

1. Synthesis of gold nanoparticles (Au NPs)

Au NPs were synthesized via the sodium citrate reduction method, which was modified by Frens et al.^[1]. Briefly, 99 mL Milli-Q water was heated to boiling temperature. Then, 1 mL HAuCl₄ (25 mM) was added under stirring. When the solution started to boil again, 1 mL Na₃Cit·2H₂O (1% w/v) was immediately added. The solution changed color from light yellow to colorless and then became black. The solution continued to boil until it turned red. The mixture was then cooled under stirring for 30 min and stored at 4 °C before use.

2. Characterization methods

- 2.1 The Au NPs filtration substrates were characterized via field emission scanning electron microscopy (SEM) (Hitachi, SU8020) with a 3 kV acceleration voltage.
- 2.2 Atomic force microscopy (AFM) (Bruker, Multimode 8) with ScanAsyst mode was used for detailed morphology characterization. An SNL-10 probe was used with a scanning frequency of 1.0 Hz, and an image of 512×512 pixels was obtained. The scanning range was 1 μm × 1 μm, and the data were processed using NanoScope Analysis software.
- 2.3 The surface charge on the Au NPs measurement was determined using a Zeta potentiometer (Malvern, Zetasizer Nano).
- 2.4 Ultraviolet-visible light spectroscopy (UV-Vis) was used to characterize the Au NP surface plasmon resonance (SPR) information. The solution was diluted a certain number of times on the basis of the performance of the instrument, and the absorbance was then recorded in the spectral wavelength range of 400–800 nm.
- 2.5 The FDTD solution software was used as the simulation software to investigate the enhancement effect with the Au NPs. Au-CRC was used as the material, and a plane wave with a single wavelength (785 nm) was used as the light source.
- 2.6 A Bruker SENTERRA II with an excitation wavelength of 785 nm was used along with a 10× objective and an integration time of 2 s for each spectrum. After 2 scanning repetitions, 25 points were measured and the mean spectrum was obtained.

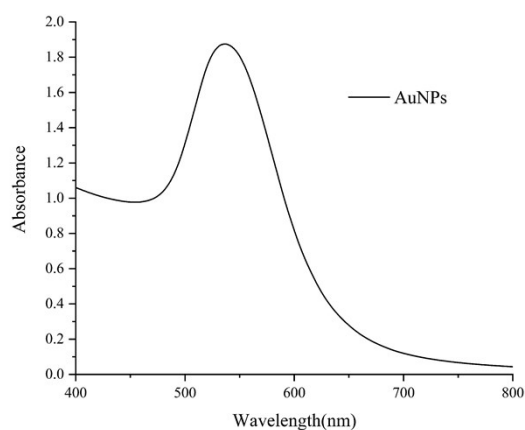


Figure S1 UV-Vis spectrum of Au NPs (the concentration was nearly 0.0593 nM)

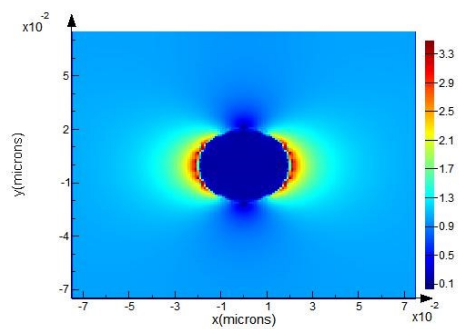
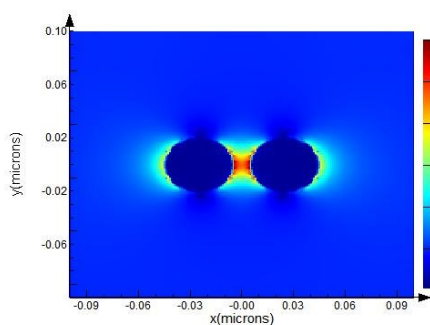
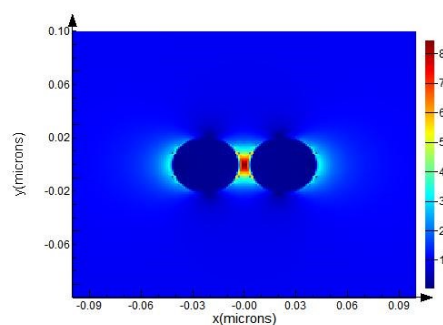


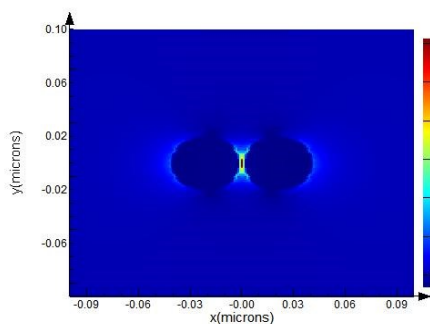
Figure S2 FDTD calculation of single Au NP (the diameter was 40 nm; the color axis is the electric field intensity; V/m)



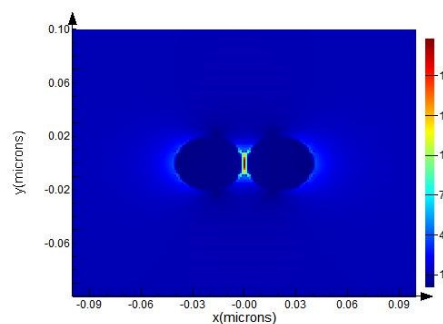
A: 10 nm gap



B: 5 nm gap



C: 2 nm gap



D: 1 nm gap

Figure S3 FDTD calculation of two Au NPs (the diameters were 40 nm) with different distances (the color axis is the electric field intensity; V/m)

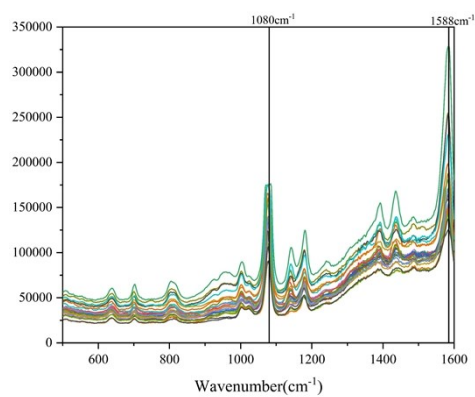


Figure S4 SERS of 10^{-6} g/mL 4-ATP in L group (25 repeated measurements)

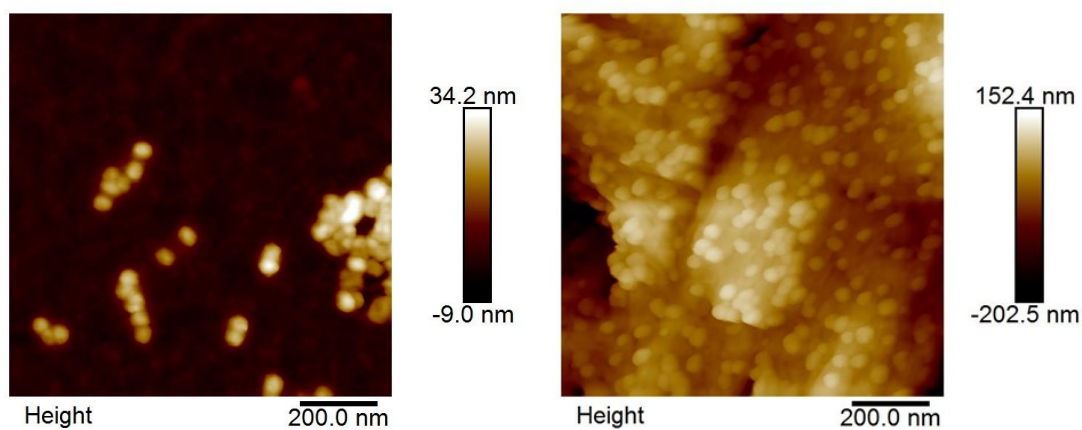
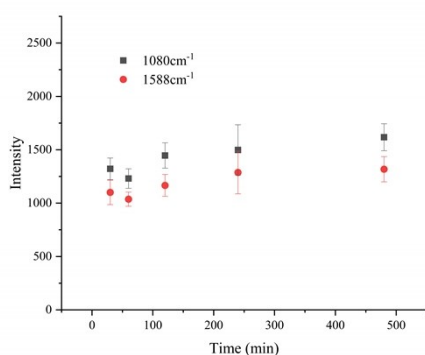
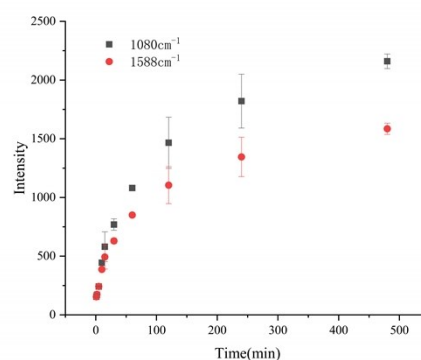


Figure S5 AFM images of the Au NPs

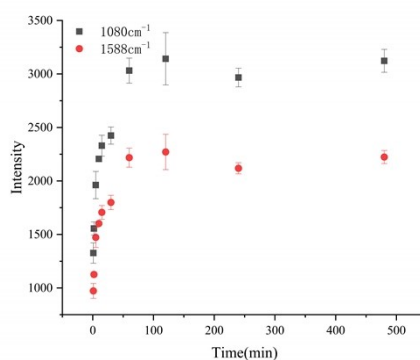
Figure S6 AFM images of the filtration-substrates



A: 10^{-7} g/mL



B: 10^{-6} g/mL



C: 10^{-5} g/mL

Figure S7 Influence of immersion time in the NL-F group by immersion test

[i] G. Frens, Controlled nucleation for regulation of particle-size in monodisperse gold suspensions, Nature-Physical Science, 241 (1973) 20-22. <https://doi.org/10.1038/physci241020a0>.