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Composite wide bandgap semiconducting oxides for high-efficiency excitonic solar cells

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Abstract

The typical photoanode in dye- and quantum dot- sensitized solar cells is composed of a wide band gap semiconductor, which acts as electron transporter for the photoelectrochemical system. Anatase TiO2 nanoparticles are one of the most used oxides and are able to deliver the highest photoconversion efficiency in this kind of solar cells, but intense research in the last years was also addressed to ZnO and other composite systems. Modulation of the composition and shape of nanostructured photoanodes is key element to tailor the physical chemical processes regulating charge dynamics and, ultimately, to boost the efficiency of the end user device, by favoring charge transport and collection, while reducing charge recombination.

We investigated light harvesting, exciton separation and charge injection and transport in several systems: (i) TiO2 nanoparticles / ZnO nanowires; (ii) Multiwall carbon nanotubes (MWCNTs) / TiO2 nanoparticles; (iii) TiO2 nanotubes; (iv) Hierarchically self-assembled ZnO sub-microstructures. Both dye molecules and semiconducting quantum dots were applied as light harvesters. Possible tailoring of structure and morphology of the photoanodes and of the quantum dots, and their implication in improving the functional properties of these kinds of excitonic solar cells will be discussed in detail.