Supporting Information

Satellite Fe_3O_4@SiO_2-Au SERS probe for trace Hg^{2+} detection

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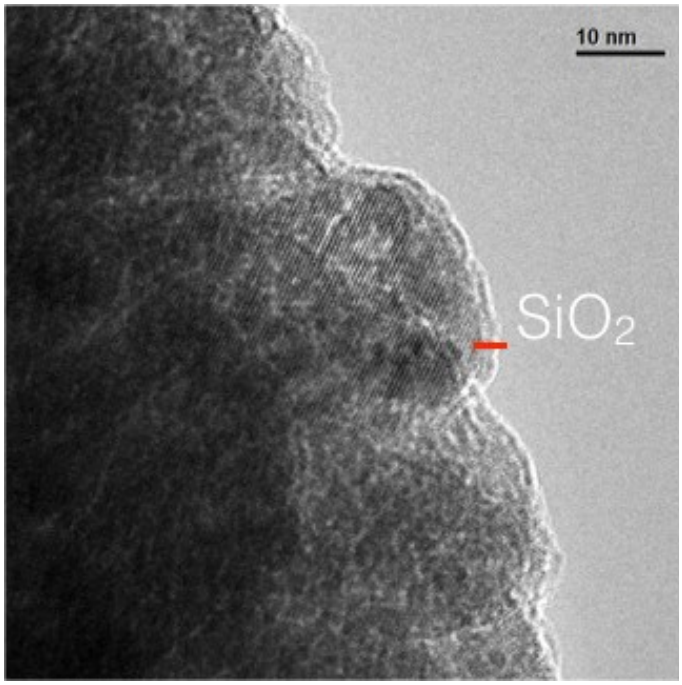

Figure S1. HR-TEM image of Fe_3O_4@SiO_2 microsphere.

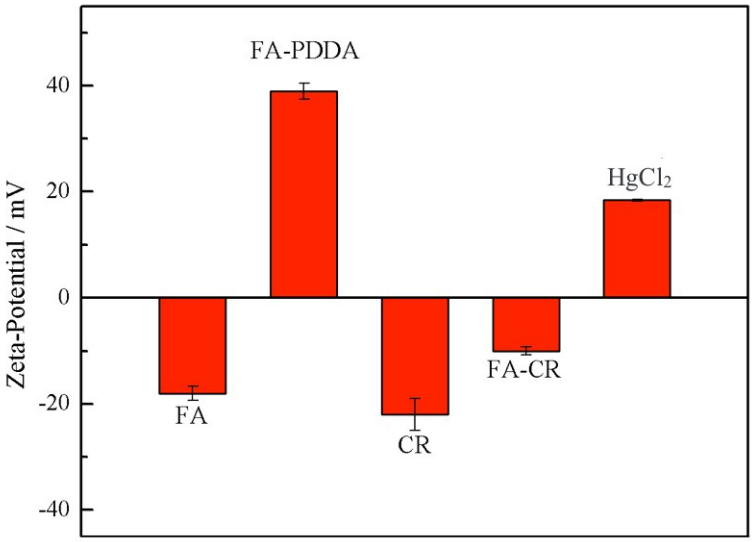

Figure S2. Zeta-potentials during FA functionalization.

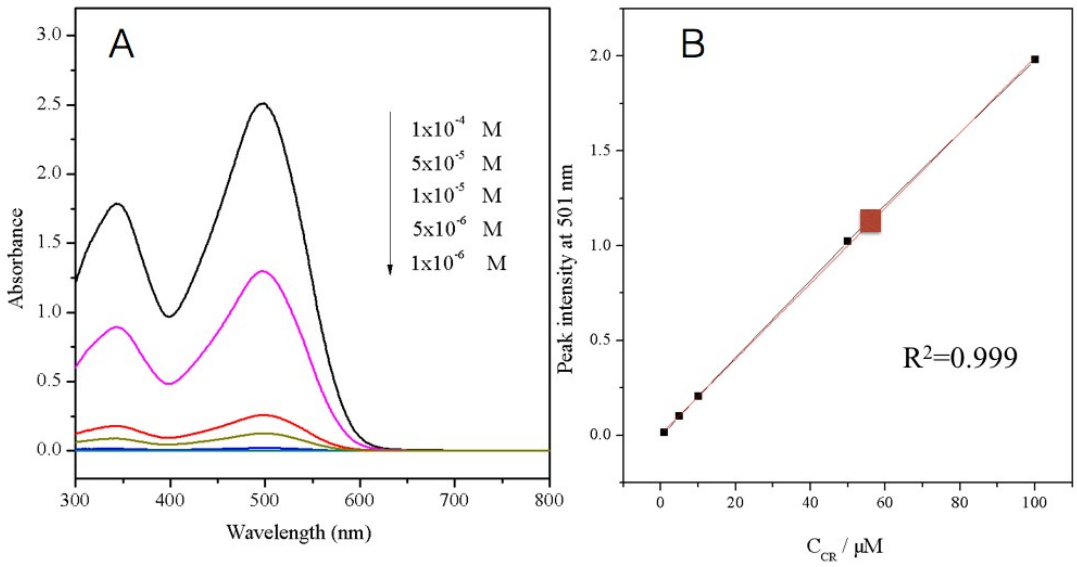

Figure S3. (A) UV-vis spectra of CR. (B) The calibration curve of CR from 0 to 100 μM. The inset red point was CR concentration after FA functionalization.

Determination of maximum CR molecule density on the FA surface

(a) CR molecule on each FA microsphere

According to UV-vis experiment (Figure S5), the amount of CR molecular functionalized on 1 mL FA substrate was

$$N_{CR1} = C_{CR} \times V_{CR}$$

$$\approx (100 - 63.3) \times 1 \times 10^{-6} \times 6.02 \times 10^{23} \times 10^{-3}$$

$$\approx 2.21 \times 10^{16}$$

There are 1mg Fe_3O_4 in 1 mL FA substrate, the amount of Fe_3O_4 was

$$N_{Fe_3O_4} \approx \frac{m_{Fe_3O_4 1}}{m_{Fe_3O_4 2}}$$

$$= \frac{1}{\frac{4}{3}\pi \times 155 \times {R_{Fe_3O_4}}^3 \times \rho_{Fe_3O_4}}$$

$$= \frac{1}{\frac{4}{3}\pi \times 155^3 \times 5.14 \times 10^{-18}}$$

$$\approx 1.25 \times 10^{10}$$

The amount of CR molecule functionalized on each FA sphere was

$$N_{CR2} = \frac{N_{CR1}}{N_{Fe_3O_4}}$$

$$\approx 1.77 \times 10^6$$

(b) Surface area of each FA microsphere

$$N_{Au} \approx \frac{4\pi}{\Phi}$$

$$\approx \frac{4 \times \pi\left(R + r + \frac{gap}{2}\right)^2}{\pi(r + \frac{gap}{2})^2}$$

$$= \frac{4 \times (115 + 10 + 3.5)^2}{(10 + 3.5)^2}$$

$$\approx 362$$

$$S_{FA} = S_{Fe_3O_4} + N_{Au}S_{Au}$$

$$= 4\pi R^2 + 362 \times 4\pi r^2$$

$$\approx 756939$$

Where Φ represents the deflection angle, Gap is distance between Au NPs, R is the radii of the Fe_3O_4 NP, r is the radii of the Au NP (Figure S6). Here, Gap, R and r are experimentally determined as Gap=7 nm, R=115 nm and r =10 nm. Based on these parameters, we obtained that the amount of Au NPs bound to an Fe3O4 sphere is about 362. Then surface area of each FA microsphere is about 756939.

(c) CR density on FA surface

$$D_{CR} = \frac{N_{CR2}}{S_{FA}}$$

$$\approx \frac{1.77 \times 10^6}{7.57 \times 10^5}$$

$$\approx 2.34$$

The CR molecule density functionalized on each FA sphere can be estimated to be about 2.34 per nm^2.

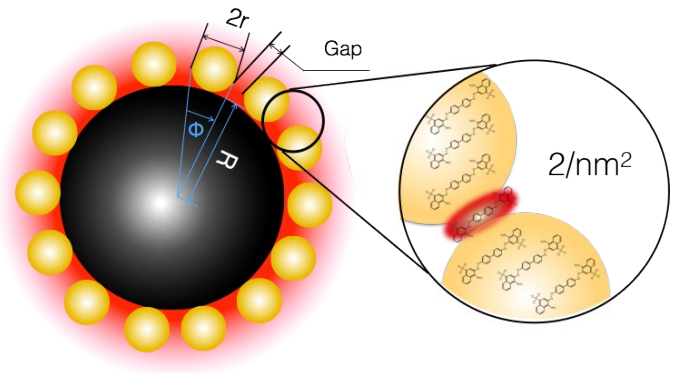

Figure S4. Estimation of the CR density on FA surface.

Table S1 EDS for sample FA-CR before Hg^{2+} adsorption

Elt.	Line	Intensity (c/s)	Atomic %	Conc	Units	MDL3-sig	
Si	Ka	76.56	14.381	4.75	wt.%	0.237	
Fe	La	77.84	62.134	40.82	wt.%	1.268	
Au	La	153.97	23.231	53.83	wt.%	.995	
Hg	La	1.54	0.255	0.60	wt.%	1.111	
			100.000	100.00	wt.%		Total

Table S2 EDS for sample FA-CR after Hg^{2+} adsorption

Elt.	Line	Intensity (c/s)	Atomic %	Conc	Units	MDL 3-sig	
Si	Ka	88.62	13.887	4.45	wt.%	0.222	
Fe	La	89.49	60.890	38.80	wt.%	1.471	
Au	La	187.18	23.653	53.16	wt.%	0.806	
Hg	La	11.33	1.571	3.59	wt.%	0.877	
			100.000	100.00	wt.%		Total

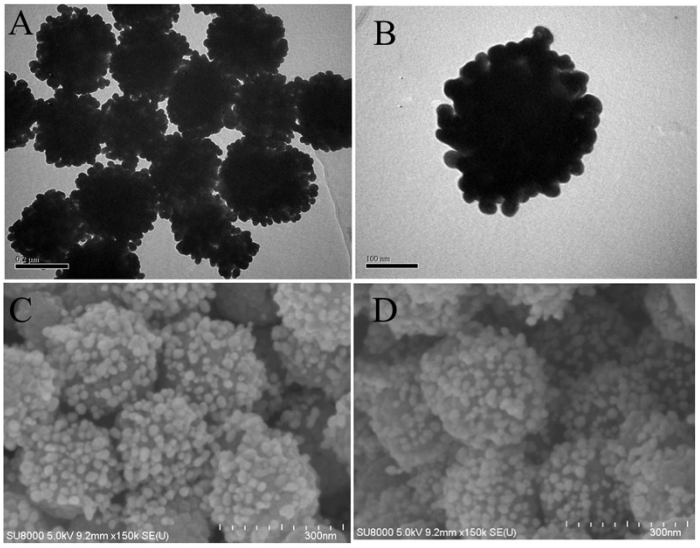

Figure S5. TEM and SEM images of FA-CR before (A, C) and after (B, D) Hg^{2+} adsorption.

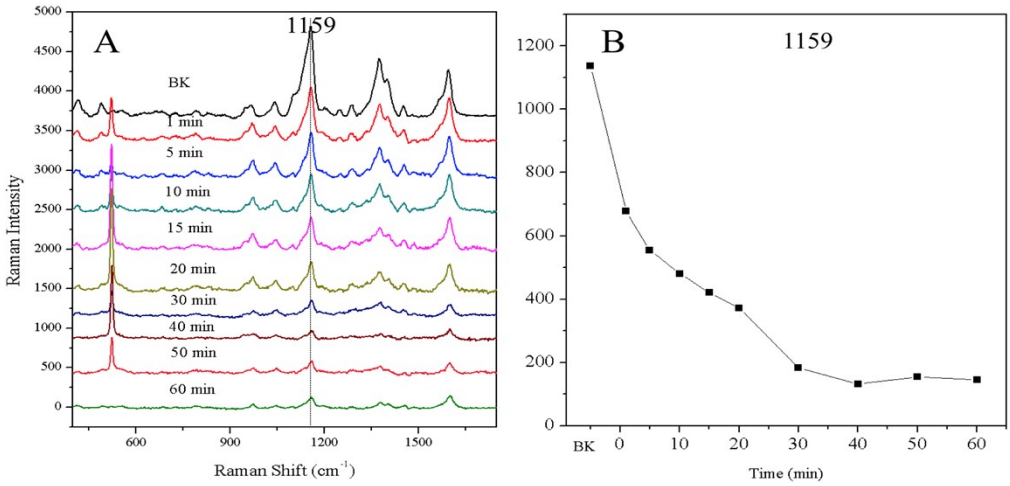

Figure S6. SERS spectra (A) and peak intensity at 1159 cm^{-1} (B) of FA-CR with 1x10^{-5} M Hg^{2+} mixing time from 1 min to 60 min. Signal collection time was 1 s.

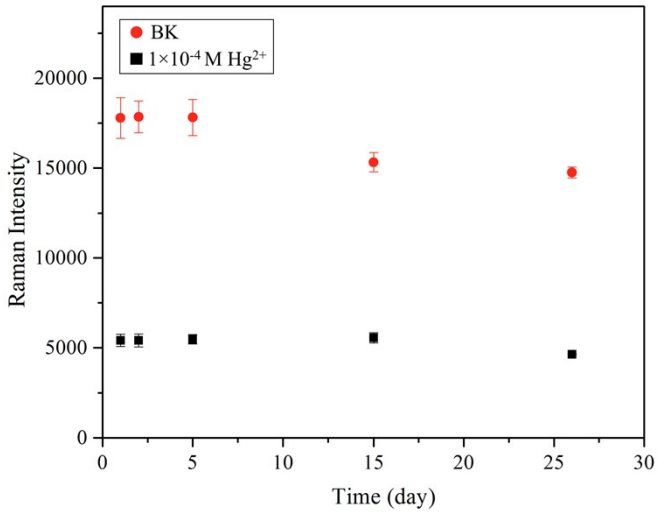

Figure S7. Peak intensity at 1159 cm^{-1} of FA-CR BK and FA-CR with 1x10^{-5} M Hg^{2+}. Signal collection time was 5 s.