BIRCK Nanotechnology Center

PURDUE UNIVERSITY
Discovery Park

Designing Semiconducting Polymers for Advanced Energy Applications

September 28, 2011
Birck 1001
1:00-2:00PM

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Brief Bio: Bryan Boudouris received a B.S. in Chemical Engineering in May 2004 from the University of Illinois at Urbana-Champaign with high distinction, and his Ph.D. in Chemical Engineering in August 2009 from the University of Minnesota. His thesis was titled, "Polythiophene-containing Block Copolymers for Organic Photovoltaic Applications". After graduation he obtained a dual appointment as a postdoctoral fellow at the University of California, Berkeley and Lawrence Berkeley National Laboratory. During this time he continued his work regarding structure-transport property relationships in semiconducting polymers and graphene. In August 2011, he started the Polymers for Optoelectronic and Widespread Energy Research Laboratory (POWER Lab) at Purdue University. His current research interests focus on the development of designer polymers for energy and biopharmaceutical separations end usages. Specifically, his group is targeting applications that involve solar energy conversion, energy storage, flexible memory media, and membranes for therapeutic protein purification.

Brief Abstract: Organic photovoltaic (OPV) devices are of great interest due to their promise of providing flexible, lightweight, and inexpensive alternatives to their currently-used inorganic counterparts. However, large-scale implementation of these modules has been hampered due to their relatively low power conversion efficiencies (PCE ~5%). Because the charge generation, separation, and collection processes in plastic solar cells occur on the nanoscale, the microstructure of an OPV active layer is of great importance to device performance. To date, this active layer morphology generally is formed through a series of well-refined coating and post-processing conditions that leads to a kinetically-trapped thin film and, as such, one that must be varied for each new active layer material. Diblock copolymers, on the other hand, are well-known to microphase separate into thermodynamically-stable microstructures with domain spacings on the order of ~10 nm. I will discuss how the systematic design of conjugated block copolymers has allowed for nanoscale self-assembly of well-ordered semiconducting morphologies that will be of great utility in functional plastic solar cells. Specifically, systems based on poly(3-alkylthiophenes) (P3ATs) will be addressed. P3ATs are used commonly as active layer components in plastic electronic devices due to their relatively high hole mobilities, low optical bandgap, and their ability to be processed from solution. To date, block copolymers containing P3ATs as a functional moiety predominantly have shown nanofibrillar morphologies identical to that of the P3AT homopolymer due to the large thermodynamic driving force for crystallization when cast from solution. However, I will show that the P3AT rod-rod interactions can be controlled by rational polythiophene side chain design. The ability to pattern these optoelectronically-active polymers into useful morphologies with nanoscopic precision over large areas offers a clear pathway for the advanced design and commercialization of plastic solar cells.

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