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Probing the origins of temperature dependence of charge transport in organic single crystal transistors

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250 word abstract:

Low temperature transport measurements of classical semiconductors are a well-defined method to determine the physics of transport behavior. These measurements are also used to evaluate organic semiconductors, though physical interpretation is not yet fully developed. The similar energy ranges of the various processes involved in charge transport in organic semiconductors, including excitonic coupling, charge-phonon coupling, and trap distributions, result in ambiguity in the interpretation of temperature dependent electrical measurements. The wide variety of organic semiconductors, ranging from well-ordered small molecule crystals to disordered polymers, manifest varying degrees of “ideal” device behavior and require intensive studies in order to capture the full range of physical mechanisms involved in electronic transport in this class of materials. In addition, the physics at electrical contacts and dielectric material interfaces strongly affect device characteristics and results in temperature dependent behavior that is unrelated to the semiconductor itself. In light of these complications, our group is working toward understanding the origins of temperature dependent transport in single crystal, small molecule organic semiconductors with ordered packing. In order to disentangle competing physical effects on device characterization at low temperature, we use TEM and Raman spectroscopy to track changes in the structure and thermal molecular motion, correlated with density functional theory calculations. We perform electrical characterization, including DC current-voltage, AC impedance, and displacement current measurements, on transistors built with a variety of contact and dielectric materials in order to fully understand the origin of the transport behavior. Results of tetracene on silicon dioxide and Cytop dielectrics will be discussed.

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Low temperature transport measurements are used to evaluate organic semiconductors, though physical interpretation is not yet fully developed. Our group is working toward understanding the origins of temperature dependent transport in single crystal organic semiconductors. In order to disentangle competing physical effects on device characterization, we use TEM and Raman spectroscopy to track

changes in the structure and thermal molecular motion with temperature, correlated with density functional theory calculations. We measure DC and AC electrical response on transistors built with a variety of contact and dielectric materials. Results of tetracene on silicon dioxide and Cytop dielectrics will be discussed.