Nanoparticulate Dye-Semiconductor Hybrid Materials Formed by Electrochemical Self-Assembly as Electrodes in Photoelectrochemical Cells

Kazuteru Nonomura[a], Thomas Loewenstein[a], Esther Michaelis[b], Peter Kunze[d], Manuela Schiek[d], Jens Reemts[c], Mirian Yoshie Iwaya[e], Michael Wark[f], Jiri Rathousky[g], Katharina Al-Shamery[d], Achim Kittel[c], Jürgen Parisi[c], Dieter Wöhrle[b], Tsukasa Yoshida[e], and Derck Schlettwein[a]

[a] Institut für Angewandte Physik, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen, Germany
[a] Institut für Organische und Makromolekulare Chemie, Universität Bremen, Germany
[c] Abteilung Energie- und Halbleiterforschung, Institut für Physik, Universität Oldenburg, Germany
[d] Physikalische Chemie 1, Institut für Reine und Angewandte Chemie, Universität Oldenburg, Germany
[e] Environmental and Renewable Energy Systems, Faculty of Engineering, Gifu University, Japan
[f] Institut für Physikalische Chemie und Elektrochemie, Universität Hannover, Germany
[g] J. Heyrovsky Institute of Physical Chemistry, Academy of Sciences of the Czech Republic, Prague, Czech Republic

Reprint requests to J. P.; E-mail: parisi@ehf.uni-oldenburg.de

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Dye-sensitized zinc oxide thin films were prepared, characterized and optimized for applications as photoelectrochemically active electrodes. Conditions were established under which crystalline thin films of ZnO with a porous texture were formed by electrochemically induced crystallization controlled by structure-directing agents (SDA). Dye molecules were adsorbed either directly as SDA during this preparation step or, preferably, following desorption of a SDA. The external quantum efficiency (IPCE) could thereby be increased significantly. Particular emphasis was laid on dye molecules that absorb in the red part of the visible spectrum. Model experiments under ultrahigh vacuum (UHV) conditions with dye molecules adsorbed on defined crystal planes of single crystals aimed at a deeper understanding of the coupling of the chromophore electronic π-system within molecular aggregates and to the semiconductor surface. Detailed photoelectrochemical kinetic measurements were used to characterize and optimize the electrochemically prepared dye-sensitized ZnO films. Parallel electrical characterization in vacuum served to distinguish between contributions of charge transport within the ZnO semiconductor matrix and the ions of the electrolyte in the pore system of the electrode.

Key words: Electrodeposition; Photosensitization; Film Growth; Adsorption; Electrical Conduction.