PLASMONIC ENHANCEMENT OF RAMAN SCATTERING AND IR ABSORPTION BY QUANTUM DOTS DEPOSITED ON METAL NANOSTRUCTURES

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Metal nanostructures can lead to localised surface plasmon resonances (LSPR) with energies located in the spectral range from ultra-violet to far-infrared depending on their morphology. They can be effectively used for surface-enhanced Raman scattering (SERS) and infrared absorption (SEIRA) by semiconductor quantum dots (QDs).

Here we present the results of an investigation of SERS and SEIRA by semiconductor QDs homogeneously deposited on arrays of Au nanoclusters, dimers, and nanoantennas. The structural parameters of semiconducting and metal nanostructures were confirmed by scanning electron microscopy (SEM). The LSPR energy in the arrays of Au nanoantennas and nanoclusters as a function of their size was determined by means of IR and optical spectroscopies.

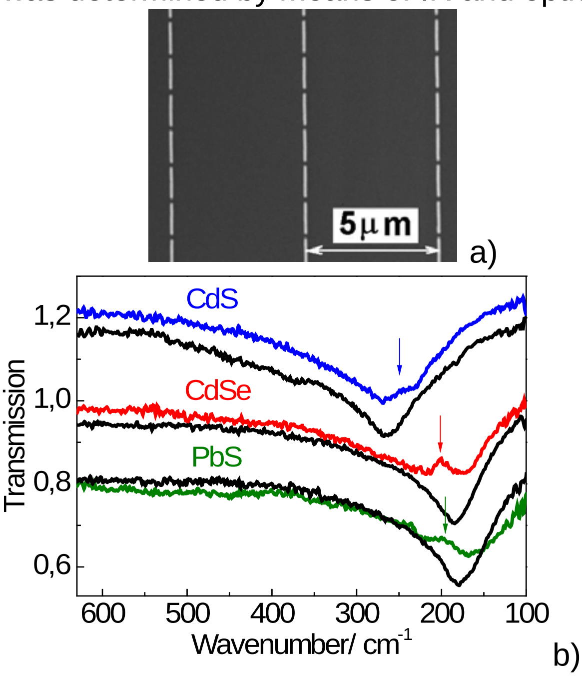

Fig.1 a)- SEM image of a Au nanoantenna array. b)- SEIRA spectra of 1 monolayer of CdS, CdSe, and PbS QDs. The IR spectra of the arrays without QDs are given for comparison.

CdSe QDs deposited on Au nanocluster arrays reveal SERS effect by confined longitudinal optical (LO) phonons in QDs. The SERS enhancement factor (EF) depends resonantly on the metal nanocluster size and thus on the LSPR energy. EF shows a polarization anisotropy for CdSe QDs on Au dimers. A confinement-induced shift of the LO phonon mode was observed for CdSe QDs deposited on the structures with single Au dimers. This shift depends on the CdSe QD size and indicates quasi-single QD Raman spectra being obtained.

3D electrodynamic simulations were used to calculate structural parameters of nanoantennas providing the maximal SEIRA enhancement at the energy of optical phonons in QDs. SEIRA by surface optical modes in monolayers of CdS, CdSe, and PbS QDs on nanoantenna arrays was observed (indicated by arrows in Fig.1b).

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