Cosolvent-Assisted Assembly of Nanoparticles into Highly Regular Plasmonic Arrays

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The development of efficient plasmonic sensors requires fabrication processes for nanostructured substrates that show homogeneous optical properties over large-scale areas. As shown in Figures 1 and 2, regular arrays of 2 and 3-dimensional nanoparticle (NP) clusters of submicron size can be realized by nanopatterned templates. The periodicity, given by parameters *a* and *b*, determines the coupling between local plasmons and, moreover, may result in lattice plasmon resonances [1]. By varying the pattern geometry, such modes can be tuned to match desired wavelengths in the visible and near infrared [2]. Whereas preceding work focused on the fabrication of assemblies on comparatively small areas [3], we extend this process to large areas introducing ethanol as a cosolvent in the dispersion of polymer-coated Au NPs of different shapes. The composition of the dispersion dramatically changes the fluid dynamics of the NPs in the droplet [4]. In this study, we have varied systematically key parameters, such as the concentrations of alcohol, surfactant, and particles, to vary the emerging flow and to finally control the repartition of NPs in the droplet before applying the target substrate. As demonstrated in Figure 2, our approach strongly improves the homogeneity of the assembly yielding evenly sized and well-separated regular structures with high reproducibility. Reduction of defects and high uniformity over macroscopic dimensions enhances the plasmonic signal and paves the way for sensitive plasmonic sensing modules.

References

[1] Wang et al., ACS Photonics, 2 (2015) 1789-1792
[2] Hanske et al., Nano Lett., 14 (2014) 6863
[3] Liz-Marzán et al., ACS Nano, 10 (2014) 10694
[4] Kim et al., Phys. Rev. Lett., 12 (2016) 12450

Figures

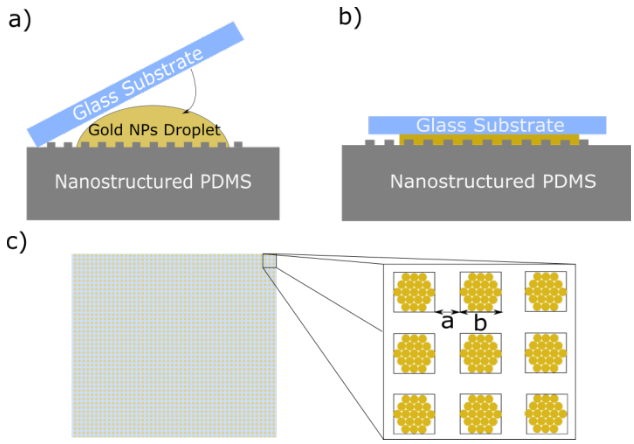

Figure 1: a) Schematic of processing Au NP arrays, b) drying process, c) gold NP assemblies on the substrate and some arrays zoomed in.

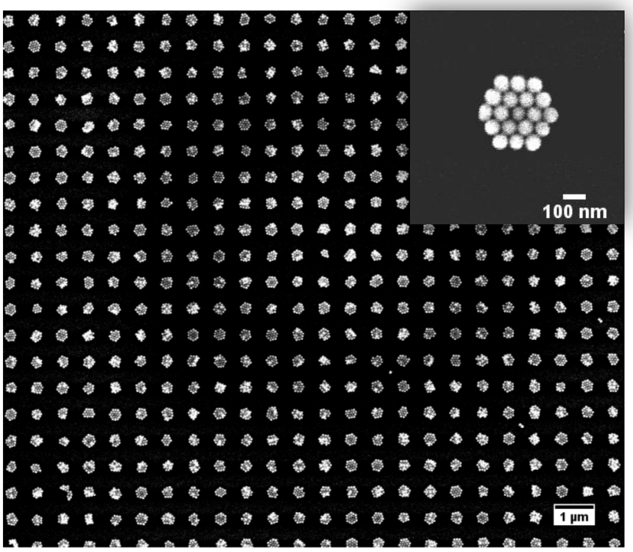

Figure 2: Electron microscopy image of an assembly of 65 nm spherical Au particles on glass.