Energy Harvesting & Storage

Room Naupaka Salon 5-7 - Session EH-WeM1

Surfaces and Interfaces for Solar Cells and Solar Fuels

Moderator: Svitlana Pylypenko, Colorado School of Mines

8:40am **EH-WeM1-3 Surface Recombination and Surface Passivation in Halide Perovskite Semiconductors**, ***David Ginger***, University of Washington **INVITED**

Halide perovskite semiconductors are being aggressively commercialized in solar photovoltaics, and are being explored in the lab as high-performance emitters of both classical and quantum light. While halide perovskites are often hailed as remarkably defect-tolerant semiconductors, they still possess surface defects that limit their performance, both as sources of non-radiative recombination, as well as mobile defects that contribute to mixed ionic/electronic conduction.This talk will describe our work to characterize, and passivate, surface defects in halide perovskite solar cells, beginning with the archetypal halide perovskite, methylammonium lead triiodide (MAPI), and extending to complex mixed-cation and mixed-halide perovskites currently being explored for multijunction tandem cells.We relate surface defects to specific vacancies, correlate their appearance with local strain and chemical defects, and demonstrate robust chemical passivation strategies that allow for increases in device performance and stability.

9:20am **EH-WeM1-5 Passivating Interfaces in Thin Film Photovoltaics**, ***Craig Perkins***, *D. McGott,* NREL; *E. Colegrove,* NREL, United States Minor Outlying Islands (the); *A. Hattori,* UC Santa Barbara; *M. Reese,* NREL **INVITED**

Economic considerations, climate change, and concerns over fossil fuel pollution have all contributed to the rise of solar photovoltaics (PV) as a major power source for humankind. As an example, solar PV is forecast to be ~60% of the 85 GW of new generation capacity to be added to US markets in 2022 and 2023. Although silicon-based PV currently dominates the market, this relatively mature technology is being challenged by several newer technologies based on thin films of compound semiconductors. In this talk, I will touch on some of the scientific advances that have driven down costs of PV power, giving particular emphasis to interfaces in PV cells comprised of polycrystalline thin films. Interfaces are of increasing importance in polycrystalline thin film PV devices because the quality of the bulk semiconductors has been improved to the point where minority carrier lifetimes are in many cases limited by carrier interaction with defective interfaces. This in turn limits the device power conversion efficiency (PCE). The analysis of interfaces in thin film PV devices usually presents complications not typically encountered in the study of “free” surfaces, and we review some of the methods used in our lab to characterize buried interfaces. Among these methods is a thermomechanical technique for cleaving CdTe-based solar cells at the interface between CdTe and the transparent conducting oxide located at the front of superstrate architecture cells. This buried interface is the first active junction that is formed in this technology, is one that changes throughout several high temperature processing steps, and its study remains an active research area even after decades of work. We show how combining thermomechanical cleaving with electron spectroscopy can tease out the details of structure, electronic properties, and passivation mechanisms in CdTe. We highlight a common structural feature found in several very different well-passivated PV materials including CdTe, the halide perovskites, and Cu(In,Ga)Se2. I will also describe a recently developed method for room temperature temporary passivation of CdTe thin film surfaces. This passivation strategy, adopted from silicon PV, allows us to measure properties of as-grown absorbers, unlike the previous best known method involving alumina deposition and high temperature processing, both of which affect a film’s bulk properties. Finally, I will review a number of ongoing challenges faced by researchers interested in characterizing interfaces of energy materials with electron spectroscopic methods.

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