Electronic Supplementary Material (ESI) for RSC Advances.

Supplementary Information for

Graphene-interlayered magnetic composite as a multifunctional SERS substrate

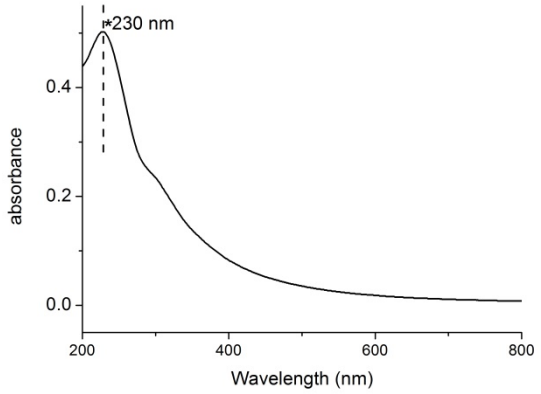

Figure. S1 UV-vis of GO nanosheets solution

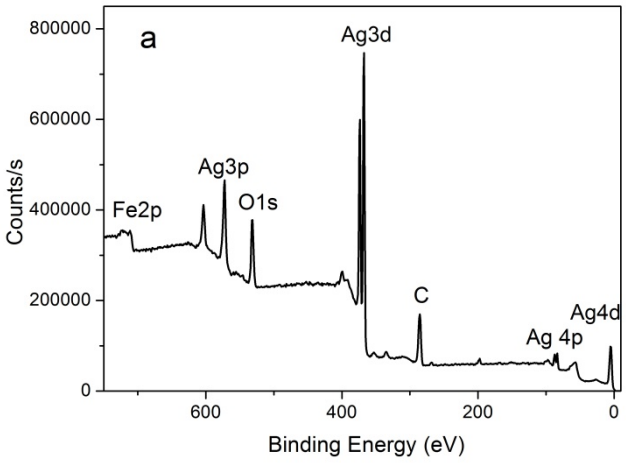

Figure. S2 (a). XPS survey spectrum of Fe_3O_4@Ag-GO

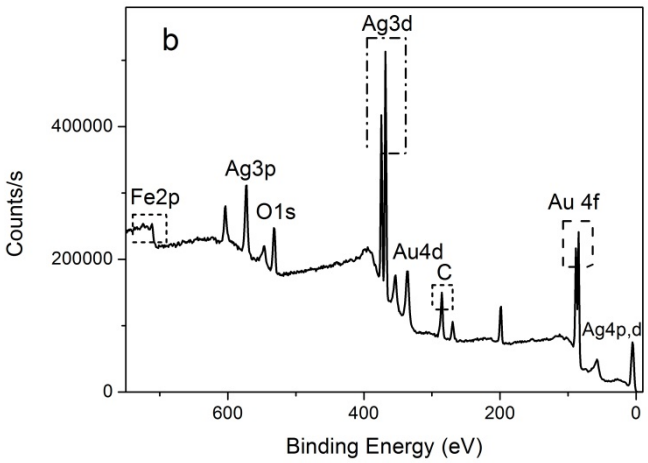

Figure. S2 (b). XPS survey spectrum of Fe_3O_4@Ag-rGO-Au. Elements labeled with dash rectangle were analysed in detail in the body.

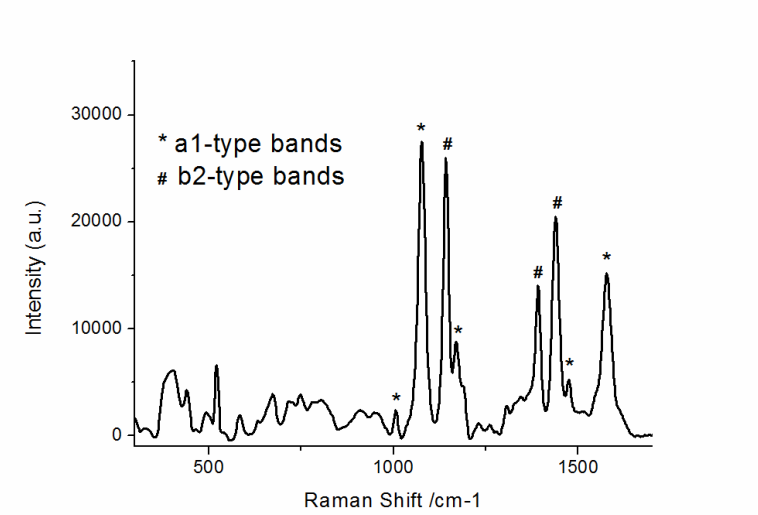

Figure. S3 SERS spectrum of PATP at a wavelength of 782 nm

Normal Raman	**SERS Signal In 785 nm**	**assignments**
391	--	$\delta CS,(a_1)$
463	--	$\gamma CCC,7a(a_1)$
634	--	$\gamma CCC,12(a_1)$
1004	1005	$\delta CC+\gamma CCC,18a(a_1)$
1076	1076	$\upsilon CS,7a(a_1)$
1140	1142	$\delta CH,9b(b_2)$
1172	1172	$\delta CH,9a(a_1)$
	1392	$\upsilon CS_+\delta CH,14b(b_2)$
	1439	
		$\upsilon CS_+\delta CH,(3b_2)$
1482	1475	$\upsilon CS_+\delta CH,19a(a_1)$

1586	1578	$\upsilon CC, 8a(a_1)$

Table S1. Raman peaks of PATP and according assignments

EF calculation:

The SERS enhancement factors (EF) for PATP can be calculated according to the equation $EF=(I_{SERS}/I_{bulk})(N_{bulk}/N_{SERS})$, where I_{bulk} is the intensity of Raman signal as calculated from the target peak area and N_{bulk} is the number of molecules in the focal volume, whereas I_{SERS} and N_{SERS} are parameters when Fe_3O_4@Ag-rGO-Au microspheres are used as active substrates. For valuable determination of N_{bulk} and N_{SERS}, 20 ul melted PATP sample and the PATP-absorbed Fe_3O_4@Ag-rGO-Au microspheres (separated from PATP solution 10^{-7} M, 2 ml) were uniformly spread on 300 nm SiO_2/Si substrates.

In detail, The solid sample of PATP was slowly heated to 42 °C and then the melted PATP (20 ul) was dropped on 0.4 cm×0.4cm SiO_2/Si substrate, formed a uniform film (~800 um). After totally cooled down, the SERS detection was conducted and the peak intensity of acquired Raman signal was I_{bulk}. The penetration depth of laser (h) is calculated by equation: $h = \int_{-\infty}^{\infty} I(z)dz/I_{max}$, I (z) is the intensity of the Raman peak of Si (520 cm^{-1}), which is measured as a reference to calculate h. As displayed in Fig. S4c, it is a function of the distance (z) deviated from the focused center. According to the equation, the penetration depth of laser (h) is measured as 460 μm. Therefore, $N_{bulk} = \pi(d/2)^2 h \rho_0 N_A/M_0 = 5.12 \times 10^{14}$. ρ_0 (1.18 g/mL) and M_0 (125.19 g/mol) is the density and molar mass of melted PATP, respectively.

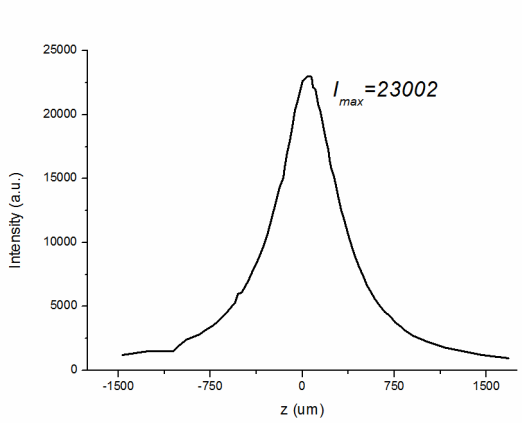

Figure. S4 Intensity of the Raman peak of Si (520 cm^{-1}) I (z), a function of the distance (z) deviated from the focused center.

The number of PATP molecules contribute to the SERS signals within the laser spot area is N_{SERS} = RA/σ, under the assumption that molecules were absorbed on the microspheres in single layer uniformly. R is the roughness factor of the nanostructure, which approximate to be 1. σ is the occupied surface area of a single molecule, which is equal to 0.22 nm^2 for PATP. A is the area of laser spot, A = $\pi(d/2)^2$. Therefore, N_{SERS} = $\pi(d/2)^2/\sigma$. The diameter of spot size d is 105μm. Finally, the N_{bulk}/N_{SERS} = h $\rho_0\sigma N_A/M_0$, and is calculated equal to 5.61×10^5.

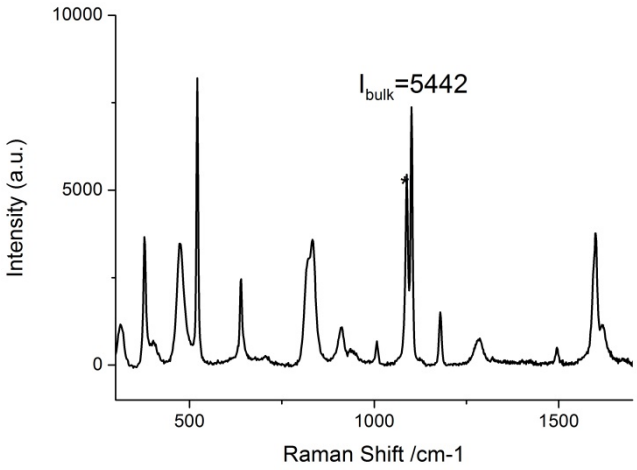

Figure. S5 (a) Raman spectrum of pure PATP

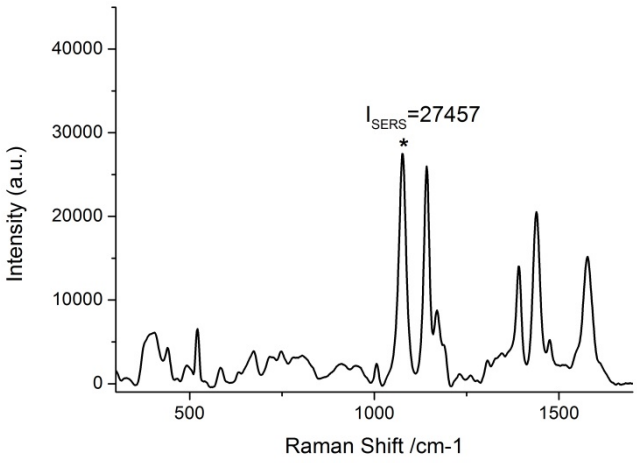

Figure. 5 (b) SERS spectrum of PATP with a concentration of 10^{-7}M

The I_{SERS}/I_{bulk} was 27457/5442=5.04 for peaks at 1077 cm^{-1}, reading from the spectra presented in Fig. S5 a and b. Accordingly, the EF value of peaks at 1077 cm^{-1} is calculated to be about 2.83×10^{6}.