Subwavelength Metallic Nanohole Arrays as Multifunctional Plasmonic Substrates for SPR and SERS Sensors

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In the past years there has been a growing interest in the development of highly sensitive substrates for Surface Plasmon Resonance (SPR) and Surface Enhanced Raman Spectroscopy (SERS). In 1998, Ebbesen and co-workers [1] discovered the extraordinary optical transmission (EOT) through periodic arrays of subwavelength holes in metallic films, an exciting breakthrough for many applications in biophotonics and near-field microscopy, among others. The physical mechanism responsible for the EOT through a metallic film with a periodic array of subwavelength holes is attributed to two different resonances: the localized waveguide resonance and periodic surface plasmon resonance [2]. Surface plasmons excitation leads to a high enhancement of the electromagnetic field close to the metal surface, which corroborated with the high sensitivity of the SPR on the dielectric constant of the surrounding medium make these structures interesting multifunctional plasmonic substrates for SPR and SERS sensors.

In this work we implemented a new variant of classical nanosphere lithography [3] which combines the reactive ion etching (RIE) of self-assembled film of polystyrene nanospheres with metal deposition in order to fabricate gold films with periodic arrays of nanoholes. The film microstructure and morphology was characterized by atomic force microscopy (AFM). The optical and SERS properties as function of metallic hole diameter were measured using an optical fiber microspectrometer and confocal Raman microscope, respectively. Typical AFM image and optical transmission spectra of the fabricated structures are depicted in figure 1.

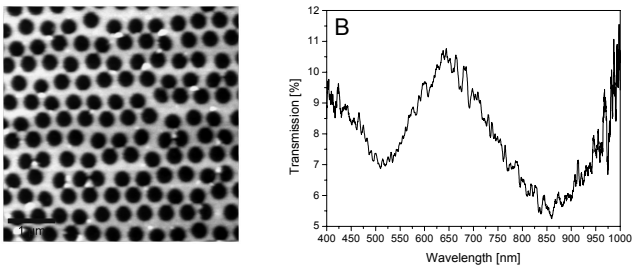

Fig. 1: (A) AFM image of metallic nanohole array; (B) Transmission through the Au film with periodic array of nanohole. The scale bar in the AFM image is 1μm.

We demonstrated SPR and SERS applicability of fabricated periodic arrays of subwavelength holes by monitoring the changes in dielectric constant of the surrounding medium and ultrasensitive detection of adsorbed molecules.

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[3] J.C. Hulteen, R. P. Van Duyne, J. Vac. Sci. Technol. A 13 (1995) 1553.

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