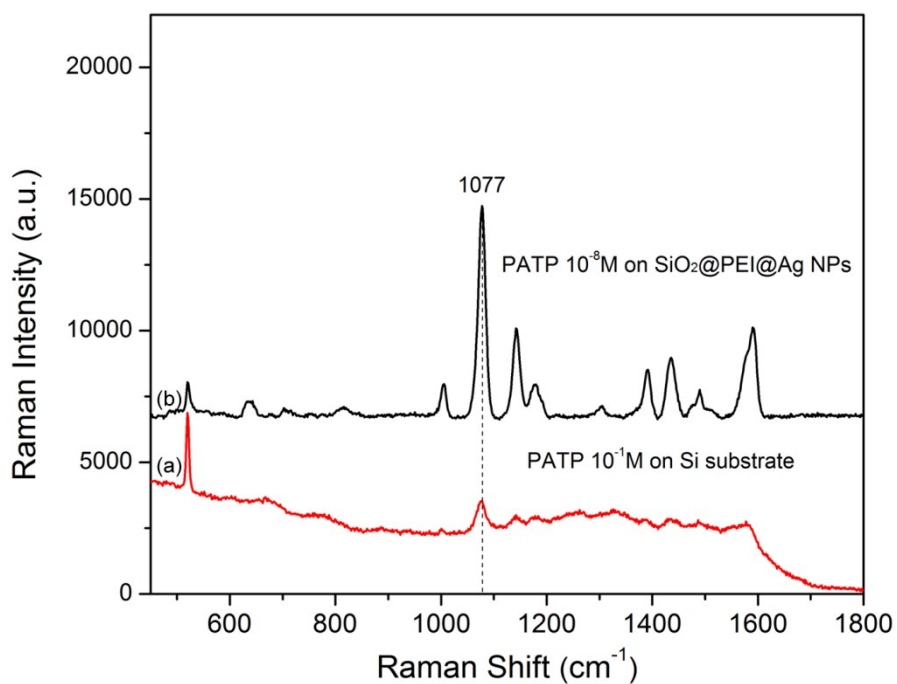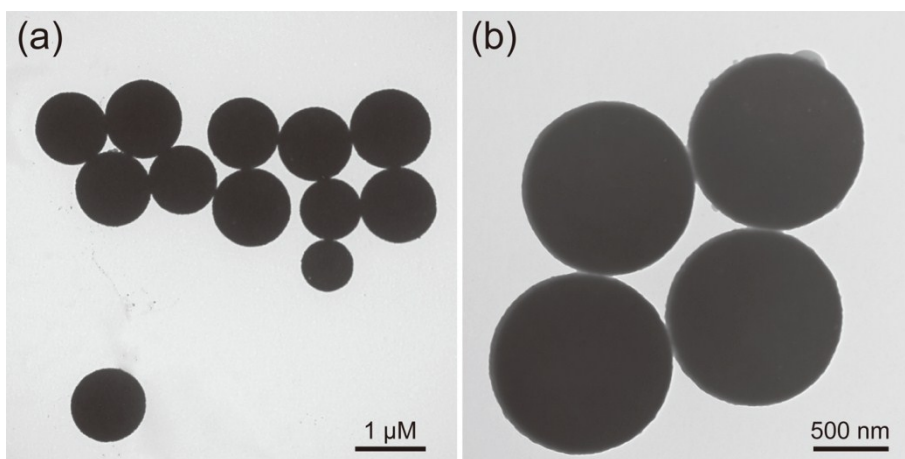
Fig. S4 Raman spectra recorded of PATP molecules with (black) and without (red) the SiO_2@PEI@Ag NPs.

Table S1

Raman shift (cm^{-1})	Assignment
932	$\upsilon(CH_3N)$ or $\upsilon(C-S)$
1148	$\rho(CH_3)$ or $\upsilon(C-N)$
1383	$\rho(CH_3)$
1508	$\upsilon(C-N)$

Table S1 Raman peaks of thiram and corresponding assignments.

Fig. S5 TEM images of (a) a-Fe$_2$O$_3$, (b) a-Fe$_2$O$_3$@SiO$_2$ microspheres.