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TECHNOLOGY TRANSFER OFFICE

Improved Dye-Sensitized Solar Cell (DSSC) for Higher Energy Conversion Efficiency

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IP Status:

Patent pending, available for exclusive or non-exclusive licensing.

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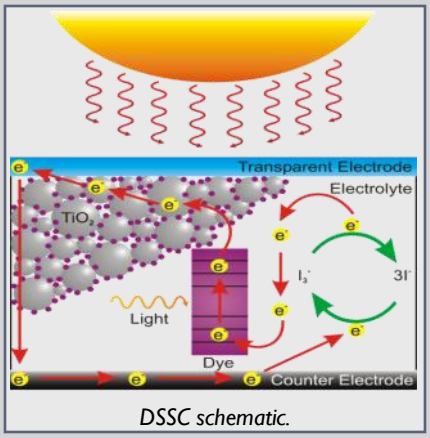
Background

Traditional solar cells are fabricated from semiconductor materials such as silicon. Silicon-based solar cells generally implement semiconductor layers to produce electron current by exploiting the photovoltaic effects that exist at semiconductor junctions. Silicon-based cells are also known to be very costly. A second type of solar cell, known as a dye-sensitized solar cell (DSSC), utilizes dye to absorb incoming light in order to produce excited electrons. DSSCs have advantages over silicon-based solar cells including device stability, low-cost fabrication, and a higher solar-to-electrical energy conversion. Dye-sensitized solar cells have a theoretical maximum energy conversion efficiency of 33%; however, due to technical constraints, the actual energy conversion efficiency of a DSSC is closer to 11%, which is less than half of the crystalline silicon-based solar cells efficiency of 24.4%. Improving DSSC efficiency is critical to widespread adoption of this technology.



DSSC schematic.

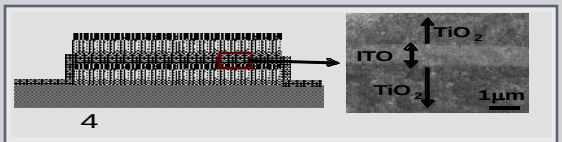


Figure shows one multi-layer DSSC anode structure tested in the Noble Lab. The TiO2 thickness is effectively doubled to 20um, allowing greater energy conversion than in traditional anodes. The use of the intermediate ITO electron collection layer minimizes electron loss due to diffusion.

Technology

A University of Colorado research group led by Miao Yu has developed a novel approach to dye-sensitized solar cells that increases solar-to-electrical energy conversion. Typically, DSSCs contain two planar conducting electrodes separated by a mesoporous material such as titanium dioxide, which produces a high surface area to enhance light absorption of the dyes. In the improved model, the mesoporous material separating the two planar conducting electrodes is nearly doubled in thickness by adding a second porous layer. This minimizes charge recombination and facilitates electron collection, enabling more efficient light harvesting. The result is over double the energy conversion efficiency of a typical DSSC. Bilayer thickness optimization may result in even higher energy conversion. By using an intermediate, layered mesoporous electron collection material, the total electron transporting distance is shorter and thus results in a higher total current level. This type of solar cell has a high performance to price ratio, allowing for these dye sensitive solar cells to potentially compete with fossil fuels.

Data Update

The NSF recently funded further work by this group to refine cell structure and develop novel dyes. The proposed research will lead to better understanding of the structure-property relationships in multi-layered DSSCs, and may open up new approaches for the development of novel structure motifs for high-efficiency DSSCs.

Key Document

High Efficiency Dye-Sensitized Solar Cell with Layered Structures.
U.S. regular application filed May 24, 2011.