

Multifunctional Plasmonic Nanostructures for Surface-Enhanced Spectroscopies

S. Astilean, M. Baia, D. Maniu, F. Toderas, C. Farcau, M. Iosin, V. Canpean

*Faculty of Physics, Babes-Bolyai University, Str. M. Kogalniceanu 1,
400084 Cluj-Napoca, Romania*

Noble-metal nanostructures exhibit an enhanced optical interaction with visible light due to the resonant excitation of localized surface plasmons [1-2]. As result, dramatic changes are observed in the optical properties of molecules when adsorbed on metallic nanoparticles. The best-known example is surface enhanced Raman scattering (SERS). A closely related and complementary surface enhanced spectroscopy, surface enhanced infrared absorption (SEIRA), can also be performed on metal structures. Single metal nanoparticles have been reported to decisively influence the molecular fluorescence as well.

Here, we report the fabrication of nanoparticle arrays *via* nanosphere lithography, chemical synthesis and self-assembling routes. In the first procedure self-assembled polystyrene nanospheres are used as lithographic masks to deposit metal and generate periodic arrays of nanoparticles or nanoholes. The second procedure of fabrication involves chemical synthesis of nanoparticles and subsequent attachment of as synthesized nanoparticles onto solid surfaces via amine-terminated molecular layer. Scanning and transmission electron microscopy, atomic force microscopy, and optical transmission and reflectivity measurements have been employed to correlate the nanometer-scale morphology and topography of fabricated nanostructures with their optical properties.

The fabricated plasmonic nanostructures have been investigated as unique multifunctional platforms for spectroscopic detection of low-concentration analytes [3-5]. The SERS efficiency was evaluated with p-aminothiophenol as probe molecule at different excitation laser lines. Both FT-SERS and SEIRA spectra of p-aminothiophenol absorbed onto nanoparticle gold films were successfully recorded from the same metallic substrate. Moreover, morphological changes induced in the initial assemblies of gold nanoparticles by annealing allowed us to convert the SERS substrate into a sensitive sensor based on local surface plasmon resonance (LSPR). We also examined the fluorescence of Eosin Y – protein (BSA) in the presence on gold colloidal nanoparticles immobilized on glass substrate in comparison with the emission of Eosin Y – BSA deposited on bare glass.

The potential use of fabricated plasmonic nanostructures as highly SERS and SEIRA-active substrates as well as LSPR-based and metal-enhanced fluorescence sensors for biomolecules detection can foster many exciting applications, from biology, biochemistry and DNA sequencing to detection and identification of single molecules.

- [1] D.A. Stuart, A.J. Haes, C.R. Yonzon, E.M. Hicks and R.P. Van Duyne, *Nanobiotech.* 152 (2005) 13.
- [2] B. J. Wiley, S. H. Im, Z.-Y. and Y. Xia, *J. Phys. Chem. B* 110 (2006) 15666.
- [3] M. Baia, L. Baia, J. Popp, S. Astilean, *Appl. Phys. Lett.* 88 (2006) 143121.
- [4] S. Astilean, *Radiation Physics and Chemistry* 76 (2007) 436.
- [5] F. Toderas, M. Baia, L. Baia, S. Astilean, *Nanotechnology* 18 (2007) 255702.

Acknowledgement

We acknowledge the financial support from the ANCS Project CEEEX No 71/2006 (Matnantech).