Hot-spots nanostructuration: Towards controlled Single Molecule Surface Enhanced Raman Scattering sensing

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One of the challenges of the last decade is to control the assembly of gold or silver colloidal nanoparticles (NPs) onto a surface, in ordre to optimize the effects of surface enhancement. This reproducible and controlled nanostructuration could be useful to systematic investigation of the mechanism of surface enhanced Raman scattering (SERS)[1]. The fabrication of structures containing few colloidal NPs with controlled characteristics (gap, size and number of colloids...) and precisely localized onto a substrate, is particularly interesting for SERS application. The electromagnetic field concentrated within the gap[2], namely "hot-spots", is strongly enhanced due to near field coupling between NPs, and the resulting enhancement factors allow to detect a few molecules. Until now, the study of these hot-spots, was difficult, due to the lack of fabrication techniques.

In order to demonstrate that dimers of NPs are particularly suitable for polarization analysis and efficient for SM-SERS sensing we present the SERS study of arrangements of colloidal NPs immobilized by two different techniques. One coupling e-beam lithography (EBL) and chemical immobilization with 40 nm diameter colloidal NPs, the second coupling EBL and capillarity force assembly with 100 nm diameter colloidal NPs[3]. In order to study such structures, methylene blue (MB) has been used as probe molecule. The structures have been studied by SERS and confocal imaging as a function of polarization state, number, and size of colloidal NPs. The dimer of NPs was estimated to be the most efficient arrangement for SM-SERS. In particular, the comparison between SERS spectrum of dimer of NPs and NPs clusters revealed the existence of new Raman lines in the former case (**Figure 1**). It is likely due to the fact that different MB molecular structures are excited in the various SERS regimes.

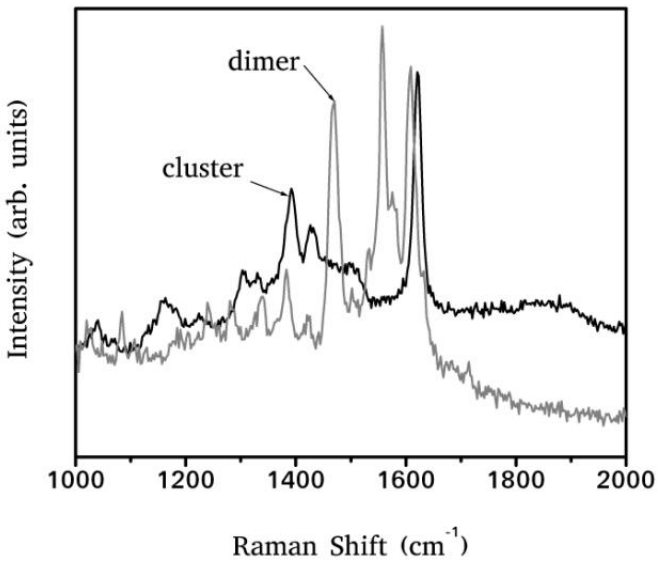

FIGURE 1. SERS spectra of methylene blue obtained at 633 nm on a cluster of NPs (black curve), and on an isolated dimer of NPs (grey curve).

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