Nanostructured Hybrid Solar Cells

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Morphology control is a key issue towards more efficient organic solar cells. In our approach we use metal-oxide nanostructures as templates for the organic materials to insure phase separation within or close to the exciton diffusion length of the organic materials.
We have experience in preparing highly ordered nanowire arrays by either template methods (anodic alumina templates) or aqueous solution growth methods (e.g. for ZnO) on large scale for use as electrode materials in solar cells.
The template method uses a porous anodized alumina (AAO) film on a conducting glass substrate (e.g. ITO). In the pores of the membrane metals or metal oxides can be inserted via electrodeposition. Etching the AAO template away results in free-standing nanowire arrays on the ITO glass. This allows a precise control over the nanowire diameter and distribution and a broad variety of different of materials (e.g. Cu_2O nanowires, see Fig.1) can be used.
Nanotubes of TiO_2 can be obtained via anodization of titanium (Fig. 2). The pore diameter and distribution can be controlled by the anodization conditions. The tube structure is very interesting as alternative to mesoporous films usually used for dye-sensitized cells. The tubes allow a direct percolation path for the charges towards the electrode. Furthermore higher electron mobility is expected in continuous tubes compared to sintered particles.

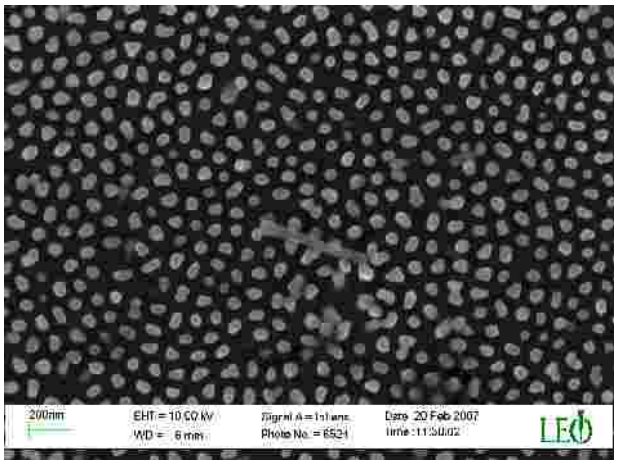

Fig.1: Cu_2O nanowire array on ITO glass substrate

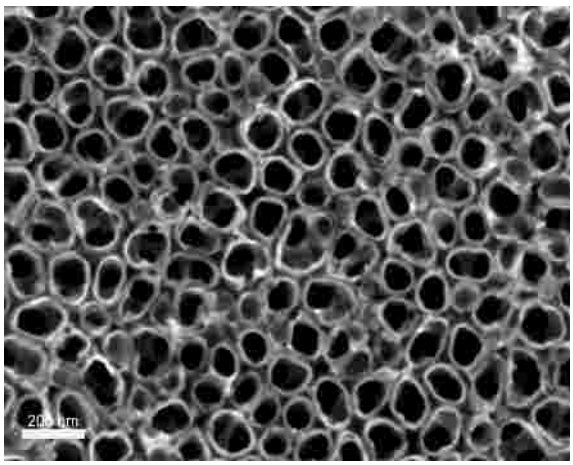

Fig.2: TiO_2 nanotubes after anodization of titanium foil

A challenge will be the filling of the metal-oxide structure with the organic material. The contact at the organic-inorganic interface will play an important role for efficient charge separation and avoiding recombination.
The group has experience in the preparation of fully organic[1] as well as dye sensitized solar cells[2]. The future focus will lay in the development and analysis of hybrid solar cells and the control of their morphology. A research focus will be the investigation of the influence of the morphology on the performance of the cells. It is expected that a nanoscale morphology will improve the performance significantly by reducing recombination. Furthermore the controlled structure will allow a more precise modelling.
The group will have an UHV-sputter-setup for the fabrication of high quality films for anodization, setups for anodization and electrodeposition as well as a setup to measure the spectral response and efficiency of the solar cells. In addition spectroscopy measurements to investigate the charge lifetime and recombination kinetics will be available.

1. Schmidt-Mende, L.; Fechtenkötter, A.; Müllen, K.; Moons, E.; Friend, R. H.; MacKenzie, J. D. *Science* **2001,** 293, 1119.
2. Snaith, H. J.; Schmidt-Mende, L. *Adv. Mater.* **2007,** 19, 3187-3200.