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Charge transport physics of single crystal organic semiconductors

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Determining the physics of charge transport in organic semiconductors has proven to be a difficult endeavor. The similar energy ranges of the many processes involved in charge transport, including excitonic coupling, charge-phonon coupling, and trap state distributions, result in ambiguity in the interpretation of temperature dependent electrical measurements. In addition, energetic mismatches at electrical interfaces and unique geometries of devices used for measurement often impact the final device characteristics more strongly than the intrinsic transport of the semiconductor. 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 in single crystal tetracene, correlated with calculation. We then perform careful DC and AC electrical characterization of single crystal tetracene devices built with a variety of contacting materials in order to fully understand the origin of resulting electrical characteristics.