Electronic Supplementary Material (ESI) for Journal of Materials Chemistry
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Supporting Information

Silver-Nanosheets Coated-inverse Opal Film as Highly-Active and Uniform SERS Substrate

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Part S1. Enlarged SEM images of AgNSs coated-inverse opal film

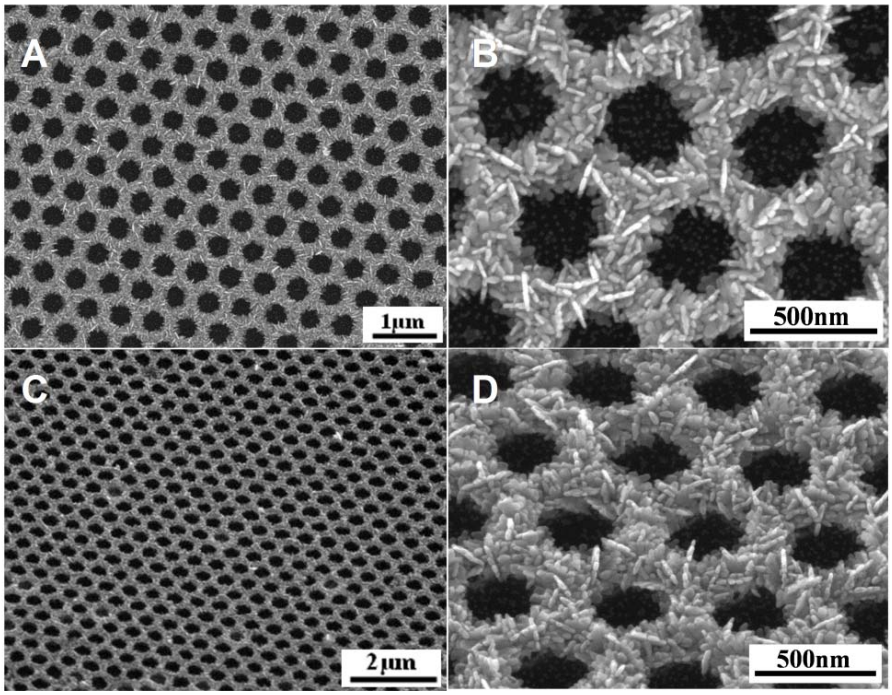

Figure S1. Top (A, B) and titled (C, D) SEM images of 2D AgNSs coated-inverse opal film.

Part S2. SERS spectra of 10fM R6G on 2D AgNSs coated-inverse opal film

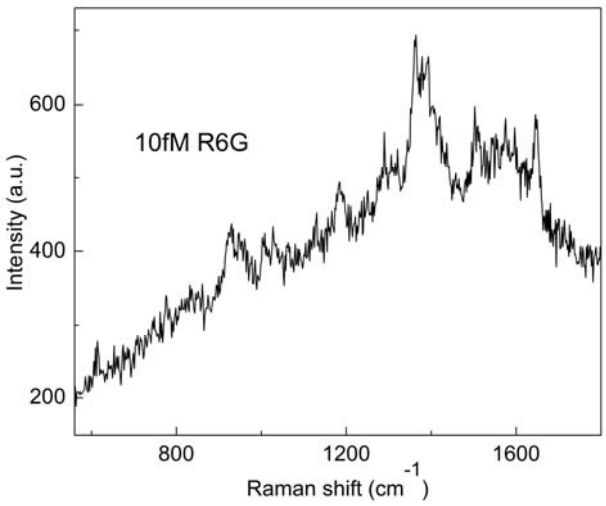

Figure S2. SERS spectra of 10 fM R6G on 2D AgNSs coated-inverse opal film.

Part S3. Calculation of the average enhancement factor (EF)

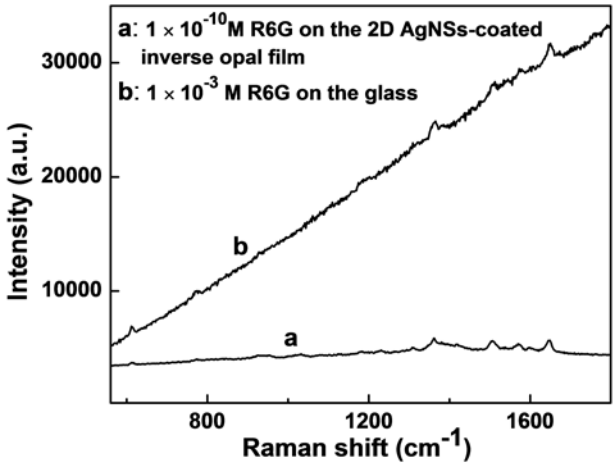

Figure S3. (a) SERS spectra of 90 μL 1×10^{-3} M R6G aqueous solution on 40 mm^2 glass slide. (b) SERS spectra of 5 μL 1×10^{-10} M R6G aqueous solution on 12.5 mm^2 2D AgNSs coated-inverse opal film.

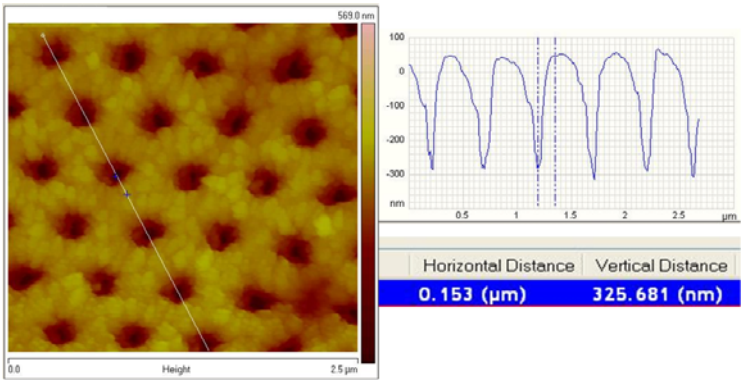

Figure S4. AFM image of 2D AgNSs coated-inverse opal film.

The EF was calculated by a well-recognized formula as follow,[1]

$EF= (I_{SERS} / I_{NR})(N_{NR} / N_{SERS})$

where I_{SERS} represents the SERS intensities of the 1361 cm^{-1} band of 1×10^{-10} M R6G adsorbed on the substrate; I_{NR} represents the normal Raman signals recorded for 1×10^{-3} M R6G adsorbed on the glass; N_{SERS} and N_{NR} represent the corresponding number of R6G molecules excited by the laser beam. For SERS examination, a certain volume V_{SERS} of R6G aqueous solution was dispersed over an area S_{SERS} at a concentration C_{SERS} on the AgNSs coated-inverse opal film substrate, and the area excited by the laser is $S_{substrate}$. For non-SERS Raman spectra, a certain volume V_{NR} of R6G aqueous solution was dispersed over an area S_{NR} at a concentration C_{NR} on a clean glass slide, and the area excited by the laser is S_{glass}. Both substrates were dried in an oven at 50 ^{o}C. The above equation thus becomes

$EF= (I_{SERS}\, S_{glass}\, S_{SERS} V_{NR} C_{NR}) / (I_{NR}\, S_{substrate}\, S_{NR} V_{SERS} C_{SERS})$

Raman measurements were conducted under identical experimental conditions (same laser power, laser wavelength, and microscope objective, etc.). For non-SERS Raman spectra, 90

μL 1×10^{-3} M R6G aqueous solution was dispersed on 40mm^2 glass slide. For SERS examination, 5 μL 1×10^{-10} M R6G aqueous solution was dispersed on 12.5 mm^2 AgNSs coated-inverse opal film. Figure S4 shows the AFM image of AgNSs coated-inverse opal film, which can be considered as a macroporous Ag film. The diameter and height of the macropore was measured to be about 370 nm (SEM) and 320 nm (by AFM, Figure S4), respectively, and its interior surface area ($S_{interior}$, the bottom was not included) can be calculated as that of a cylinder. We assume that the R6G molecules are dispersed evenly on the whole surface. Molecular on the bottom of the macropores (S_{bottom}) illuminated have no SERS effect, and only the molecules dispersed on the Ag surface contribute to the SERS spectra and the Raman spectra.

S_{SERS}=12.5 mm^2+ $nS_{interior}$= 35.26 mm^2 ; $S_{substrate} = S_{laser} + mS_{interior} - mS_{bottom}$= 2.29 μm^2

(n,m represent the number of the macropores)

S_{NR}= 40 mm^2 ; S_{glass}= S_{laser}=1 μm^2

The intensities (height in the Raman spectra) for the C−C stretching mode at 1361 cm^{-1} are 1100 units for the AgNSs coated-inverse opal film, and 1300 units for the glass slide substrate, respectively. The average EFs are calculated to be 5.8×10^7 (~6×10^7) for the AgNSs coated-inverse opal film.

Part S4. Reproducibility of AgNSs coated-inverse opal film substrates

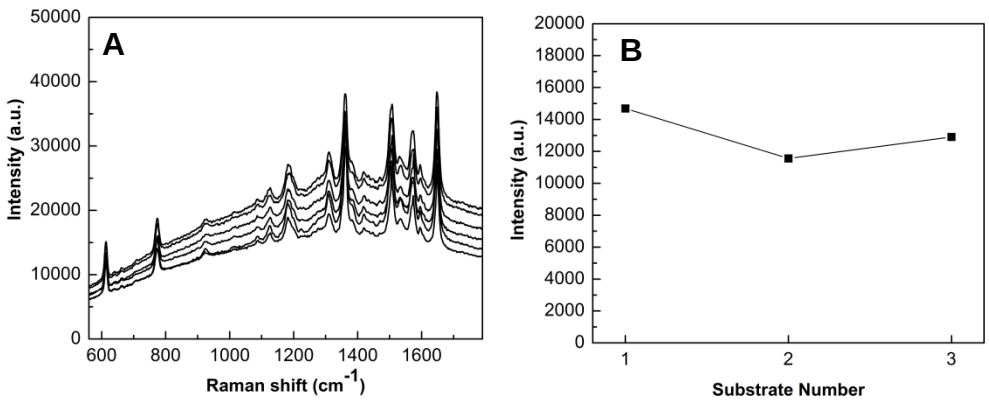

Figure S5. (A) SERS spectra recorded from 6 random spots for 1×10^{-6} M R6G on another AgNSs coated-inverse opal film substrate, and (B) the intensity (height) of 1361 cm^{-1} on three different AgNSs coated-inverse opal film substrates.

Three substrates produced by the same method were dispersed with 1×10^{-6} M R6G to investigate the reproducibility of different substrates. Six random points were recorded on each substrate under the same experiment condition. Figure S5 (A) shows the SERS spectra recorded for another substrate. The intensity (height in the Raman spectra) of 1361 cm^{-1} was chose as the reference. In figure S5 B, the points stand for the average intensity of 1361 cm^{-1} on the three substrates.

Part S5. Reproducibility and stability of the AgNSs coated-inverse opal film for DNA detection

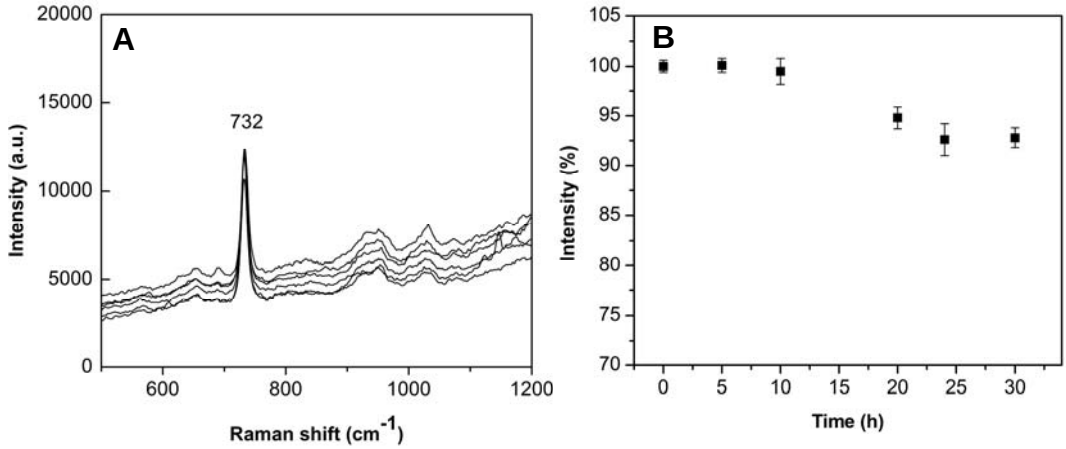

Figure S6. (A) SERS spectra recorded from 6 random spots for 1000 nM SSDNA immobilized on the AgNSs coated-inverse opal film substrate; (B) Decay of SERS signals of 1000 nM SSDNA with time. The intensity (height in the Raman spectra) of 732 cm^{-1} is taken as the reference. The error bar measures the scatter of the data.

The data in figure S6 (B) contains a scatter of six similar experiments on different pieces of the same substrate. Hence, the scatter is a measure of the reproducibility of the substrate.

Referrence

(1) Chaney, S. B.; Shanmukh, S.; Zhao, Y. P.; Dluhy, R. A. Appl. Phys. Lett. 2005, 87, 31908 (3p).