HL 39: Quantum Dots and Wires 6: II-VI and related

Time: Friday 9:30–10:45 Location: H32

HL 39.1 Fri 9:30 H32

Raman and X-ray photoemission study of thin films of binary and ternary semiconductor quantum dots — •Oleksandr Selyshchev[1,2], Volodymyr Dzhagan[3,4], and Dietrich R.T. Zahn[1,2] — [1]Semiconductor Physics, TU Chemnitz, Germany — [2]Center for Materials, Architectures, and Integration of Nanomembranes (MAIN), TU Chemnitz, Germany — [3]Institute of Semiconductors Physics, NAS of Ukraine, Kyiv, Ukraine — [4]Taras Shevchenko National University of Kyiv, Ukraine

Quantum dots (QDs) of ternary semiconductor chalcogenides MInS2 (M = Cu, Ag) attract attention as environment friendly alternatives to toxic cadmium and lead chalcogenides. Even though both ternary and binary QDs exhibit size dependent absorption and photoluminescence spectra, the properties of ternary compounds additionally depend on composition, variety of crystalline phases, and defects. Here, we present a comparative Raman and X-ray photoemission spectroscopic (XPS) study of thin films of binary CdS and ternary MInS2 QDs to examine their structural and electronic properties. Raman results show that MInS2 QDs co-exist in chalcopyrite and Cu-Au type phases. XPS study revealed indium-rich surface deviating from ideal stoichiometry. Auger parameters confirm metal ions in the expected oxidation states, while the boundary states of sulfur indicate surface passivation through the thiolate group of thioglycolate ligands. The ionization potentials of binary and ternary QDs are found to be the same as those for the bulk indicating that the bandgap increase is due to quantum confinement of electrons in the conduction band.

HL 39.2 Fri 9:45 H32

Collective Properties of CdSe-CdS giant-shell Quantum Dots — •Yannic Stächelin[1], Artur Feld[1], Agnes Weimer[1], Michael Deffner[2,3], Sonja Krohn[4], Jan Steffen Niehaus[4], and Holger Lange[1,3] — [1]Institut für Physikalische Chemie, Universität Hamburg, Hamburg, Germany — [2]Institut für Anorganische und Angewandte Chemie, Universität Hamburg, Hamburg, Germany — [3]The Hamburg Centre for Ultrafast Imaging, Hamburg, Germany — [4]Fraunhofer IAP-CAN, Hamburg, Germany

CdSe-CdS core-giant-shell QDs are nowadays available with near-unity quantum yields, which makes them interesting candidates for lasing or display applications. Bright, high-PLQY QDs might also contribute to photonic quantum technologies as building blocks. QDs can realize deterministic photon-emitters and enable key quantum photonic resources and functionalities. Interaction of densely packed QDs can lead to collective phenomena like excitonic and photonic coupling, superfluorescence and enhanced quantum coherence. Incoherent dephasing processes may deteriorate the inherent quantum properties of QDs. We investigate dependencies of exciton formation in CdSe-CdS giant-shell QDs and interaction in dense ensembles of QDs via ultrafast THz and transient absorption spectroscopy. Polymer-micelles are used to produce dense ensembles containing a variable amount of QDs. In dense ensembles, we observe the onset of a collective dynamic depending on the excitation conditions, which are thus a means of controlling the dynamics.

HL 39.3 Fri 10:00 H32

Excitonic fine structure of epitaxial Cd(Se,Te) on ZnTe type-II quantum dots — •Petr Klenovsky[1,2], Piotr Baranowski[3], and Piotr Wojnar[3] — [1]Department of Condensed Matter Physics, Faculty of Science, Masaryk University, Kotlářská 267/2, 61137 Brno, Czech Republic — [2]Czech Metrology Institute, Okružní 31, 63800 Brno, Czech Republic — [3]Institute of Physics, Polish Academy of Sciences, Al Lotników 32/46, PL-02-668 Warsaw, Poland

The structure of the ground state exciton of Cd(Se,Te) quantum dots embedded in ZnTe matrix is studied experimentally using photoluminescence spectroscopy and theoretically using $\mathbf{k} \cdot \mathbf{p}$ and configuration interaction methods. The experiments reveal a considerable reduction of fine-structure splitting energy of the exciton with increase of Se content in the dots. That effect is interpreted by theoretical calculations to originate due to the transition from spatially direct (type-I) to indirect (type-II) transition between electrons and holes in the dot induced by increase of Se. The trends predicted by the theory match those of the experimental results very well.

The theory identifies that the main mechanism causing elevated fine-structure energy in particular in type-I dots is due to the multipole expansion of the exchange interaction. Moreover, the theory reveals that for Se contents in the dot > 0.3, there exist also a peculiar type of confinement showing signatures of both type I and type II and which exhibits extraordinary properties, such as almost purely light hole character of exciton and toroidal shape of hole states.

HL 39.4 Fri 10:15 H32

Polarized emission with sub-meV linewidth from single, two-dimensional PbS nanoplatelets — •Pengji Li[1], Lars Klepzig[2,3], Jingzhong Yang[1], Michael Zopf[1], Jannika Lauth[2,3,4], and Fei Ding[1] — [1]Institut für Festkörperphysik, Leibniz Universität Hannover, 30167 Hannover, Germany — [2]Institute of Physical Chemistry and Electrochemistry, Leibniz Universität Hannover, 30167 Hannover, Germany — [3]Cluster of Excellence PhoenixD, Welfengarten 1A, D-30167 Hannover, Germany — [4]Universität Tübingen, Institute of Physical and Theoretical Chemistry, Auf der Morgenstelle 18, D-72076 Tübingen, Germany

In the past few decades, the tunability and strong light-matter coupling in nanometer-sized colloidal systems promotes their potential use in novel applications such as quantum metrology, quantum imaging or quantum communication. Two-dimensional (2D) nanoplatelets (NPLs) have recently moved into focus due to their controllable photoluminescence properties. In this work, the optical properties of single colloidal 2D PbS NPLs are explored at cryogenic temperature (T=4 K). Stable and narrow-band excitonic emission of single PbS NPL near 1.8 eV is observed with linewidths down to 0.6 meV.The prominent exciton-phonon interaction are detected. The emission features a strongly polarized emission with a degree of polarization up to 77%. These findings denote the first observation of narrow-band polarized photoluminescence (PL) from 2D PbS nanoplatelets, which were believed to suffer from broad PL due to complex band-edge exciton states evolving from the 64-fold degeneracy in PbS.

HL 39.5 Fri 10:30 H32

Exciton recombination dynamics and polarization properties in CsPbI3 perovskite nanocrystals — •Gang Qiang[1], Dmitri R. Yakovlev[1,2], Elena V. Shornikova[1], Danil O. Tolmachev[1], Mikhail A. Prosnikov[3], Elena V. Kolobkova[4], Peter C. M. Christianen[3], and Manfred Bayer[1,2] — [1]Experimentelle Physik 2, Technische Universität Dortmund, D-44221 Dortmund, Germany — [2]St. Petersburg, Russia — [3]High Field Magnet Laboratory (HFML-EMFL), Radboud University, 6525 ED Nijmegen, The Netherlands — [4]St. Petersburg, Russia

We synthesized CsPbI3 NCs in fluorophosphate glass matrix and investigated the optical properties at various temperatures down to 4.2 K and in external magnetic fields up to 30 T. Recombination dynamics demonstrate clearly two-exponential decay characteristic for exciton emission with the dark exciton as a ground state. An anomalous polarization properties is observed at low temperature (e.g. 4.2 K), i.e. with the increasing of magnetic field, the degree of circular polarization (DCP) increases smoothly, while at ~21 T a 'hump' shows up. Higher temperature blurs this behavior, and it can not be clearly observed at 20 K. Moreover, for the spin dynamics, at low temperature (4.2 K) and high magnetic field (> 8 T), after reaching the maximum, the time resolved DCP tends to decreases and slowly relaxes to at a constant level, which is quite different from the observations in III-V and II-VI NCs.