HL 52: Symposium Semiconducting Nanoparticles for Nano-Optics and Optoelectronics

Time: Friday 10:30–13:00 Location: ER 270

Invited Talk HL 52.1 Fri 10:30 ER 270

Semiconducting nanoparticles in industrial applications — •Martin Trocha, André Ebbers, Anna Prodi-Schwab, and Heiko Thiem — Evonik Degussa GmbH

Nanoscale semiconducting particles are already in use for large scale industrial applications since decades. Some examples are UV and IR absorbers in coatings, as absorbing additives in polymers and plastics, and for antistatic coatings on surfaces. Nevertheless the semiconducting nanoparticles play only a passive role as a mere additive.

From the industrial point of view semiconducting nanoparticles are also attractive to be used as active material in optoelectronic devices. Their particulate character allows the fabrication of dispersions and inks. Therefore efficient and cost-saving printing processes, even on flexible substrates, can be used to produce optoelectronic devices.

First applications developed by Evonik Industries are printed transparent conductive films in luminescent devices based on ITO and field effect transistors based on different semiconducting nanoparticles. In this presentation the current status and the future prospective of semiconducting nanoparticles will be outlined.

Invited Talk HL 52.2 Fri 11:00 ER 270

Silicon and Germanium Nanoparticles: Spectroscopy and Electronic transport — •Cedrik Meier, Stephan Lüttjohann, Matthias Offer, Sonja Hartner, Hartmut Wiggers, and Axel Lorke — CeNIDE-Center for NanoIntegration Duisburg-Essen, Lotharstraße 1,47057 Duisburg

Silicon nanoparticles are attractive candidates for photovoltaic and optoelectronics applications, as they allow to combine the advantages of a semiconducting material with the ease of handling of dispersed particles. However, for the realization of optoelectronic devices, one needs to optimize both, the optical efficiency of the emitter as well as the current transport in thin particle films.

In this talk, I will present spectroscopic results and discuss the fundamental limits of silicon nanoparticles as a quantum mechanical emitter in the strong confinement regime. Moreover, the excitonic fine structure in silicon nanoparticles which can be controlled via the temperature as an external parameter will be discussed.

Finally, results on electronic transport through nanoparticle films are presented. While the conductance of unsintered silicon nanoparticles is still unsufficient for most device applications, I will present recent results on magnetotransport through Germanium nanoparticle layers which are promising for applications.

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Invited Talk HL 52.3 Fri 11:30 ER 270

Photoluminescence Spectroscopy of Semiconductor Nanorods and Their Hybrid Structures — •Andrey Rogach — Physics Department and CeNS, LMU Munich

Colloidal semiconductor nanocrystals can be produced nowadays in a variety of sizes, shapes and compositions. Due to their flexible surface chemistry, colloidal nanocrystals are also very attractive objects for use as building blocks in different functional hybrid structures within the bottom-up assembly approaches. Starting from a general overview on semiconductor nanocrystals and their assemblies, we will switch to ensemble and single particle photoluminescence spectroscopy data on the 'nanocrystals of mixed dimensionality', consisting of spherical CdSe cores with elongated CdS shells. The quantum confined Stark effect is in particular pronounced in these nanorod-like particles, and we demonstrate this by direct manipulation of the excited state of the nanorods using strong external electric fields. Electrical control of energy transfer will be addressed on hybrid structures of CdSe/CdS nanorods and organic dye molecules.

Invited Talk HL 52.4 Fri 12:00 ER 270

Charge carrier dynamics of surface modified semiconductor nanocrystals — •Alf Mews, Ma Xuedan, Jessica Völker, Maxime Tchaya, and Herbert Kneppe — Physical Chemistry, University of Siegen, 57068 Siegen, Germany

The optical and electronic properties of semiconductor nanostructures are strongly related to their inorganic and molecular surface modification. This is a direct consequence of surface passivation and/or the electronic interaction between the molecular surface ligands and the inorganic semiconductor cores. For example, photo induced charge transfer from the nanocrystals to the attached surface ligands will have a strong effect on both, the fluorescence intensity and the fluorescence lifetime of the nanocrystals.

Here we present a detailed study of different core/shell nanoparticels and several nanoparticle-ligand combinations, which are investigated by a combination of optical spectroscopy and cyclic voltametry (CV), respectively. This allows to measure the absolute energetic positions of the electronic NC- and ligand-levels by CV and compare them to the respective band-gaps and fluorescence intensities from the optical spectra. In addition we present different functional ligands, where the energetic levels are depending on the chemical environment. Finally we present results from single nanoparticle fluorescence spectroscopy to get a deeper insight into the fluorescence dynamics of individual surface modified nanocystals.

Invited Talk HL 52.5 Fri 12:30 ER 270

Ultrafast Exciton Relaxation Dynamics in Silicon Quantum Dots — •Carola Kryschi, Volker Kuntermann, Carla Cimpean, Vincent Groenewegen, and Anja Sommer — Institut für Physikalische Chemie I, FAU, Egerlandstr. 3, D-91058 Erlangen

A fundamental objective in nanoelectronics is to understand and to control electron flow between semiconductor nanoparticles which is mediated by chromophores attached to the nanoparticle surfaces. Our research activities are directed to the development of silicon quantum dots (Si qdots)with optical and electronic properties which may be adjusted by strong electronic interactions with suited chromophores. Therefore Si qdots with covalently bound chromophores were prepared which exhibit photoluminescence (PL) in the visible with quantum yields up to 37 %. The spectral features of the PL were observed to strongly depend on both, the quantum dot size and the conjugation of the electron system of the chromophores. In order to elucidate the electronic interactions between chromophore states and Si bulk states the PL properties of Si qdots dispersions were examined conducting stationary and time-resolved PL spectroscopy experiments, while ultrafast exciton rise and decay dynamics were studied using femtosecond transient absorption spectroscopy. A pyridine based chromophore was observed to provide nearly resonant electronic interactions with bulk states, whereas the temporal evolution of the transient absorption spectra obtained from a thiophene based chromophore gave unambiguous indication of excitation energy transfer from the chromophore to the Si bulk.