Nanogap plasmonic structures for biosensing applications

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Plasmonic structures containing a few nanometers wide gaps allow for extreme light trapping and enhancement at the nanometric scale due to the excitation of localized surface plasmons. These highly confined modes exhibit extraordinary sensitivity to environmental refractive index changes that might be caused for instance by the adsorption of biological molecules at the nanostructured metal surface. All of the above indicate that the nanogap plasmonic structures may be an ideal platform for the next-generation biosensors [1-2].

The main motivation of our work is to design, fabricate and apply new types of plasmonic nanostructures. In our view, those should allow us to conduct fundamental research but at the same time should be user-friendly to facilitate real-life applications. In this study, we present a simple method of fabricating randomly distributed plasmonic nanoobjects in a variety of geometries covering a few cm^2 surface. A novel fabrication method based on nanosphere lithography was used to create non-periodic arrays of nanoobjects containing gaps such as discs and core-shell nanoparticles (Fig. 1). Their optical response can be tuned in the broad spectral range from UV to NIR thanks to an exceptional resolution of tuning the gap size reaching single nanometers.

The sensing properties of the chosen nanostructures were investigated theoretically and experimentally. Using the finite-difference time-domain method the electromagnetic field enhancement, resonance position, and bulk sensitivity are examined as a function of the geometrical and material parameters of the investigated system. The fabricated structures are characterized by means of scanning electron microscopy, spectrophotometry, and ellipsometry. The sensing capabilities of the nanostructures are confirmed in the experiment with the use of sugar solution of different concentrations.

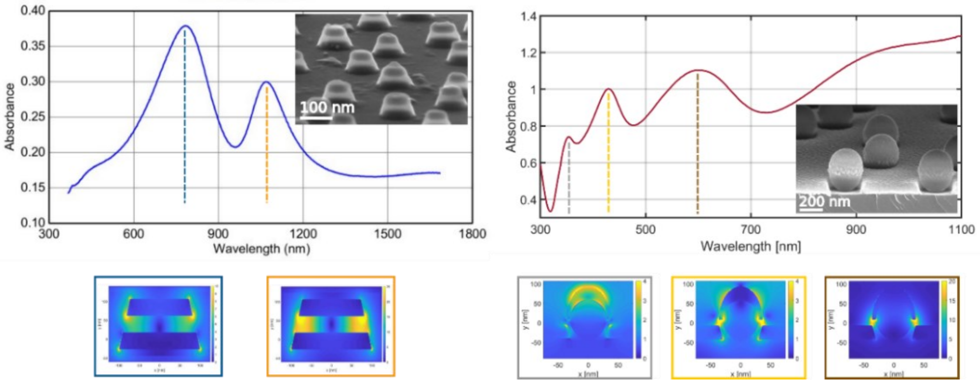

Fig. 1. The absorbance of the random arrays of nanogap plasmonic disks (left) and core-shell-gap nanoparticles (right) fabricated by nanosphere lithography (inset). Bottom panel: FDTD-calculated electromagnetic field distribution at the nanostructure corresponding to the subsequent resonances.

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