MSE 520: SEMINAR SERIES

MATERIALS SCIENCE & ENGINEERING | WINTER 2018

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Towards Printable High-Efficiency Tandem Photovoltaics with a Chalcogenide Bottom Cell and Hybrid Perovskite Top Cell

The cost of photovoltaics has dropped dramatically over the past decade. However, the large capital cost of photovoltaic manufacturing significantly inhibits the growth rate of the sector and is much higher than the capital cost of power generation with natural gas. By developing new chemistry and processing routes that enable solar cells to be printed with roll-to-roll processing, the capital cost of solar energy could be significantly reduced (resulting in even further decreased cost of electricity from photovoltaics). Over the past decade, we have developed new ink-based routes to chalcopyrites (CuInGaSe2 or CIGS), Earth abundant element kesterites (Cu2ZnSnSe4 or CZTS), and most recently, hybrid perovskites such as CH3NH3PbI3. Our most recent efforts are aimed at the development of printable tandem solar cells that utilize low-bandgap chalcopyrites or kesterites for the bottom cell and high-bandgap hybrid perovskites for the top cell. The presentation will include introductions to and discussions of fundamental optoelectronic processes in photovoltaic materials, our development of new photoluminescence characterization methods, materials chemistry and ink formulation, doping and alloying (particularly in CZTS), grain growth and elemental transport (in CIGS and CZTS), stability and processing (for high bandgap hybrid perovskites), and single junction and tandem photovoltaic device performance.

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Hugh Hillhouse is currently the Rehnberg Chair Professor of Chemical Engineering at the University of Washington. He obtained his Ph.D. in Chemical Engineering from the University of Massachussetts in 2000. Prior to becoming a Professor at the University of Washington, he was an Associate Professor at Purdue Univeristy. At the UW, Hillhouse's research lies at the nexus of nanomaterials and energy conversion. Within the realm of molecular and nanoscale science many new molecules, nanocrystals, electronic materials, and device architectures can be envisioned that may be able to address our current energy harvesting, utilization, and storage challenges. However, the scientific understanding of the chemistry and fundamental processes involved and the engineering necessary to develop economic and sustainable solutions is still in its infancy. Research efforts within the group span the range from fundamental studies of molecular precursor chemistry, nanocrystal nucleation and growth, and materials defect chemistry to device fabrication, characterization, and modeling of solar cells and fuel cells to system-level analyses of the life-cycle and impact of potential new technologies. This system-level approach is used to identify opportunities, avoid unforeseen consequences (like indirect market effects and environmental issues), and enlighten the molecular and nanoscale approaches we develop.

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