

Nanostructures in Organic Semiconductors and the Energy Challenge

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Abstract

According to a recent report by the Department of Energy, “world demand for energy is projected to more than double by 2050 and to more than triple by the end of the century.” Thus, the development of alternative energy sources is now recognized by government, society and the global community as an urgent need. Sunlight is the most abundant source of energy on Earth and, if harvested efficiently and economically, can address the energy demands in the future. Organic solar cells potentially offer a low cost, large area, flexible, light-weight, clean, and quiet alternative energy source for indoor and outdoor applications. However, power conversion efficiencies and operational lifetimes of these devices are still low for use in any practical application. Our research in this area focuses on controlling material processing conditions and designing/synthesizing materials having a broad absorption spectrum and high charge carrier mobility. In parallel with materials synthesis and processing, we have developed characterization techniques to probe film morphology, to image the donor-acceptor networks laterally and vertically, to assign phase domains to the donor and the acceptor components, and to study nanoscale charge transport in polymer solar cells. Another problem related to energy issue addressed in our group is to understand and control the charge injection mechanism in organic light emitting diodes, which find applications in lighting and display technologies. The ability to control the charge injection leads to devices that operate at lower bias and are therefore more power efficient. From an overall perspective, these studies tackle fundamental critical problems associated with emerging organic semiconductor based technologies that generate energy and that contribute to energy conservation.

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