Monash e-Research Centre

Monday 5 December 2011
Monash-Technion MURPA Seminar

Metal-oxide Photoelectrodes for Solar-induced Water Splitting: Turning Rust to Gold
Presented by Prof Avner Rothschild
(Department of Materials Engineering, Technion-Israel Institute of Technology)

Time: 5 - 6pm
Location: Room 135, Bldg 26, Clayton Campus
Visit: *https://messagelab.monash.edu.au/MURPA/TechnionMURPA*

Abstract:

Efficient conversion of solar energy to hydrogen via water photoelectrolysis is a long-standing challenge holding great promise for solar energy conversion and storage. Important advances in understanding the physics, chemistry and electrochemistry underlying water photoelectrolysis by semiconductor photoelectrodes and photocatalysts have been achieved in the last four decades since Fujishima and Honda's seminal report on photo-induced water splitting by TiO2 photoanodes. Despite these advances no system for solar hydrogen production has met the technological requirements in terms of efficiency (≥ 10% solar to hydrogen conversion efficiency), durability (≥ 5000 h) and cost (≤ 3 USD per kg of H2). Numerous semiconductors were examined, but most of them were found unstable in aqueous solutions. A small subset of semiconducting oxides including TiO2, SrTiO3, WO3 and a-Fe2O3 are stable under conditions of water photoelectrolysis. Among these oxides a-Fe2O3 is the only candidate that can potentially reach, and surpass, the 10% solar to hydrogen conversion efficiency benchmark. However, the lifetime of minority carriers in a-Fe2O3 is extremely short (< 1 ns), resulting in massive bulk recombination loss. The short lifetime of minority carriers gives rise to short diffusion length, much shorter than the absorption length in a-Fe2O3. In order to overcome the tradeoff between optical and charge collection efficiencies nanostructured architectures that decouple the optical and charge transport paths are employed.

In this talk I will present our work on semiconducting oxide photoelectrodes for water splitting, focussing on the a-Fe2O3 model system. We investigate the fundamental processes involved in the photoelectrochemical water splitting reaction using model thin film electrodes with precisely controlled microstructures and chemical compositions. Our goal is to understand the correlation between materials properties and photoelectrochemical performance and identify the limiting factors in order to overcome these limitations and achieve high performance. We explore innovative cell designs employing photon management schemes aimed at optimising the light harvesting and charge separation yields in order to enhance the solar-to-hydrogen conversion efficiency.

Biography: (Visit: *http://materials.technion.ac.il/rothschild.html* **)**

Dr. Rothschild has published 31 articles in peer-reviewed journals, one book chapter and five patents and provisional patent applications. He has presented more than 75 papers in scientific conferences, including 20 invited talks. He is a member of the editorial board of the Journal of Electroceramics (Springer), the Technion's Energy Team, and the academic board of the Israeli Center for Research Excellence on Solar Fuels. Dr. Rothschild has won several awards, among them are the Hershel Rich Innovation Award (Technion, 2011) and the Yemini Environmental Sciences Fellowship (Wolf Foundation, 2008).

Current research topics in Dr. Rothschild's group include photoelectrodes for solar-induced water splitting, epitaxial growth of complex oxide films and heterostructures for oxide electronic devices, gas sensors, and high-temperature electrolysis of CO2 and H2O to produce H2 and CO.

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