Strong coupling of two metal nanoparticles

Gernot Schaffernak, Andreas Hohenau

Institute of Physics, University of Graz, Universitätsplatz 5, 8010 Graz, Austria

Metal nanoparticles interact with electromagnetic radiation through their free conduction electrons. At optical wavelengths the electrons act as a plasma and the collective volume and surface charge-density oscillations driven by the radiation are called plasmons. Surface plasmon resonances lead to a very strong optical near-field close to the surface that can be further enhanced by electromagnetic coupling of two nanoparticles separated only by a fraction of the optical near-field range leading to plasmon hybridization [1].

We approach this strong coupling regime experimentally and present results from lithographically fabricated gold particle-pairs with controlled gap widths in the range of 1-20 nm [2]. Measured optical extinction spectra of coupled particle pairs are compared to the results of simulations done with the boundary element method [3]. An example for the measured extinction spectra for gold disks of diameter 100 nm and height 30 nm as well as for coupled gold disks separated by a 10 nm SiO_2 layer is given in (Fig. 1). For another sample with a slightly larger spacer layer of 20 nm the two disks can be distinguished well with a scanning electron microscope (Fig. 2). As the inter-particle distance can be controlled very well for this structure, we believe it is well-suited to study the enhanced interaction with light of dye molecules embedded in the spacer layer.

Funding by FWF (project P 25034) and NAWI Graz is gratefully acknowledged.

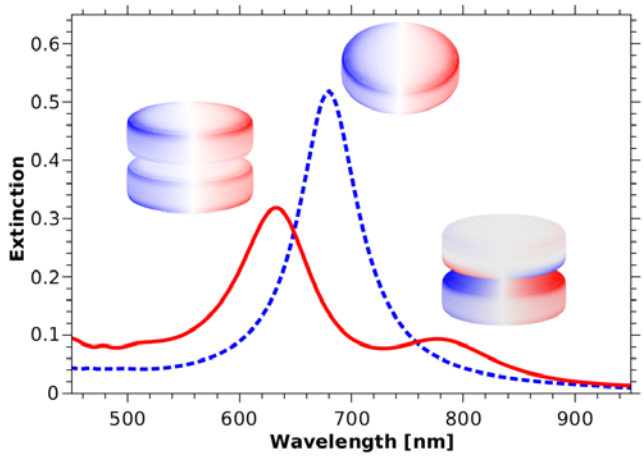

Fig. 1: *Optical extinction spectra of single gold disks and pairs of particles separated by a 10 nm dielectric layer. The insets show the simulated surface charge distribution at the peaks.*

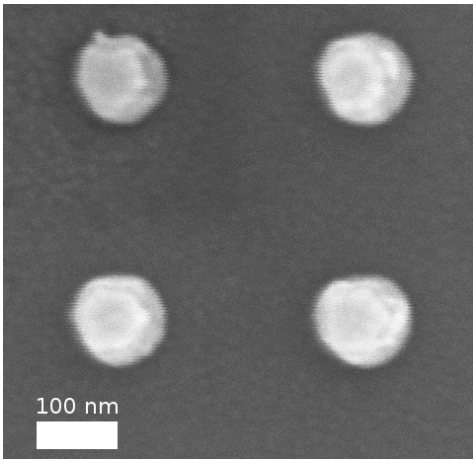

Fig. 2: *SEM image of the metal-dielectric-metal structure. The top particle is smaller due to narrowing of the mask during evaporation of the particle materials.*

[1] A. Dmitriev et al., small 3 (2007) 294-299.
[2] G. Schaffernak et al., Photonics, Devices, and Systems VI, Proc. SPIE 9450 (2015) 945015

[3] U. Hohenester and A. Trügler, Comp. Phys. Commun 183 (2012) 370.