

## CPP 27: Nanoparticles and Composite Materials II

Time: Wednesday 15:00–16:30

Location: H39

CPP 27.1 Wed 15:00 H39

**Growth of silver nanowires within nanotubular J-Aggregates** — ●EGON STEEG, HOLM KIRMSE, FRANK POLZER, YAN QIAO, JÜRGEN RABE, and STEFAN KIRSTEIN — Institut für Physik, Humboldt-Universität zu Berlin

It was demonstrated earlier [1] that ultrathin but long Ag nanowires with diameters less than 7 nanometer and length exceeding micrometers can be fabricated by reduction of silver salt using uniform nanotubular J-Aggregates of amphiphilic cyanine dyes as templates. Here, we report on the growth mechanism of these Ag wires as revealed by conventional and cryogenic transmission electron microscopy. The growth is initiated by short illumination with UV light and observed over time scales ranging from minutes to days. In an early stage, within the tubular aggregates silver nanoparticles are formed which act as seeds for continuous growth of separate pieces of wires. The diameter of the wires is determined by the inner diameter of the tubes. In the final state, the pieces of wire totally fill the aggregate. As revealed by high resolution TEM, the fragmented growth of the wires from separate seeds leads to silver nanowires consisting of single crystalline domains exceeding 100 nm in length. The growth process indicates transport of Ag-ions through the tubular wall membrane. The experiments demonstrate that these J-aggregates may also act as a soft template for the growth of other wire-like inorganic materials.

[1] D.M. Eisele et al., J. Am. Chem. Soc. 132 (2010) 2104.

CPP 27.2 Wed 15:15 H39

**Adhesion Forces between TiO<sub>2</sub> Nanoparticles in Agglomerates** — ●REBECCA SCHOLZ<sup>1</sup>, SAMIR SALAMEH<sup>2</sup>, and LUTZ MÄDLER<sup>2</sup> — <sup>1</sup>Ruhr-Universität Bochum, Physical Chemistry I, Universitätsstraße 150, 44801 Bochum — <sup>2</sup>Foundation Institute of Materials Science (IWT), Department of Production Engineering, University of Bremen, Badgasteiner Str. 3, 28359 Bremen

Nanoparticle aggregates and their films have wide spread applications such as catalysis, sensing, and hybrid materials. The adhesion force between the aggregates plays a major role for their functionality and influence mechanical but also chemical stability. Therefore, information on key parameters influencing the particle-particle-contact are very important. However, direct measurements of the contact forces for particles in size ranges of about 10 nm are rather challenging. Here, we present a method to determine these forces [1], which includes a statistical analysis of the force curves measured by atomic force microscopy (AFM) and in-situ measurements of the rearrangements of the nanoparticles in an AFM/TEM setup. We use this method to first clarify the question of the influence of the primary TiO<sub>2</sub> particle size on the contact force and to then investigate the agglomerate size. In order to separate the influence of the agglomerate size we generated monodisperse agglomerates. Our results show that sliding and rolling events increase with agglomerate size. These findings, especially of the influence of the agglomerate size on the contact force, will be presented and discussed in this presentation.

CPP 27.3 Wed 15:30 H39

**Fluorescence spectroscopy of individual semiconductor nanocrystals in solution** — ●SANDRA FLESSAU and ALF MEWS — Institute for Physical Chemistry, University of Hamburg

Colloidal II-VI semiconductor nanocrystals are crystalline fragments of the corresponding bulk material with sizes of 1 to 10 nm. In this range, the surface-to-volume ratio is considerably large. For a CdSe nanocrystal of 3 nm in diameter, already one third of its atoms is at the surface. The states of the surface influence charge carriers which are three-dimensionally confined within this volume, and therefore become important in determining many of the nanocrystal properties like fluorescence intensity, fluorescence lifetime and blinking behavior.

Here, we present experiments on the impact of chemical or physical modification of the surface on individual nanocrystals. Therefore, the nanocrystals are immobilized within microfluidic channels which are fabricated by soft lithography. Time-resolved single particle fluorescence spectroscopy is performed to explore the details of photophysical changes of one and the same nanocrystal before and after rinsing the channel with varying solutions, e.g. with different dielectric properties or which contain different molecules that can attach to the nanocrystal surface.

CPP 27.4 Wed 15:45 H39

**Electrochemical Manipulation of Single CdSe/ZnS Quantum Dots** — ●NICOLE AMECKE, DAVID PLOTZKI, and FRANK CICHOS — Molecular Nanophotonics Group, University of Leipzig

Despite immense research on semiconductor quantum dots (QDs), the mechanisms of their intensity fluctuations remain a highly speculative subject. Most fluctuations are attributed to non-radiative decay channels arising from charges and fluctuating trap states at the QD interface, surface or close environment. A more specific assignment is difficult, especially due to the extraordinary statistics, which resemble power law distributions of bright and dark periods over several decades in time. With electrochemistry we can access those trap states as well as charges, while simultaneously monitoring QD intensity, lifetime and spectra. In this way we can observe the influence of reduction and oxidation processes on the fluorescence of each single QD. We find, that there is a preferred electrochemical potential for QD-fluorescence. Lower potentials introduce electrons in the conduction band, while higher potentials introduce trap states for the electron. The desired potentials depend on substrate, QD size and vary from dot to dot. The time dependence of the reaction to a potential step indicates a rearrangement of traps and charges in the QD environment.

CPP 27.5 Wed 16:00 H39

**New Tools for reliable photoluminescence quantum yield measurements of near-infrared emissive quantum dots** — ●SOHEIL HATAMI<sup>1</sup>, SUSANNE LEUBNER<sup>2</sup>, VLADIMIR LESNYAK<sup>2</sup>, NIKOLAI GAPONIK<sup>2</sup>, CHRISTAN WÜRTH<sup>1</sup>, MARKUS GRABOLLE<sup>1</sup>, ALEXANDER EYCHMÜLLER<sup>2</sup>, and UTE RESCH-GENGER<sup>1</sup> — <sup>1</sup>BAM Federal Institute for Materials Research and Testing, Berlin, Germany — <sup>2</sup>Physical Chemistry/Electrochemistry, TU Dresden, Dresden, Germany

Semiconductor quantum dots (QDs) are applied as fluorescent labels and active components in optical devices. QDs emitting in the near-infrared (NIR) region like CdTe, and CdHgTe are of increasing importance, due to their high photoluminescence quantum yields (QY) compared to any other chromophore at wavelengths above 900 nm. The characterization of the performance of these NIR and IR QDs requires reliable methods for the determination of QY under biological application-relevant conditions. For often performed relative optical measurements, standard dyes with precisely known QY are mandatory, with the lack of reliably assessed QY standards for the NIR hampering the performance of such measurements. This encouraged us to design a new integrating sphere setup for the absolute measurement of QY values in the spectral range of 600 nm to 1700 nm and to develop procedures for the relative and absolute determination of QY of emissive materials in this wavelength region. Here, the design of our setup and its calibration will be presented as well as first QY measurement of NIR dyes and CdTeHg QDs of varying size and material composition.

CPP 27.6 Wed 16:15 H39

**Absolute Photoluminescence Quantum Yield of Hexagonal  $\beta$ -NaYF<sub>4</sub>:Er<sup>3+</sup>, Yb<sup>3+</sup> Upconversion Nanoparticles** — ●MARTIN KAISER<sup>1</sup>, WÜRTH CHRISTIAN<sup>1</sup>, RESCH-GENGER UTE<sup>1</sup>, HYPÄNEN IKO<sup>2</sup>, and SOUKKA TERO<sup>2</sup> — <sup>1</sup>BAM Bundesanstalt für Materialforschung und -prüfung, Richard-Willstätter-Str. 11, 12489 Berlin — <sup>2</sup>Department of Biotechnology, University of Turku, Tykistökatu 6A, FI-20520 Turku, Finland

Hexagonal  $\beta$ -NaYF<sub>4</sub> doped with Er<sup>3+</sup> and Yb<sup>3+</sup> is currently the most efficient upconversion (UC) phosphor to convert near-infrared (NIR) to green light. For the design of nm-sized UC particles, there is a need for reliable spectroscopic tools for the characterization of the signal-relevant optical properties of these materials like the absolute quantum yield (QY), which equals the ratio of emitted to absorbed photons. Due to the upconverting nature of the photoluminescence and the lack of UC QY standards and conventional QY standards with absorption at 980 nm, the QY of these particles can be presently measured only absolutely. This presents a considerable challenge due to the low absorption coefficient of these materials and the power density dependence of QY. We present here a custom-designed integration sphere setup equipped with a power-stabilized 980 nm-laser diode for spectrally resolved and power density-dependent measurements of the absolute UC QY as well as the transmission and reflection of UC materials in suspension and in

the solid state. The characterization of this setup is detailed as well as | first QY of nm-sized  $\beta$ -NaYF<sub>4</sub>:Er<sup>3+</sup>, Yb<sup>3+</sup> in different environments.