Electronic Supplementary Material (ESI) for Lab on a Chip

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Batch fabrication of disposable screen printed SERS arrays

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The Supplementary Material includes:

Six figures (Fig. S1-S6)

One text (Text S1)

One table (Table 1)

Results and Discussion

Fig. S1 to S6

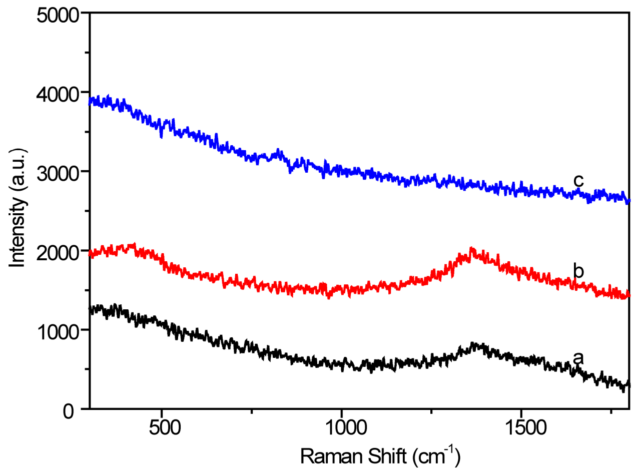

Fig. S1 (A) SERS spectra of various supporting materials (a) the glass fiber plate, (b) glass and (c) filter paper.

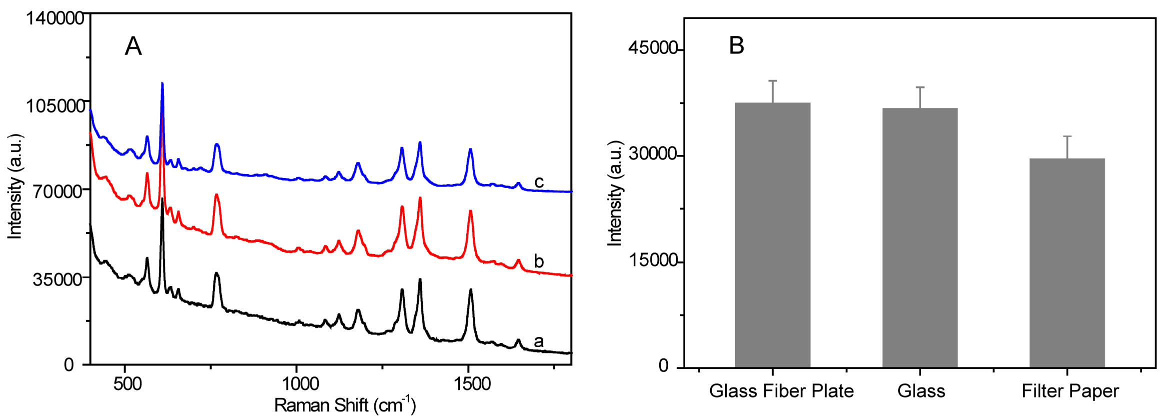

Fig. S2 (A) SERS spectra of 1 μM R6G acquired from various supporting materials: (a) the glass fiber plate, (b) glass and (c) filter paper; (B) SERS intensity of R6G peak centered at 608 cm^{-1} with respect to different supporting materials. Each data point represents the average value from three SERS spectra. Error bars show the standard deviations.

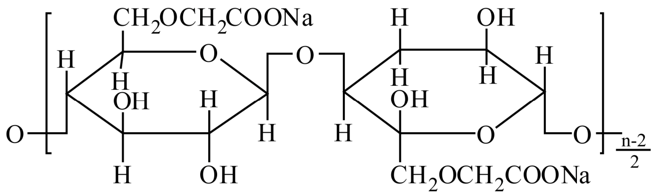

Fig. S3 Structure of sodium carboxymethylcellulos (CMC)

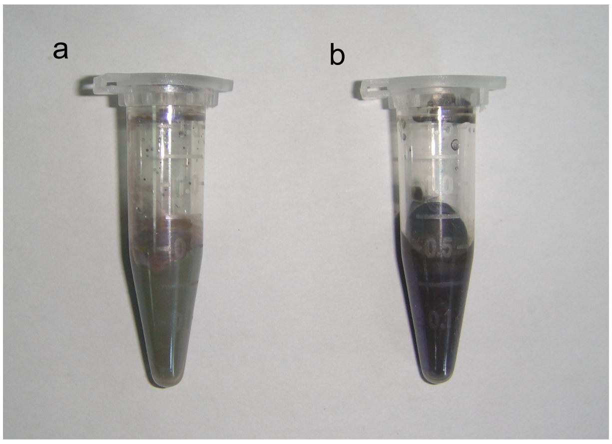

Fig. S4 Photos of the screen printing ink with different concentrations of CMC: (a) 0 wt.%; (b) 4 wt.%.

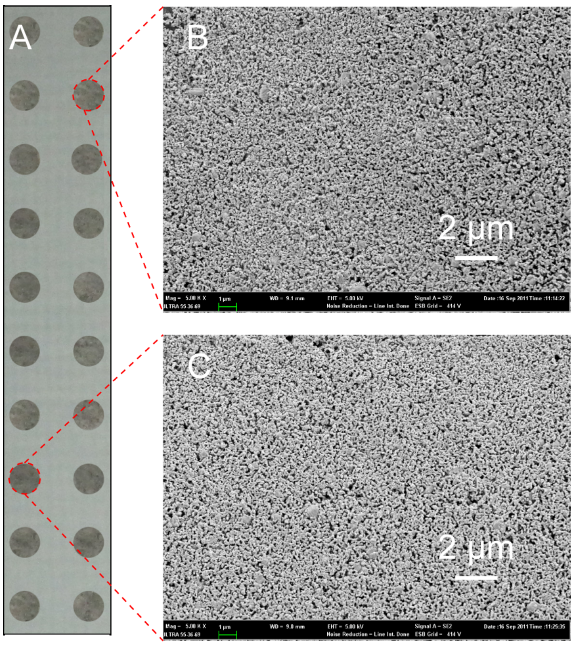

Fig. S5 (A) Photo of screen printed SERS arrays, (B) and (C) are SEM photos of different printed spots.

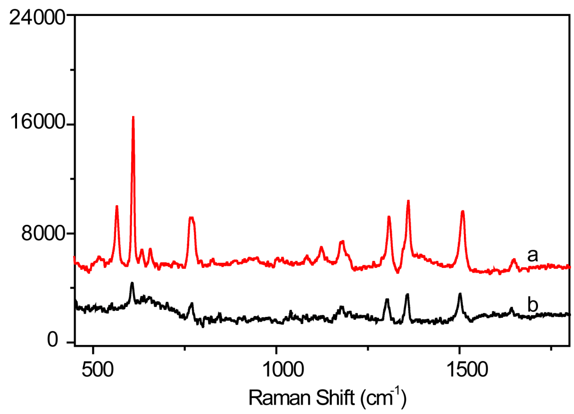

Fig. S6 SERS spectrum of 1×10^{-9} M R6G obtained on the screen printed arrays (a) and normal Raman spectrum of bulk R6G (b).

Text S1

Estimation of Raman Enhancement Factor. To further test the SERS ability of screen printed arrays, the SERS enhancement factor for rhodamine 6G (R6G) is estimated according to the following formula: [1-3]

$$EF = (I_{SERS}/ I_{bulk}) \cdot (N_{bulk}/ N_{surf})$$

where I_{SERS} and I_{bulk} are the vibration intensities in the SERS and normal Raman spectra of R6G, respectively. N_{surf} and N_{bulk} are the number of molecules for SERS, and the number of molecules for the bulk sample under laser illumination, respectively. The N_{surf} and N_{bulk} values can be calculated on the basis of the estimated concentration of the surface species or bulk sample and the corresponding sample areas. In our experiment, 5 μL of 1×10^{-9} M R6G solution was pipetted on the screen printed SERS arrays, after the droplet evaporated in air, a circular spot with the diameter of 1.8 mm was formed. Therefore, the average surface density of R6G was calculated as 1.96×10^{-21} mol/μm^2. Taking the sample area (ca. 10 μm in diameter) into account, N_{surf} has a value of 1.54×10^{-19} mol ($N_{surf} = 1.96\times10^{-21}$ mol/μm$^2 \times \pi \times 25$ μm$^2 = 1.54\times10^{-19}$ mol). For the solid sample, the sampling volume is the product of the area of the laser spot (ca. 10 μm diameter) and the penetration depth (~2 μm) of the focused laser beam. Assuming the density of bulk R6G is 0.79 g/cm^3, N_{bulk} can be calculated to be 2.59×10^{-13} mol (N_{bulk}=0.79 g/cm^3×π×25 μm^2×2 μm/(479.01 g/mol)=2.59×10^{-13} mol). For the vibration mode at 1359 cm^{-1}, the ratio of I_{SERS} to I_{bulk} was about 2.6, hence EF was calculated to be 4.4×10^6.

Table S1

Table S1 Comparison of screen printing method with other methods

Method	Large Scalability	Low Cost	Facil Fabrication	Excellent SERS Activity	High Reproducibility	Good Stability
Chemical Reduction [4,5]	√	√	√	√	×	×
Nanoparticles Self-assembly [4,6]	×	√	√	√	√	√
Vapor Deposition [4,7,8]	×	√	√	√	×	×
Electron Beam Lithography [4,9,10]	×	×	×	√	√	√
Our Method	√	√	√	√	√	√

References

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