3D Assembly of nanocrystals induced by microfluidic platforms for advanced applications in SERS detection.

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The main objective of this project is the design, manufacture and validation of plasmonic microfluidc platforms based on hierarchical 3D assemblies of plasmonic nanocrystals for their application in the detection of analytes by surface Raman scattering spectroscopy.

Surface-enhanced Raman scattering, SERS, is an advanced analytical technique that can be used for the ultrasensible detection of various analytes related to biology, medicine, forensics and environment. SERS detection is based on the improvement of Raman signals, mainly by the strong electromagnetic fields in the plasmonic surfaces. Recent theoretical simulations have shown that when crystalline order is imposed on the assembly of nanoparticles, antenna effects occur, which leads to greater SERS efficiency.[1] The most common strategy to obtain 3D supercrystal films on flat substrates is by drop-casting, which often results in nonuniform films of different thicknesses that limits their potential plasmonic applications. To achieve the desired crystalline degree, a microfluidic technique, such as microevaporation may be used to induce nanoparticle assembly.

Our first results indicate that it is possible to obtain highly ordered assemblies of gold nanoparticles inside the channels of a microfluidic chip mediated by solvent pervaporation (see Figure 1A).[2] The high monodispersity of the Au nanocrystals combined with the use of a microfluidic technique based on microevaporation will allow the self-assembly of the particles into uniform 3D supercrystals. Additionally, these plasmonic substrates exhibit high and uniform SERS signals over extended areas with intesities increasing with the Au nanoparticle size. Thus, microfluidic-induced assembly is a very promising approach for the preparation of uniform three-dimensional assemblies of nanoparticles of any size using the corresponding templates. Also, the configuration of the microfluidic systems could allow the assembly of a great variety of metallic particles of different morphologies, sizes, and even functionalisation.

These preliminary results envisage a great potential for such systems for the SERS-based detection and quantification of different type of Raman active analytes. Additionally, the microfluidic channel configuration will allow the infiltration of the analytes inside the 3D assembly leading to a greater sensibility limit through *on-chip* measurements.

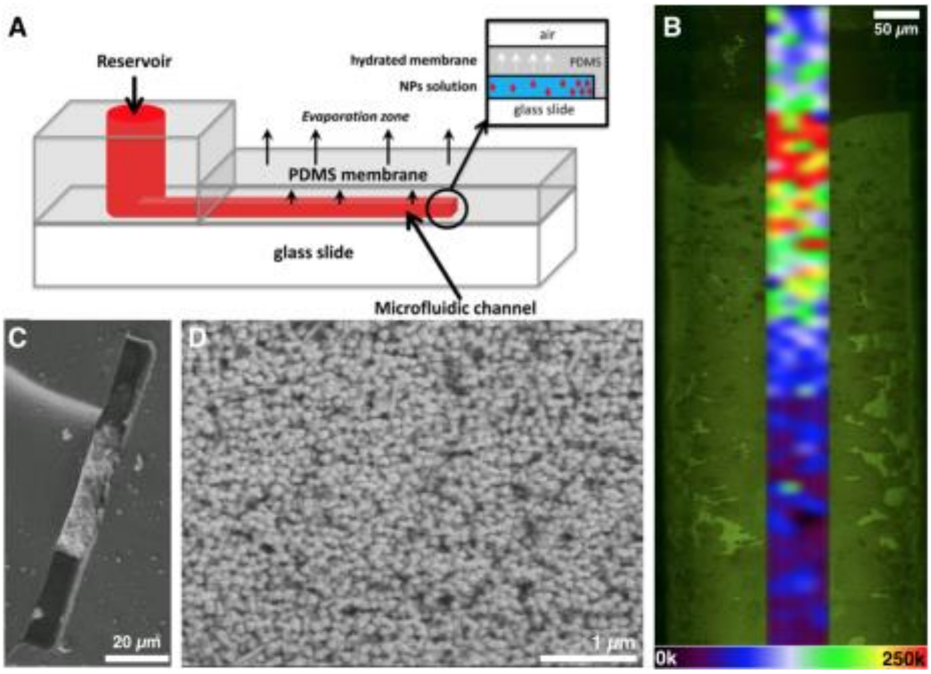

Fig. 1: (A) Schematic illustration of the evaporation-based microfluidic cell used for controlled assembly of Au octahedra. **(B)** SERS-Map of the signal in the presence of the analyte p-nitrobenzenethiol. **(C-D)** Representation SEM images of channel section.

1) D. M. Solís et al.; *ACS Nano*, **2014**, 8, 7559.
2) S. Gómez-Graña *et al*., *Chem. Mater.*, **2015**, *27*, 8310.