Bulk-Heterojunction Nanocomposites for Solar Cells

Yunfei Zhou[1,2], Gerald A. Urban[2], Michael Krüger[1,2*]

[1]*Freiburg Materials Research Centre (FMF), University of Freiburg*
Stefan Meier Strasse 21, D- 79104 Freiburg, Germany
[2]*Department of Microsystems Engineering (IMTEK), University of Freiburg,*
George Köhler Allee 103, D-79110 Freiburg, Germany
*e-mail: michael.krueger@fmf.uni-freiburg.de

Abstract

The group of Dr. Krüger started from 11/2006 on with the synthesis of semiconducting colloidal nanocrystals (NCs) at the Freiburg Materials Research Centre (FMF). The aim is to perform fundamental research on the NC synthesis as well as on the tailored surface modification of NCs for specific purposes and applications like biolabelling, solar cells, LEDs and Lasers. In the framework of the Graduate School of the German Science Foundation (DFG) "Micro Energy Harvesting" Mr. Zhou is performing his PhD work at the FMF on bulk-heterojunction nanocomposites for photovoltaic applications.

Synthesis of NCs

A highly reproducible synthesis method for CdSe NCs has been developed, leading to monodisperse NCs with excellent photophysical properties. Current research is performed to control the shape and the lattice structure of the NCs within the same synthesis approach. These findings will be applied to other semiconducting materials like CdS, CdTe, PbSe, PbTe etc.. A new type of magic size luminescent CdSe nanoclusters have been found. Their role as nuclei during the formation of NCs as well as their use as building block for the formation of defined superstructures is presently investigated. Potential applications as well as the synthesis of clusters of other materials will be evaluated.

Nanocomposite Materials

The NCs are incorporated in commercially available conducting polymer systems like Poly-3-hexylthiophene (P3HT). The mixtures will be optimised for solar cell applications. Our intention is to enhance the carrier mobility and balance the electron and hole transport within the system. The photovoltaic devices will be fabricated and tested in cooperation with the Fraunhofer Institute for Solar Energy Systems (ISE), Freiburg (Germany). Improvements are expected by using "ligand free" NCs and nanocomposites out of NCs and Carbon Nanotubes.

Future Approaches

- using nanostructured electrodes (e.g. parallel aligned nanowire arrays).
- ligand design and molecular tuning for dedicated semiconducting NCs.
- applying new synthesis routes like the generation of ligand free nanoparticles in ionic liquids.
- using different nanomaterials as building blocks to form dedicated assemblies for efficient energy harvesting (e.g. hetero-tetrapod-structures).
- development of new technologies for the deposition of metals as electrode material (e.g. electrochemical deposition of Al in ionic liquids).