PLASMONIC NANOSTRUCTURES FOR CHEMICAL SENSOR APPLICATION

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In the last years, many theoretical and experimental studies have been made on metal nanoparticles because of their possible chemical and biological sensor applications. Significant attention has been paid in particular to the Localized Surface Plasmon Resonance modes (LSPR) that gold and silver nanostructures are able to support when stimulated by incident light under specific conditions. These non-propagating plasma oscillations are strictly related to the optical properties of the local environment, allowing real-time monitoring of molecular adsorption with potential applications in gas and biosensing. Optical absorption and scattering of nanostructures can be exploited for different applications. Therefore, it is very important to understand how these properties depend on the particle's geometry, in order to find the best configuration for the selected application. Following this aim, a theoretical study of the optical properties and electric field distribution of metallic nanoparticles is proposed in this work. A finite element analysis with the RF module of COMSOL Multiphysics is used to explore several key parameters for sensitivity enhancement of LSPR sensors. For illustrative purpose we report in this work the application of FEM calculations to a particular case. We measure the angle integrated total reflectivity of a system composed by disordered silica nanowires decorated with Au spherical nanoparticles. The light trapping properties of this kind of structures can be exploited to improve the efficiency of traditional plasmonic sensors [1]. As expected from the results of our FEM analysis, the presence of gold NPs immobilized on the nanowires, induces a clear reflectivity reduction only in the spectral region where the LSPR is activated. By dipping the system in different solvent and monitoring the variations of the LSPR peak, we confirmed the ability of this system to detect even small changes in the refractive index of the environment. Further simulations with COMSOL Multiphysics will help to better understand the optical response of metallic nanostructures, allowing the fabrication of new LSPR sensors characterized by better performances in the gas and biosensing field of research.

[1] A. Convertino, M. Cuscuna` and F. Martelli, Nanotechnology 21 (2010) 355701