

Plasmonic supercrystals integrated in microfluidics for ultrasensitive and selective SERS detection

Daniel García-Lojo

Sergio Gómez-Graña, Isabel Pastoriza-Santos and Jorge Pérez-Juste

CINBIO, Universidade de Vigo, Campus universitario Lagoas, Marcosende, 36310 Vigo, Spain

danielgarcia@uvigo.es

Surface-enhanced Raman spectroscopy, SERS, is an advanced analytical technique that can be used for the ultrasensitive detection of analytes. It is based in the enhancement of the Raman signal of a molecule at the surface of a plasmonic nanostructure mainly due to the presence of strong electromagnetic fields generated after the plasmon excitation. Moreover, this effect could be more intense in the case of plasmonic supercrystals due to antenna effects as demonstrated by recent simulations.¹

As we previously reported, microfluidic platforms allow generating a highly-ordered assembly of uniform gold nanoparticles inside their microchannels through the slow pervaporation of the solvent (Figure 1A-B).² While plasmonic supercrystals made by drop-casting show poor uniformity that limits their potential plasmonic applications.³ Microfluidic approach enables the fabrication of supercrystals of any dimension or morphology. Furthermore, the integration of a plasmonic supercrystal inside microfluidic platform guarantees the infiltration of the desired analyte, even without affinity for gold surface, within the plasmonic supercrystals and therefore its ultrasensitive detection.

Herein, we show the fabrication and characterization of plasmonic supercrystals using gold octahedra nanoparticles synthesized through a wet chemical method. Besides, the study of the sensing capabilities of these platforms showed a highly uniform and intense SERS activity (Figure 1C), being both key parameters to achieve quantitative and ultrasensitive analysis (LOD) (Figure 1E).⁴ In fact, LOD as low as 10^{-19} M was achieved for the detection of Crystal Violet (CV), which is several orders of magnitude lower than those found in the literature. Also, we investigate the possibility of combining the capabilities of our SERS sensor with the chromatographic properties of silica nanoparticles to develop a sensor device with the ability of separate analytes by charge (Figure 1D).

REFERENCES

- [1] D.M. Solís et al.; ACS Nano 8 (2014) 7559.
- [2] S. Gómez-Graña et al., Chem. Mater., 27 (2015) 8315.
- [3] D. García-Lojo et al., Acc. Chem. Res. 52 (2019), 7, 1855
- [4] D. García-Lojo et al., ACS Appl. Mater. Interfaces (2020), in press.

FIGURES

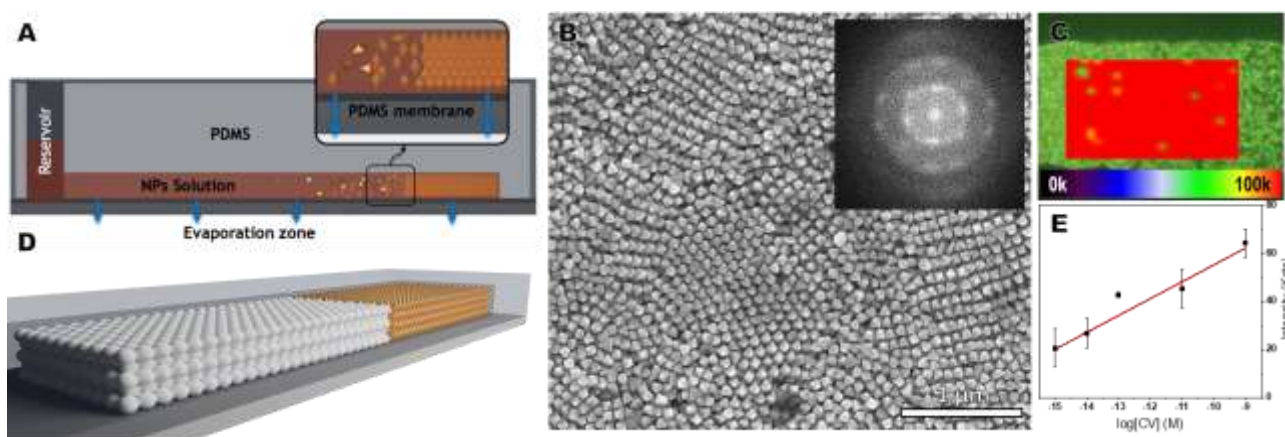


Figure 1: (A) Schematic illustration of self-assembly of gold octahedra nanoparticles inside microfluidic platform induced by pervaporation. (B) Scanning Electron Microscopy (SEM) image of the supercrystal. Inset corresponds with the result of applied Fourier Transform (C) SERS hot-map obtained at 1617 cm^{-1} in the presence of 10^{-7} M of CV. (D) Schematic representation of the final SERS Sensor modified with a silica supercrystal for chromatographic separation. (E) SERS intensity obtained for different concentrations of CV (10^{-7} - 10^{-14} M).