

Directing Assembly of Organic Electronics Inspired by Living Systems

Ying Diao, University of Illinois at Urbana-Champaign

November 7, 2019 | 11am - 12:00pm

Pettit Microelectronics Building 102 A&B

Abstract: Directed assembly, crystallization and microphase separation have played a central role in the development of modern electronics and energy materials. Recent years, printed electronics based on semiconducting molecular systems have emerged as a new technology platform that promise to revolutionize the electronics, clean energy and medical industry. In contrast to traditional electronic manufacturing that requires high temperature and high vacuum, these new electronic materials can be solution printed at near ambient conditions to produce flexible, light-weight, biointegrated forms at low-cost and high-throughput. However, it remains a central challenge to control the morphology of semiconducting molecular systems across length scales. The significance of this challenge lies in the order of magnitude modulations in device performance by morphology parameters across all length scales.

This challenge arises from the fact that directed assembly approaches designed for conventional hard materials are far less effective for soft matters that exhibit high conformational complexity and weak, non-specific intermolecular interactions. On the other hand, biological systems have evolved to assemble complex molecular structures highly efficiently. We are eager to transfer the wisdom of living systems to developing printed electronics technologies as to enable next generation electronics for clean energy and healthcare. In this talk, we present new insights and strategies we recently developed for controlling multi-scale assembly and transformation of semiconducting molecules. We learned from living systems and designed bioinspired assembly processes, allowing molecules to put themselves together cooperatively into highly ordered structures otherwise not possible with significantly improved electronic properties. We discovered molecular design rules that impart dynamic and switchable electronic properties through the mechanism of molecular cooperativity – a mechanism ubiquitous in nature. These new solid-state properties could potentially enable new sensing and actuation mechanisms not possible before. We further developed 2D and 3D printing process to realize on-the-fly morphology control down to the molecular and nanoscale.

Bio: Professor Diao is a Beckman Fellow, Dow Chemical Company Faculty Scholar and Assistant Professor at University of Illinois at Urbana-Champaign. She received her Ph.D. degree in Chemical Engineering from MIT in 2012. Her doctoral thesis was on understanding heterogeneous nucleation of pharmaceuticals by designing polymeric substrates. In her subsequent postdoctoral training with Prof. Zhenan Bao at Stanford University, she pursued research in the thriving field of printed electronics. Diao group, started in January 2015 at Illinois, focuses on bioinspired assembly of organic functional materials and printing approaches that enable structural control down to the molecular and nanoscale. Her work has been frequently featured in scientific journals and news media such as the Science Magazine and Nature Materials. She is named to the MIT Technology Review's annual list of Innovators Under 35 as a pioneer in nanotechnology and materials. She is also a recipient of NSF CAREER Award, 3M Non-Tenured Faculty Award and was selected as a Sloan Research Fellow in Chemistry as one of the "very best scientific minds working today". She serves as an editor for an ACS.