CORE-CM SEMINAR
Michigan State University — Department of Chemistry

Charge Selective Contacts in Photovoltaic and Photoelectrochemical Devices

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Abstract: Charge selective contacts are essential to the efficient operation of both solar photovoltaic and photoelectrochemical devices [1]. In solar photovoltaics, transparent electron collecting contacts (n-type) such as ITO, FTO, and AZO are widely used; however, the analogous transparent hole collectors (p-type) are considerably less developed. Transparent p-type conductors based on the CuZnS alloy family will be described. This material can be made in thin film form by pulsed laser deposition [2] and by scalable chemical bath deposition [3]. The combination of high hole conductivity (up to 1000 S cm-1) and transparency in the visible (>80%) is among the best of all reported p-type transparent materials, particularly considering those which can be deposited at close to room temperature. Heterojunction n-Si/p-CuZnS solar cells have a 1 sun open circuit voltage of 535 mV. This value compares favorably to other emerging heterojunction Si solar cells which use a low temperature process to fabricate the contact, such as single-walled carbon nanotube/Si (370−530 mV) and graphene/Si (360−552 mV) [3].

Charge selective contacts for photocathodes and photoanodes used for solar water splitting will be described. For H_2 evolving photocathodes, TiO_2 functions as an effective electron collector [4]. Developing an effective hole collector for photoanodes is more challenging, as materials stability considerations arise. It is shown that p-type transparent conducting oxides (p-TCOs) can function both as a selective hole contact and corrosion protection layer for photoanodes used in light-driven water oxidation. Using $NiCo_2O_4$ as the p-TCO and n-type Si as a prototypical light absorber, a rectifying heterojunction capable of light driven water oxidation was created. The system is stable for at least 100 hours under continuous operation and detailed corrosion analysis suggests that multi-year longevity is possible [5]. 1 sun current densities of nearly 40 mA cm^{-2} have been achieved by using atomic layer deposited $NiCo_2O_4$ on textured n-Si to maximize light absorption.

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Thursday, February 2, 2017
12:00 pm
Room 1400 – Biomedical Physical Building
Professor Rémi Beaulac – Host