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Dye-sensitized Solar Cells

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15.1 INTRODUCTION TO DYE-SENSITIZED SOLAR CELLS (DSSC)

15.1.1 Background

Photoelectrochemical solar cells (PSCs), consisting of a photoelectrode, a redox electrolyte, and a counter electrode, have been studied extensively. Several semiconductor materials, including single-crystal and polycrystal forms of *n*- and *p*-Si, *n*- and *p*-GaAs, *n*- and *p*-InP, and *n*-CdS, have been used as photoelectrodes. These materials, when used with a suitable redox electrolyte, can produce solar light-to-current conversion efficiency of approximately 10%. However, under irradiation, photocorrosion of the electrode in the electrolyte solution frequently occurs, resulting in poor stability of the cell, so efforts have been made worldwide to develop more stable PSCs.

Oxide semiconductor materials have good stability under irradiation in solution. However, stable oxide semiconductors cannot absorb visible light because they have relatively wide band gaps. Sensitization of wide band gap oxide semiconductor materials, such as TiO_2, ZnO, and SnO_2, with photosensitizers, such as organic dyes, that can absorb visible light has been extensively studied in relation to the development of photography technology since the late nineteenth century. In the sensitization process, photosensitizers adsorbed onto the semiconductor surface absorb visible light and excited electrons are injected into the conduction band of the semiconductor electrodes. Dye-sensitized oxide semiconductor photoelectrodes have been used for PSCs.

Gerischer and Tributsch studied a ZnO electrode sensitized by organic dyes including rose bengal, fluorescein, and rhodamine B [1, 2]. In early studies, however, single-crystal and polycrystal materials, which cannot adsorb a large amount of dye, were used for the photoelectrode, which resulted in low light-harvesting efficiency (LHE) and,

Handbook of Photovoltaic Science and Engineering. Edited by A. Luque and S. Hegedus

ISBN: 0-471-49196-9