TiO_2-based dye-sensitized solar cells

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Today, due to the increasing global demands on energy, it is imperative that a renewable energy source be determined, that is cost effective and reliable. Solar cell technology has shown much promise over the years to replace the use of fossil fuels. However, with the current technology, the cost per watt is rather high due to the high cost of manufacturing silicon-based solar cells.

In the conventional p–n junction solar cells, only the electrons and holes that can diffuse to the space charge region can be collected as a current. In order to get a long diffusion length, the purity of semiconductors should be increased and the defect concentration should be decreased, resulting in the expensive solar cell materials. In a dye-sensitized solar cell, a photon absorbed by a dye molecule gives rise to electron injection into the conduction band of nanocrystalline oxide semiconductors such as TiO2 or ZnO. Because of the high surface area, relatively high photocurrent can be obtained in spite of the simple process. The dye is regenerated by electron transfer from a redox species in solution.

The major components of a DSSC include an n-type semiconductor, a sensitizer (i.e., dye), and a redox electrolyte. A sensitizer is chemically tethered to the semiconductor surface by functional anchoring moieties (usually carboxyl group) to harvest a broad range of spectrally distributed light and transfer energy from absorbed photons to excite electrons. If the energy of exited electrons is sufficiently high, electrons will inject into the conduction band of n-type semiconductor to generate photocurrent. The ability to promote a fast electron generation in sensitizer as well as a fast recovery of oxidized sensitizer, a rapid and efficient electron transport in n-type semiconductor, and a fast recovery and diffusion of redox couple in electrolyte is the key to achieve high power conversion efficiency

Different nanostructured TiO2 have been utilized as photoanode to produce DSSCs, including nanoparticles, nanorods, nanowires, and nanotubes.

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