

New Concepts for Highly Efficient Dye-Sensitized Solar Cells

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Our group is working in the field of dye-sensitized solar cells since more than 10 years. Recently we are also investigating new optical concepts for advanced photovoltaic systems. We started to work on luminescent concentrators and on 3rd generation photovoltaics.

Dye-sensitized solar cells (DSSC):

Strong experimental background in DSSC preparation including TiO₂ nanocrystal synthesis, electrophoretic deposition, mechanical pressing and plasma treatment. Synthesis of core-shell systems, molecular surface modification of mesoporous TiO₂ films and DSSC characterization (IPCE, IPVE, V_{oc} -decay, electron transport measurements including photocurrent transients). Fabrication and characterization of solid and quasi-solid electrolyte DSSCs.

Waveguide enhanced DSSCs:

To enhance the optical pathway of photons inside DSSCs we use flat optical waveguides with a thin DSSC prepared onto its surface. By choosing an appropriate angle for light incoupling we use the evanescent wave from the waveguide to excite the dye. This configuration allows the use of rather thin TiO₂ films, which is beneficial to minimize electron loss into the electrolyte.

Luminescent concentrator:

A promising concept to decrease the costs of PV generated electricity is the use of light concentrators. Recently we started to work on luminescent concentrators, which are based on a luminescent material (dye, quantum dots,...) embedded in a transparent host material. Diffuse and/or direct sunlight excites the luminescent material that subsequently emits a photon, which is guided by total internal reflection to the edges of the concentrator. So far re-absorption of the luminescent light is major restriction for large area concentrators. We are currently investigating new concepts to decrease re-absorption and thus to improve the concentration properties such devices.

3rd generation photovoltaics:

Splitting the solar spectrum by a dichroic mirror into two energy bands is used to increase the overall light to electric power conversion efficiency. Instead of an single junction solar cell which is optimized for the entire solar spectrum we use two different solar cells which are optimized for the high and low energy band, respectively.