NWS08-2008-000115

Abstract for an Invited Paper
for the NWS08 Meeting of
the American Physical Society

Organic (opto)electronic materials: understanding charge carrier dynamics[1]

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There is growing interest in using organic (opto)electronic materials for applications in electronics and photonics. In particular, organic semiconductor thin films offer several advantages over traditional silicon technology, including low-cost processing, the potential for large-area flexible devices, high-efficiency light emission, and widely tunable properties through functionalization of the molecules. Over the past decade, remarkable progress in materials design and purification has been made, which led to applications of organic semiconductors in light-emitting diodes, polymer lasers, photovoltaic cells, high-speed photodetectors, organic thin-film transistors, and many others. Most of the applications envisioned for organic semiconductors rely on their conductive or photoconductive properties. However, despite remarkable progress in organic electronics and photonics, the nature of charge carrier photogeneration and transport in organic semiconductors is not completely understood and remains controversial, partly due to difficulties in assessing intrinsic properties that are often masked by impurities, grain boundaries, etc. Measurements of charge carrier dynamics at picosecond time scales after excitation reveal the intrinsic nature of mobile charge carriers before they are trapped at defect sites. In this presentation, I will review the current state of the field and summarize our recent results on photoconductivity of novel high-performance organic semiconductors (such as functionalized pentacene and anthradithiophene thin films) from picoseconds to seconds after photoexcitation. Photoluminescent properties of these novel materials will also be discussed.

[1]Support from NSF(CAREER), ONAMI, ONR, AFOSR and PRF is gratefully acknowledged.