Abstract Submitted
for the MAR16 Meeting of
The American Physical Society

Lifetime, Mobility, and Diffusion of Photoexcited Carriers in Ligand-Exchanged PbSe Nanocrystal Films Measured by Time-Resolved Terahertz Spectroscopy[1] SIMING LI, GLENN GUGLIETTA, Drexel University, YAOTING WU, NATALIE GOGOTSI, CHRISTOPHER MURRAY, University of Pennsylvania, JASON BAXTER, Drexel University — Colloidal semiconductor nanocrystals have been used as building blocks for electronic and optoelectronic devices ranging from field effect transistors to solar cells. Properties of the nanocrystal films depend sensitively on the choice of capping ligand to replace the insulating synthesis ligands. Thus far, ligands leading to the best performance in transistors result in poor solar cell performance, and vice versa. To understand this dichotomy, we used time-resolved terahertz spectroscopy to study the mobility and lifetime of PbSe nanocrystal films with five common ligand-exchange reagents. The films treated with different displacing ligands show more than an order of magnitude difference in the peak conductivities and a bifurcation of time-dynamics. Inorganic chalcogenide ligand-exchanges with Na_2S or NH_4SCN show high mobilities but nearly complete decay of transient photocurrent in 1.4 ns. In contrast, ligand exchanges with EDA, EDT, and TBAI show lower mobilities but longer lifetimes, resulting in longer diffusion lengths. This bifurcated behavior may explain the divergent performance of field-effect transistors and photovoltaics constructed from nanocrystal building blocks with different ligand exchanges. Ref: Guglietta et al., ACS Nano, 2015.

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Date submitted: 06 Nov 2015 Electronic form version 1.4