

Charge transport in colloidal nanomaterials

Christian Klinke

University of Rostock/Germany and Swansea University/UK

Ultrathin, atomically flat, two-dimensional semiconductor nanocrystals receive a rapidly increasing attention due to their unique physicochemical properties. I will show that ZnS nanoplatelets exhibit sharp excitonic absorption and narrow excitonic emission. I will demonstrate that direct manganese doping leads to tunable emission and photoluminescence lifetime. The initially low dopant PL quantum yield can be dramatically enhanced by passivating the surface trap states of the samples. Using time-resolved PL spectroscopy and density functional theory calculations, a connection between coupling and PL kinetics of Mn ions can be established. We believe that the presented doping strategy and simulation methodology of the Mn-doped ZnS system is a universal platform to study dopant location- and concentration-dependent properties also in other semiconductors and might be an interesting system for catalysis.

In a second part of my talk, I will present concepts for transistors based on colloidal metal nanoparticles and nanoclusters. We combine high-quality chemical synthesis of the materials with scalable surface deposition methods and lithography techniques. Eventually, the resulting transistors show high on/off ratios, reliable transfer characteristics, and good room temperature operation. Furthermore, this concept allows for versatile tuning of the device properties. The results demonstrate the potential of metal particles as solution processed materials for semiconducting devices.

Bio: Christian Klinke studied physics at the University of Würzburg and the University of Karlsruhe where he also obtained his diploma degree in the group of Thomas Schimmel. Then, he joined the group of Klaus Kern at the Institute of Experimental Physics of the EPFL (Lausanne, Switzerland). This was followed by postdoctoral stay at the IBM TJ Watson Research Center (Yorktown Heights, USA) in the group of Phaedon Avouris. Going back to Germany, he started his own group as assistant professor at the University of Hamburg. Since 2017, he is an associate professor at the Chemistry Department of the Swansea University and since 2019 full professor at the Institute of Physics of the University of Rostock. He is also member of the Interdisciplinary Department "Life, Light & Matter" and Associate Editor for the RSC journals "Nanoscale" and "Nanoscale Advances". He received the German Nanotech Prize (AGeNT-D/BMBF) and recently, he was selected as Henriette Herz Scout of the Alexander von Humboldt Foundation. His research concerns the colloidal synthesis of nanomaterials and the optoelectronic characterization of these materials.