High-amplification SERS platforms based on nanopatterned aluminium for molecular detection

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Abstract

The detection of ultra-low concentrations of analytes is of great significance for medical diagnostics, biomedical monitoring, food safety, and therapy [1,2]. Simple sample preprocessing, high stability, and label-free and rapid detection are the principal requirements of a sensing technique [3].

Among all the different existing sensing techniques, Raman spectroscopy is an important analytical tool for both qualitative and quantitative studies of organic and inorganic systems allowing fast, non-destructive and precise identification [4]. However, Raman spectroscopy has two main limitations: the inherent Raman insensitivity, as only ~1 in 10^6 incident photons scatter in Raman; and fluorescence emission interference, which depends on the nature of the analyte molecule and the excitation wavelength used [5]. Surface-enhanced Raman scattering (SERS) technique, where the presence of a rough metal substrate enhances the Raman signal, minimizes the above mentioned limitations of Raman spectroscopy, being capable of detecting molecules even at the single-molecule scale on or near the surface of plasma nanostructures [6].

In this work, a simple, repeatable and cost effective method for obtaining ordered distribution of gold nanoparticle platforms with very high enhancement Raman signal is presented and successfully used for SERS detection of several analytes. The platform consists of a initial aluminum substrate nanopatterned with concavities distributed in an hexagonal order [7], obtained by the initial grow and a subsequent removal of a nanoporous alumina (NAA) layer [8,9]. The highly ordered nanoconcavities patterning of the aluminum is covered by a nanometric layer of a metal (gold, silver, etc) [10] that, after a thermal annealing, presents a distribution of gold nanoparticles with size and order dependent of the different fabrication parameters (NAA formation parameters [11-13], gold deposition time, annealing adjustments, etc.)

The fabricated platforms are demonstrated to be excellent sensing SERS substrates for the detection of a broad range of molecules [14]. Also a complete evaluation of the different steps fabrication parameters is presented.

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Figures

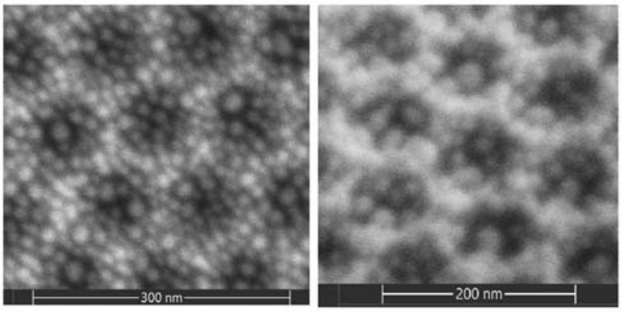

Figure 1. Top (left) and tilted (right) view of a nanoconcavities structure Al-based platform with gold nanoparticles distribution.