

Graphene: New challenge for dye sensitized solar cell

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The dye sensitized solar cell (DSC) also called the Graetzel cell, is an attractive alternative to solid state photovoltaics due to high efficiency, low cost and ease of fabrication. The generic device is a photoelectrochemical DSC. Its key components are dye-sensitized TiO₂ photoanode, electrolyte solution with a redox mediator and the cathode material. The latter is typically a film of Pt nanoparticles on F-doped SnO₂ (Pt-FTO) and the former is the I₃⁻/I⁻ in aprotic electrolyte medium. Graphene nanoplatelets (GNP) in the form of optically transparent thin films on FTO are useful as cathode material to replace platinum. They exhibit good electrocatalytic activity towards I₃⁻/I⁻, particularly in electrolyte based on ionic liquids. Recent progress in the field has been highlighted by replacing the traditional I₃⁻/I⁻ mediator by Co-based redox couples with more positive redox potentials. The obvious motivation consists in enhancing the voltage of DSC. GNP exhibit high electrocatalytic activity for a mediator Co(L)₂; where L is 6-(1H-pyrazol-1-yl)-2,2'-bipyridine, and even higher activity for Co(bpy)₃^{3+/2+}. In the latter case, GNP is clearly outperforming Pt-FTO. The exchange current densities for the Co(III/II) redox reaction scaled linearly with the GNP film's optical absorbance, and they were by 1-2 orders of magnitude larger than those for the I₃⁻/I⁻ couple on the same electrode. Dye-sensitized solar cells achieved energy conversion efficiencies between 8 to 10 % for both GNP and Pt-based cathodes. However, the cell with GNP cathode is superior to that with Pt-FTO cathode particularly in fill factors and in the efficiency at higher illumination intensities.

Biography

Ladislav Kavan graduated in inorganic chemistry from the Faculty of Science, Charles University, Prague, CZ. (Ph.D. 1979, Assoc Prof. 1992, Prof. 2002, DSc. 2006). Currently, he is the head of Department of Electrochemical Materials in the J. Heyrovsky Institute of Physical Chemistry of the Academy of Sciences of the Czech Republic. He is an author of more than 200 peer-reviewed publications, 3 books, 25 book chapters and 7 patents.

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