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Nanoislands from Gold Films for Plasmonic Sensing Application

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Abstract

Nanostructured noble metal films possess a distinctive optical property when it interacts with the light waves at the metal-dielectric interface. This results in the phenomenon known as localized surface plasmon resonance (LSPR) with a band in the UV-VIS spectral range. The characteristics will be determined by the size, shape of the nanoparticles (NPs), distance between the particles or structures and the refractive index of the surrounding medium. In the last few decades it has been demonstrated that the local refractive index changes when the biomolecules attach to the nanoparticle surface.

Lately, considerable efforts have been made in the development of nanostructures such as nanoislands, to be used as plasmonic platforms, specifically for label-free chemical and biological sensing applications [1-3]. Nano-islands are highly stable nanostructures that can be fabricated by the thermal dewetting of flat continuous metal films, deposited through physical methods such as thermal or e-beam evaporation, sputtering, etc. They have been proven to be suitable sensing platforms and are effectively used in various bio applications [4, 5]

One of the most commonly used metals for plasmonic platforms is gold because it has several excellent properties. In addition, it has a very high surface diffusivity, and therefore it can be easily dewetted to different size and shape of nanostructures such as nanoislands. However, gold is chemically inert so it results in a very poor adhesion to the substrates. During the sensing protocol gold can be effortlessly functionalized as it forms strong bonds, especially, to thiol functional groups. However, in general that is carried out in an aqueous environment and it might lead to delamination and peeling of the film. Growing continuous ultra-thin gold films on bare glass and other common oxide substrates, using standard deposition methods, is very challenging because of the poor wetting of gold to these materials. Therefore, the adhesion can be improved by evaporating adhesion (seed) or "glue" layers, of Cr, Ti, Ni, Pt or Ge or organic (amino- or mercapto-silane) coupling layers, or polymers on the substrate, before depositing the gold film [6,7].

In this work, we are reporting on the optical and morphological characteristics of nanoislands based plasmonic platforms, intended for biosensing applications. This platform consists of glass substrates, with adhesion layer of chromium and a gold layer deposited by electron-beam physical vapor deposition. The samples were annealed at various temperatures and duration to form mechanically and chemically stable nanoisland plasmonic platforms for sensing applications. The optical properties and morphology of the plasmonic platforms were investigated by UV-VIS spectroscopy and SEM to evaluate the smoothness of the systems and their application for sensing chemical and biomolecules.

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