Outstanding Young Investigator

Talk Presentation: Nanostructured Polymer-Titania Solar Cells

Michael McGehee
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The Outstanding Young Investigator Award has been established to recognize outstanding interdisciplinary materials research by a young scientist or engineer. This award was presented to Michael McGehee of Stanford University for his innovation in the application of organic semiconductors in lasers, light-emitting diodes, transistors, and solar cells.

Michael McGehee graduated from Princeton University with a degree in physics (1994) after researching mesostructure self assembly with Sol Gruner and Ilhan Aksay. He received a PhD (1999) from the University of California-Santa Barbara for his research with Alan Heeger on the use of semiconducting conjugated polymers as materials for lasers and light-emitting diodes. After graduating, he studied the co-assembly of block-copolymer/metal-oxide nanostructures in the research groups of Galen Stucky and Brad Chmelka. In the spring of 2000, he joined the faculty of Stanford University's Materials Science and Engineering Department. McGehee won the MRS Graduate Student Gold Medal Award (1999), a Dupont Young Professor Award (2001), and an NSF CAREER Award (2001). He was a Gilbreth Lecturer at the National Academy of Engineering's 2006 Annual Meeting.

At Stanford, McGehee has led a group of students who make ordered organic-inorganic bulk heterojunction solar cells, studying the electronic processes that occur in them. His group also studied the effects of molecular packing on charge transport in polymer field-effect transistors, and developed methods for improving light extraction from polymer light-emitting diodes. He teaches classes on nanotechnology, polymer science, organic electronics, and solar cells.

Abstract

Well-ordered bulk heterojunction solar cells can be made by filling nanoporous films of titania with semiconducting polymers. The nanoporous films are made by self-assembling with block copolymer structure directing agents or with nanoimprint lithography. Since the pore diameters of our best films are still larger than the exciton diffusion length of most polymers, we have explored ways to enhance exciton transport. One is to use resonance energy transfer from a donor to an acceptor with a slightly smaller energy gap. We showed an example where the effective diffusion length and consequently the efficiency of the photovoltaic cell is enhanced by a factor of three. We also discussed the effect that modifying the titania surface with benzoic acids has on electron transfer, the current and voltage of the solar cells.