Spin properties in II-VI and Perovskites colloidal quantum dots

Efrat Lifshitz, Schulich Faculty of Chemistry, Russell Berrie Nanotechnology Institute, Solid State Institute, Technion, Haifa 32000, Israel.

Colloidal semiconductor quantum dots (CQDs) have been at the forefront of scientific research for more than two decades, based on their size tunable properties. Although implementation of CQDs in opto-electronic devices already occurs, various fundamental issues with a direct impact on technology are left as open questions. Recent years showed an interest in the investigation of magneto-optical properties of various CQDs with substantial importance for opto-electronic and spin-based devices.

The talk includes the study of two different CQD platforms: (1) Synthesis and magneto-optical characterization of spectrally stable pure and diluted magnetic semiconductor CQDs from the II-VI semiconductor family (e.g., Mn@CdTe/CdSe); (2) Magneto-optical characterization of perovskite CQDs of the type $APbBr_3$(A - methylamonium or Cs^+). Both systems show intriguing spin properties of special scientific and technological interests. The uniqueness of the spin properties and their novelty will be the focus of the plenary talk.

Mn^{+2}@CdSe/CdS and CdSe/ Mn^{+2}@CdS: The Mn^{+2} doping induces internal spin interactions between photo-generated species (electron and hole) and the dopant spins, leading to giant magnetization or to an internal energy transfer into the dopant orbitals, and consequence emission from host-dopant hybrid- or from dopant atomistic-states. The current study developed a method to position the Mn ions selectively either at the core or at the shell, in host CQDs that possess quasi-type-II character (viz., electron and hole are partially separate), hence Mn spins are coupled either to the hole or to the electron. The magneto-optical measurements, including the use of optically detected magnetic resonance, exhibited resonance transitions related to the coupling of the Mn spins with the individual photo-generated carriers. The information gained put a grown for designing the spin properties of CQDs of significant importance for applications.

$APbBr_3$ (A=Cs^+, methylamonium): The perovskites are minerals that have been studied extensively in the past. They are the focus of new interest in recent years, due to their exceptional performance in photovoltaic cells. Perovskites semiconductors possess high absorption coefficients as well as long-range transport properties. Currently, they are also prepared in the form of CQDs with very interesting properties including ferroelectricity, magnetism and exciton effects. The magneto-optical measurements of excitons in $APbBr_3$ as individuals were investigated by monitoring the micro-photoluminescence spectra in the presence of an external magnetic field, while monitoring either the circular or linear polarization components. Gradual band splitting occurring upon the application of a magnetic field, deviating from a common Zeeman interaction behavior, proposes the existence of a more complex mechanism, when Rashba split is one of the plausible interpretations. Theoretical considerations strongly supported the existence of Rashba split in the studied materials, emanated from structural polarization and distortion, viz., breaking of an inversion of symmetry.