FOXSI
Functional Oxide Surfaces and Interfaces

EINLADUNG

zum Vortrag
von

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Electrodes for Dye-Sensitized Solar Cells: A Case of Titanium Dioxide and Graphene

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Abstract:

The growing world's demand for electricity, confronted with inherent limitations of fossil and nuclear fuels, point at renewable resources to be the realistic energetic perspective for the society. Sun is unique source of renewable energy, providing the requested terawatt power in a global scale.

The dye sensitized solar cell (DSC) is an alternative to Si-based photovoltaics; it is favored by low cost and ease of fabrication. The generic device is a photoelectrochemical DSC with nanocrystalline TiO_2 photoanode, electrolyte redox mediator and a cathode. The latter is typically a film of Pt nanoparticles on F-doped SnO_2 (Pt-FTO) and the former is the I_3^-/I^- in aprotic electrolyte medium. Design of TiO_2 photoanode represents significant challenge for nanoscience. Recent progress in the field highlighted the (001)-oriented TiO_2 (anatase) nanosheet exhibiting larger open circuit voltage in DSC than the reference (101)-terminated anatase nanocrystals. The voltage enhancement is attributed to the negative shift of flatband potential for the (001)-face. The back electron transfer is significantly slower for the (001)-nanosheets compared to the same process on (101)-nanoparticles. This can be rationalized in terms of titania-surface/dye interaction.

Graphene nanoplatelets (GNP) in the form of optically transparent thin films on FTO are useful as cathode material to avoid platinum in DSC cathode. They exhibit good electrocatalytic activity towards I_3^-/I^-, particularly in electrolyte based on ionic liquids. Recently, the traditional I_3^-/I^- mediator was replaced by Co-based redox couples with more positive redox potentials. The obvious motivation consists in enhancing the voltage of DSC. This strategy allows demonstration of DSC with 12.3% efficiency, which is the current world record for solar energy conversion in DSC. GNP exhibit high electrocatalytic activity for a mediator $Co(L)_2$; where L is 6-(1*H*-pyrazol-1-yl)-2,2'-bipyridine, and even higher activity for $Co(bpy)_3^{3+/2+}$. In the latter case, GNP is clearly outperforming the performance of Pt as electrocatalyst.

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