Paul D. Cunningham,
4th year graduate student, University of Maryland, Baltimore County
Advisor: Dr. L. Michael Hayden

Charge transport in organic materials:

Organics present a low-cost alternative to inorganic materials for photovoltaic, light-emitting diode, and opto-electronic applications with the benefits of easy fabrication and tunable properties. Despite a wealth of research and commercially available devices, fundamental properties such as primary photogenerated products, photo-induced charge generation and subsequent charge transport are not yet fully understood. These intrinsic properties are further convoluted by their dependence on morphology and processing conditions. Systematic studies are necessary to elucidate the nature of these properties that impact device performance.

Time-resolved THz studies:

Terahertz radiation, which lies in the far-infrared, corresponds to collective oscillations in crystals and organic molecules. This characteristic combined with its low, non-ionizing, energy makes THz spectroscopy well suited for security, biomedical, and other spectroscopic applications. Time-resolved THz studies are a special case of ultrafast pump-probe spectroscopy, where the THz low energy probe does not perturb the system. Coherent methods, such as the electro-optic effect, allow for the detection of THz electric field transients. The fact that the inverse of carrier scattering times correspond to THz frequencies makes THz radiation well suited for studying the evolution of the dielectric properties of a material after excitation. Such studies can aid in determining how charge generation and transport in nanocrystalline materials differ from their bulk counterparts, examining quasi-particle dynamics in superconductors, exploring multi-exciton generation in quantum confined structures, and elucidating charge generation and transport in organic crystals and polymers.