Spring 2017 Joint Colloquium
Materials Department & Materials Research Laboratory

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How chain properties affect the optoelectronic properties of conjugated polymers

Polymers may play an important role in various emerging optoelectronic applications because they can combine the chemical versatility of organic molecules and the flexibility, stretchability and toughness of polymers with dielectric or semiconducting properties. Nevertheless, in order to achieve the full potential of polymers for electronic applications, a clear description of how their structure, morphology, and macroscopic properties are interrelated is needed. We propose that the starting point for understanding conjugated polymers includes a description of chain conformations and phase behavior; unfortunately, further efforts to measure these crucial parameters are needed. Predictions and measurements of the persistence length of various conjugated polymers have significantly refined our intuition of the chain stiffness, and have led to predictions of the nematic coupling parameter and nematic-to-isotropic transitions. We show that the consequence of stiff backbones is a ubiquitous alignment layer near interfaces. Rheological measurements have led to refined estimates of the entanglement molecular weight and the glass transition temperature of both poly(3-alkylthiophenes) and push-pull copolymers, leading to new ways of thinking about how crystallites are interconnected within semicrystalline structures. Current efforts continue to refine our knowledge of chain conformations and phase behavior and the factors that influence these properties, thereby enabling the prediction of novel optoelectronic materials based on conjugated polymers. For example, more complex architectures, such as fully conjugated block copolymers, provide opportunities to control the microstructure of the active layer of electronic devices and therefore enhance electrical performance.

Bio

Enrique D. Gomez received his B.S. in Chemical Engineering from the University of Florida in 2002 and his Ph.D. in Chemical Engineering from the University of California, Berkeley in 2007. After a year and a half as a postdoctoral research associate at Princeton University with Lynn Loo, he joined the faculty at the Chemical Engineering Department of the Pennsylvania State University in August of 2009. Enrique's research focus is on understanding how structure at various length scales affects macroscopic properties of soft condensed matter. In particular, the current emphasis of his research group is on the relationship between microstructure and electrical properties in the active layers of organic thin film transistors and photovoltaics. Enrique has received multiple awards, including a Visiting Scientist Fellowship from the National Center for Electron Microscopy, the Ralph E. Powe Junior Faculty Award by the Oak Ridge Associated Universities, the NSF CAREER Award, the Rustum and Della Roy Innovation in Materials Research Award, and the Penn State Engineering Alumni Society Outstanding Research Award.

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