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Designing aggregates of metallic nano-particles to generate tunable Resonant Raman structures

Abstract

Our group develops a new approach combining an Atomic Force Microscope and a confocal-Raman microscope where AFM microscope is used to image and to manipulate nano-particles under the confocal optical microscope coupled at the Raman spectrometer [1-2]. Our optical device allows us to scan the resonance effects by tuning the wavelengths of excitation.

At first, this talk will begin with the results obtained with some home designed symmetric structures of assembling of gold nano-particles (AuNPs) [1], in the vicinity of a single and isolated carbon nanotube (CNT). The super-resolved Raman spectra will be discussed as a function of the different sub-wavelength-scale geometries of AuNPs aggregates. The different interactions between AuNPs aggregates and the CNTs, including their impact on resonance effects will investigated. In particular, we will focus on the enhancement of the local electrical field by metallic nano-structures to probe single objects.

Secondly, at larger scale, this talk will finish with network of linear assemblies of metallic NPs. In line with the approach known as shell-isolated nanoparticle-enhanced Raman spectroscopy (SHINERS) [3], in which Raman signal amplification of analytes is provided by metallic NPs with an ultrathin dielectric shell, this presentation will report on a Surface-Enhanced Raman Spectroscopy (SERS) substrate consisting of periodic lines of metallic NPs embedded in dielectric surfaces for enhancing Raman signals [4]. These PLANEDSERS (fig. 1.) substrates produced by glancing-angle ion-beam sputtering deposition on nano-rippled patterns present polarization-dependent near field amplifying regions thanks to localized plasmon resonances of the NPs assembly. This design of a substrate-platform without chemical specificity to enhance in equal manner all the weak Raman signals of usual organic molecules.

Finally, we will conclude with another nano-thin 3D gold assembly [5], lamellar nanogold thin films, allowing the monitoring of traces in the vapor phase with enhancements aided by "remote Raman" scattering processes [6].

References

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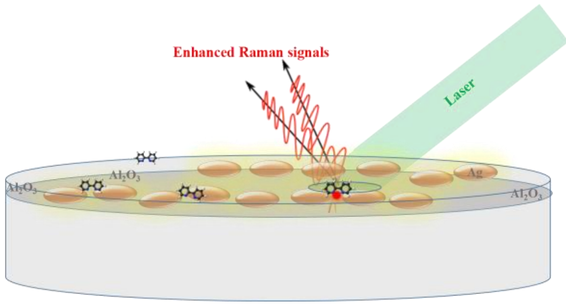
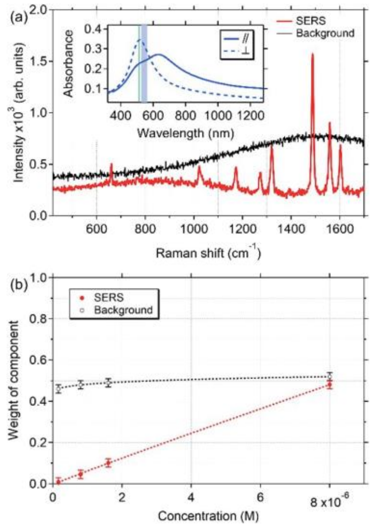
Figures

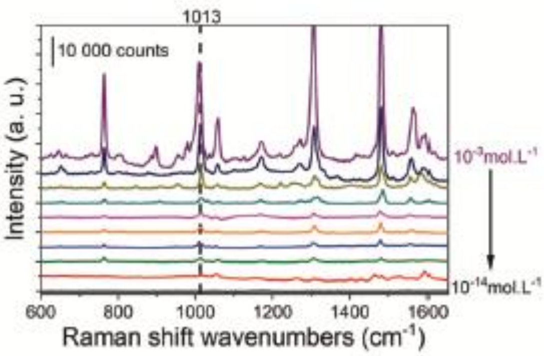


(A)



(B)

Figure 1: ‘PLANEDSERS’ substrates (schemed in A) as washable and reusable chemical sensors with a good level of repeatability (B)



(A)

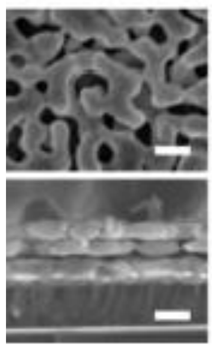

(B)

Figure 2: SERS Spectra recorded between 10-4 M and 10-14 M of bipyridine with nano-thin film of porous gold substrate (SEM images at right, top=plan view and down= cross section, scale bar=100 nm) .