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High quality crystalline pentacene and rubrene FETs

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Molecular organic materials offer the promise of novel electronic devices but also present challenges for understanding charge transport in narrow band systems. We find that one of the most important intermolecular transport FET parameters, the effective channel mobility, is parameterized by two factors: (1) the degree of carrier trapping in localized DOS band-tail states, which are higher in concentration for FET structures than for bulk crystal, and (2) the free-carrier mobility, μ_0. Our analysis shows crystalline devices possess μ_0 $\sim$70 cm^2/Vs, significantly greater than polycrystalline thin film devices where free-carrier mobility μ_0 $\sim$1 cm^2/Vs. Low temperature studies elucidate fundamental transport processes. We report the lowest temperature field effect transport results on a crystalline oligomeric organic material, rubrene. Gated transport shows a factor of $\sim$10 suppression of the thermal activation energy in 10-50 K range and nearly temperature independent resistivity below 10 K. Other examples of 2 dimensional charge carrier transport will also be discussed.

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