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Gate Voltage Dependent Resistance across Interspherulite Boundaries in Solution-Processed Organic Semiconductor Thin Films

ANNA HAILEY, Department of Chemical and Biological Engineering, Princeton University, MARCIA PAYNE, JOHN ANTHONY, Department of Chemistry, University of Kentucky, YUEH-LIN LOO, Department of Chemical and Biological Engineering, Princeton University — Grain boundaries formed by impinging spherulites in solution-processed organic semiconductor thin films limit charge transport in organic field-effect transistors that comprise these polycrystalline active layers. Thin films of triethylsilylethynyl anthradithiophene (TES ADT) exhibit limited order upon spin-coating; subsequent exposure to 1,2-dichloroethane vapor induces growth of TES ADT spherulites, with a mixture of low-angle (LA) and high-angle (HA) interspherulite boundaries (ISBs) defining neighboring spherulites. Our ability to control the directionality of TES ADT growth allows us to prescribe the formation of ISBs, forming exclusively LA [$0\pm20°$] and HA ISBs [$90\pm20°$] over macroscopic distances. Gated four-point probe transistor measurements allow us to quantify differences in resistance within spherulites and across these LA and HA ISBs as the devices are switched from "off" to "on" states. Surprisingly, for devices in the "on" state, the gate-independent resistances across LA [6 ± 3MΩ] and HA ISBs [16 ± 6MΩ] remain quantitatively different from that within an individual spherulite [1.9 ± 0.7MΩ], suggesting that the angle of mismatch of the ISB continues to affect charge transport, even after all traps are filled.

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