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4:00pm Tech L211

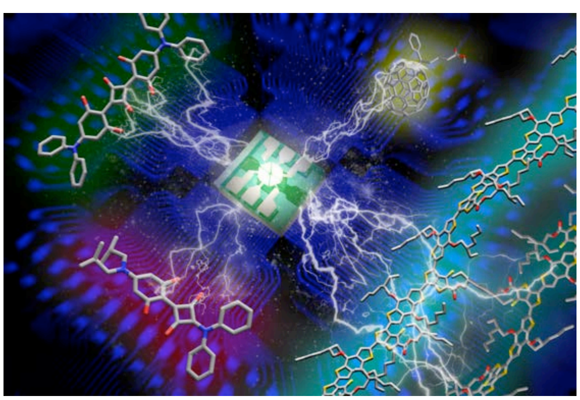
Challenging Nanostructured Materials for Advanced Energy Devices

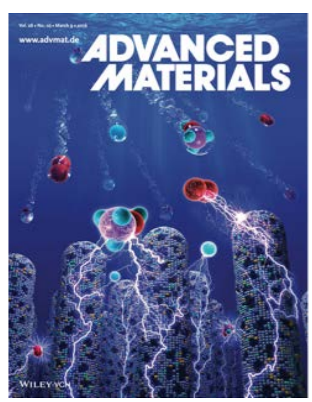
Abstract: One of the key challenges facing the widespread use and commercialization of promising energy devices (i.e. fuel cells, batteries, organic solar cells etc.) is the high cost of the electrocatalytic and electrolyte materials and inefficiencies in their assembly and utilization. In this talk, I will present three examples of how we are designing nanomaterials such as graphene-based carbons, MXenes, and bulk metallic glass (BMG) alloys that can be incorporated into new architectures for high performance nanostructured-enabled energy devices.

1) *Transparent Electronics*. We have developed a fully automated Spin Spray Layer by Layer assembly system with sub-second deposition cycle times allowing nano-level control over film growth with a demonstration of transparent (invisible) battery electrodes. Techniques for developing freestanding multifunctional single-walled nanotube (SWNT) and MXene composite thin films for solar cell transparent conductive electrodes will also be described.

2) *Electrocatalysts.* I will describe a new class of materials, $Pt_{58}Cu_{15}Ni_{5}P_{22}$ bulk metallic glass that can circumvent Pt-based anode poisoning and agglomeration/dissolution typically associated with supported catalysts during long-term operation in fuel cells. By using subtractive (dealloying) and additive (galvanic replacement) techniques we can push these materials into new directions beyond their glass formability. These amorphous metal alloys can serve as an interesting platform for next-generation catalysts and devices such as the first all bulk metallic glass micro fuel cell.

3) *New Device Architectures*. Our development of a mesoporous catalytic membrane for $Li\text{-}O_2$ batteries recently led us to the recent development of vampire batteries that use heme molecules as a redox mediator. We will also describe our latest efforts on Förster resonance energy (FRET) based solar cells with a single junction power conversion efficiency >10% for a polymer based solar cell.





Bio: Prof. André D. Taylor is an Associate Professor and leads the Transformative Materials and Devices Group in the Chemical and Environmental Engineering Department at Yale University. He specializes in the synthesis and arrangement of nanomaterials in devices such as fuel cells, lithium ion batteries, and solar cells. He received all three degrees in chemical engineering with a BS from the Missouri University of Science and Technology, an MS from Georgia Institute of Technology, and a PhD from the University of Michigan. While in graduate school Dr. Taylor was a Sloan Fellow, NSF-Rackham Merit Fellow, Eastman Kodak Fellow, and GEM (MS and PhD) Fellow. He worked as a research engineer for DuPont's Engineering Polymers division and Intellectual Asset Management Group and was a research faculty scientist in the chemical engineering department at the University of Michigan. Dr. Taylor has developed CMOS compatible micro fuel cells (with integrated heaters and temperature sensors) and a method of patterning ITO substrates for both flat and non-planar surfaces for optoelectronic devices (Artificial Eye Project). Dr. Taylor has given several invited lectures at the local, national, and international levels. He has several patents and archival publications related to his research. He is an NSF CAREER award recipient and a Presidential Early Career Award in Science and Engineering (PECASE) recipient. In 2015, Dr. Taylor was a Dr. Martin Luther King Jr. Visiting Associate Professor at MIT. See website above for publication links and recent press releases from his lab.