Solution Processing of High-Performance Solar Cells: Opportunities & Technological Challenges

Professor David Mitzi
Duke University

While ever expanding worldwide energy demand necessitates a broad portfolio of energy options, the progressive drop in cost and ubiquitous carbon-free "fuel" for photovoltaic (PV) technologies suggests that this pathway will play a vital role in this mix. This talk addresses several particularly promising thin-film PV technologies based on Cu-In-Ga-S-Se (CIGS), Cu-Zn-Sn-S-Se (CZTS) and related chalcogenide absorbers and a relatively simple liquid-based film deposition process that enables the fabrication of high-performance absorber layers, with resulting device sunlight-to-electricity power conversion efficiencies of as high as 15%. Key focal points include developing appropriate solution/precursor chemistries, and film deposition and defect engineering approaches. For the relatively new CZTS system, the combination of progressively higher record efficiency, earth abundant starting materials, and lower-cost solution-based processing opens opportunities for development of a potentially pervasive PV technology. In addition, metal-halide perovskite compounds, offering near-ambient temperature solution processing, a high degree of chemical tunability and unprecedented improvement in efficiency to the 20+% level over only a few short years of development, will also be discussed. The three technologies (CIGS, CZTS and perovskites) provide outstanding examples of how solution-based processing may, not only lead to a pathway for low cost PV, but also to performance levels that rival and even beat vacuum-based deposition, which is crucial for these technologies to have market penetration.

David Mitzi is currently the Simon Family Professor of Engineering at Duke University with appointments to the Department of Mechanical Engineering and Materials Science and the Department of Chemistry. He received his B.S. in Electrical Engineering and Engineering Physics from Princeton University in 1985 and his Ph.D. in Applied Physics from Stanford University in 1990. Prior to joining the faculty at Duke in 2014, Dr. Mitzi spent 23 years at IBM’s T.J. Watson Research Center, focusing on the search for and application of new electronic materials, including organic-inorganic hybrids and inorganic materials for photovoltaic, LED, transistor and memory applications. During his final five years at IBM, he served as manager for the Photovoltaic Science and Technology Department, where he initiated and managed a multi-company program to develop a solution-based approach to deposit thin-film chalcogenide-based absorber layers for high-efficiency solar cells. Dr. Mitzi holds a number of patents, and has authored or coauthored more than 190 papers and book chapters.

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IMNI@BROWN.EDU • PHONE: 401.863.1386 • FAX: 401.863.1387