

Dye Sensitized Solar Cells: Energetic Considerations and Applications*

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The high concentration of electrolyte ions permeating the nanoporous films of dye sensitized solar cells eliminates all but nanoscopic electric fields in the solution and in the TiO₂. The only substantial electric field is expected to occur at the TiO₂/solution interface, and it is primarily across this interface that the photopotential drops in operating cells. In the dark, the low conductivity of the TiO₂ and the high conductivity of the solution ensure that applied potentials drop over only a small fraction of the nanoporous TiO₂ film near the substrate electrode. Therefore, measurements in the dark cannot be directly compared to measurements under illumination because the latter access most or all of the TiO₂ film. The sensitizing dye is located partially inside the electrochemical double layer at the TiO₂/solution interface and so its redox potential is not fixed relative to either the TiO₂ or the solution. If the dye is mostly inside the double layer, its potential will tend to follow that of the TiO₂; if it is mostly outside, it will be almost independent of the TiO₂. Different photovoltage-limiting kinetic steps can result in these two cases. The narrow absorption spectra of many dyes provides the dye cells with a natural advantage over conventional solar cells in applications such as photoelectrochromic windows and power windows.

1. Introduction

The recently discovered dye sensitized solar cells [1–8] have a number of special features that distinguish them from the more common solar cells. Several of these features and their relevance to the photoconversion process and its applications are discussed here: 1. The nanoporous, high surface area nature of the semiconductor substrate allows electrolyte to permeate the photoactive layer. This eliminates all but nanoscopic electric fields in these films and plays an important role in the charge separation process [9].

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