Size Selective Spectroscopy of PbSe/PbS Core-Shell Semiconductor Nanocrystals

M. Brumer and E. Lifshitz, Dept. of Chemistry and Solid State Institute, Technion, Haifa 32000, Israel (ssefrat@tx.technion.ac.il)

The nanometer-sized crystals of lead chalcogenides (PbS, PbSe) show an increasing technological and scientific interest, due to the distinguished physical properties of these semiconductors. A bulk PbS and PbSe have a cubic (rock salt) crystal structure, with narrow direct band gap (02-0.41 eV, at 300K) and large exciton Bohr radius (18-46 nm), which is eight times larger than that of CdSe. Thus, size quantization effects are strongly pronounced in PbSe and PbS crystals, showing a unique possibility to probe the strong confinement regime. Colloidal nanocrystals with core-shell structures were recently synthesized in our laboratory, offering an effective chemical and electronic passivation, and leading to an increase of the quantum efficiency of the exciton absorption and emission.

The electronic and optical properties of the aforementioned core-shell structures were examined by size selective spectroscopy, including fluorescence line narrowing (FLN) and photoluminescence excitation (PLE). The non-resonance excited photoluminescence (PL) of 4.0 nm nanocrystals exhibit featureless band, centered at 1.41 eV. The FLN spectra were excited at various energies within the PL band, showing a zero-phonon narrow band and its LO replica. The zero-phonon band is Stokes shifted from the corresponding excitation by about 70 meV, which decreased with the decrease in the excitation energy (or the increase of the nanocrystalline's size). In a similar manner, the PLE spectra were blue shifted with the increase in the detection energy. The Stokes shift is associated with the energy difference between the bright and dark states that vary with the nanocrystalline size. Further investigation of the electronic characteristic and angular momentum of the indicated states will be examined in the near future, by the use of linear and circular polarized detection of the FLN spectrum in the presence of an external magnetic field.