HIGHLY STRUCTURED ZINC OXIDE THIN FILMS GROWN BY SOLUTION DEPOSITION FOR PHOTOVOLTAIC APPLICATIONS

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Over the last decade several novel configurations for photovoltaic devices have been proposed, as exemplified by the Grätzel and eta cells.[1] Photovoltaic cells such as these, based on highly structured substrates, have been shown to be more efficient in comparison to their planar counterparts. A key feature of these cells is the increased surface area. Highly structured substrates are favourable for light trapping, due to a reduction in specular reflectance but increased internal scattering, leading to increased optical path lengths for photon absorption. Moreover, transport lengths for photoexcited carriers in the absorber are reduced and so electrons and holes do not need to travel over large distances before separation and collection.

Of particular interest in the present study is the extremely-thin-absorber or eta cell, which is conceptually similar to the Grätzel cell.[2] Eta-cells comprise a thin, conformal p-type semiconductor absorber/ sensitizer layer deposited on a micro/nano-structured substrate such as ZnO, which serves as an n-type semiconductor window layer. Columnar ZnO films may offer fundamental advantages over nanoporous TiO_2 such as improved electrical transport properties. We have described a novel, two-step approach for solution growth of highly orientated ZnO microcolumn arrays.[3] The procedure involves solution deposition of ZnO template layers of the desired morphology and subsequent overgrowth of ZnO microcolumns from aqueous solutions containing a zinc carboxylate salt and hexamethylenetetraamine (HMT) on the templates.

In this paper we present some results from our studies on low-temperature solution deposition of high surface area, micro- and nanocolumnar arrays of ZnO on different ZnO template layers on glass and TOF-glass substrates. Films have been characterized by spectroscopic methods (UV-vis, PL), microscopy (SEM) and XRD methods. X-ray diffraction data obtained from ZnO microstructures indicate that crystal growth occurs most rapidly along the long c-axis on the polar c-faces of ZnO, leading to strong enhancement of the (002) *vs.* (101) reflection. The phenomenon is demonstrated most clearly for ZnO films grown on nanocrystalline ZnO template films. Nanocrystalline ZnO templates and subsequent ZnO array structures grown on glass microscope slides are non-scattering and optical transparent. These films provide a high surface area substrate for subsequent overgrowth of semiconductor sensitizer layers, such as copper sulfide and selenide.

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