HIGHLANDS IN CHEMISTRY SEMINAR SERIES

MARCH 1, 2024

2:30PM

HAHN HALL NORTH 140

FACULTY HOST:
LINA QUAN

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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

“Vapor-phase synthesis of energy-harvesting materials: From water splitting silicon nanowires to solar absorbing hybrid perovskites”

The vapor-phase provides a unique capacity to encode precise composition and morphology in nanostructured and thin-film semiconductor materials for energy-harvesting functionality. Here, we highlight recent developments in the vapor-phase synthetic control of silicon nanowires and hybrid perovskite materials, providing platforms to design nano- or micro-structured systems encoded for applications ranging from electron ratchets to solar water splitting and photovoltaics. First, we show how geometrical asymmetry in a silicon nanowire can be used to control the flow of electrons due to the quasi-ballistic motion of electrons, inducing an electron ratchet effect that permits rectification into the THz regime. Second, we show how abrupt transitions between p-type, intrinsic, and n-type silicon allow nanowire p-i-n superlattices to be synthesized that behave as multijunction photovoltaic devices. By tuning the number of junctions, photovoltages in excess of 10 V can be generated from single nanostructures. Using spatio-selective photoelectrochemical deposition of hydrogen and oxygen-evolving co-catalysts, water splitting particle suspensions are demonstrated. Finally, we demonstrate the first metal organic chemical vapor deposition (MOCVD) growth of methylammonium lead iodide (MAPbI3). Using separate vapor precursors for the lead, organic, and halide components allows tuning of reaction conditions to grow the material directly from the vapor phase with high purity. Overall, the projects highlight the precise and tunable control of material composition, morphology, and functionality provided by the vapor phase.

Bio

Prof. Jim Cahoon received his bachelor’s degree in Chemistry and Philosophy from the College of William and Mary in 2003 and then moved to the University of California-Berkeley to pursue a PhD in Physical Chemistry, studying the femtosecond light-driven reactions of molecules in solution with Prof. Charles Harris. In 2009, he moved to Harvard University for a post-doctoral fellowship with Prof. Charles Lieber, where he worked to develop nanostructured photovoltaic devices. In 2011, Jim started his faculty career in the Department of Chemistry at UNC Chapel Hill, being promoted to Associate Professor in 2017 and Professor in 2022. He has received awards including a Packard Fellowship for Science and Engineering, Sloan Research Fellowship, Cottrell Scholar Award, and UNC Phillip and Ruth Hettleman Prize for Artistic and Scholarly Achievement. He currently serves as the Executive Director of Research Core Facilities for the College of Arts and Science, UNC site director of the Research Triangle Nanotechnology Network, and thrust leader for the DOE Center for Hybrid Approaches in Solar Energy to Liquid Fuels.

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