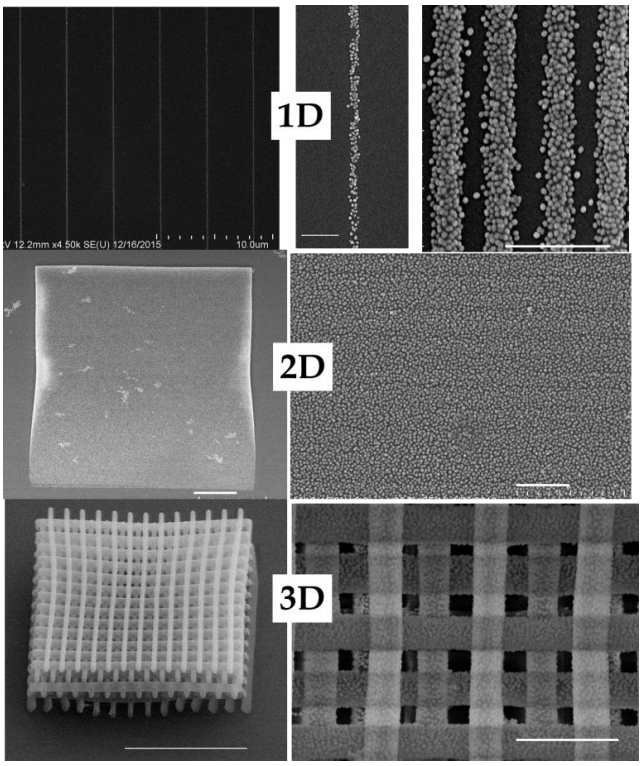
Polymer functionalization for the assembly of gold nanoparticles on 1D, 2D and 3D microstructures

A. Issa[1,2], I. Izquierdo-Lorenzo[1], J. Toufaily[2], F. Elomar[2] and S. Jradi[1]*

[1] Laboratoire de Nanotechnologie et d'Instrumentation Optique, Institut Charles Delaunay, UMR-6281 CNRS, Université de Technologie de Troyes, 12 rue Marie Curie, 10004 Troyes, France
[2] Ecole Doctorale des Sciences et de la Technologie (EDST) et Laboratoire des Matériaux, Catalyse, Environnement et Méthodes Analytiques, Université Libanaise, Hadath, Liban



SEM images of linear, planar and 3D gold nanoparticle arrangements. Scale bars: left: 10 µm, right: 1 µm

Gold nanoparticles (GNPs) present interesting optical properties in the visible region due to their localized surface plasmon resonance. [1] Moreover, when organized in ensembles, collective properties are obtained that differ from those of individual particles and the resulting optical properties can be further tuned and even amplified.[2] Also, the implementation of metallic NPs in devices requires their precise placement over large areas. For these reasons, there has been considerable effort in the last decade dedicated to the controlled deposition of plasmonic nanoparticles from colloidal solutions onto patterned surfaces. To the date, patterning of plasmonic nanoparticles is an active challenge. [3]

In this context we will present a highly versatile approach to control the assembly of GNPs that is based on the functionalization of a homemade photopolymerizable mixture. By 2-photon polymerization of the functionalized mixture and immersion of the resulting microstructures in a NPs colloid, lines, planes or 3D arrangements of GNPs can be built with high precision. Indeed, the linear arrangements can be as thin as 2-3 NPs wide for several microns of length, separated down to 400 nm (Figure 1-1D). Nanoparticle aggregation on the surface is rare even in relatively large surfaces: on Figure 1-2D, a 50×50 µm square is showing mainly a single layer arrangement. More interestingly, the colloidal solution can penetrate inside a complex 3D microstructure which can be completely covered by GNPs. In Figure 1-3D, the inclusion inside a woodpile photonic crystal of 20×20×8 µm with a period of 1 µm is shown. SERS and extinction spectra were performed on the GNPs patterns.

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