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Electrostatic Injection of Very Large 2D Charge Carrier Densities to Obtain Metallic Conductivities in Organic Semiconductors MATTHEW PANZER, C. DANIEL FRISBIE, University of Minnesota — The traditional choice of SiO_2 for the gate dielectric material in organic field-effect transistors (OFETs) limits the amount of charge that one can induce via the field effect due to its relatively weak dielectric strength. In fact, the maximum 2D charge density achievable (near SiO_2 breakdown, typically >100 V applied) is only $\sim 10^{13}$ charges/cm^2, while the 2D molecular packing density of many common organic semiconductors is on the order of 5×10^{14} molecules/cm^2. In order to achieve a higher fraction of charged semiconductor molecules in the 2D OFET channel, a dielectric layer with a higher capacitance is required. We have used a solid polymer electrolyte as an OFET dielectric in order to obtain 2D charge densities exceeding 10^{14} charges/cm2 at operating voltages under 3 V in a variety of organic semiconductors. We have observed metallic conductivity values ($\sim$1000 S/cm) and nearly temperature-independent resistance ratios in poly(3-hexylthiophene) films using a polymer electrolyte-gated OFET. In addition, conductivity maxima at carrier densities approaching 1 charge/molecule were observed in oligomeric, polymeric, and single-crystal organic semiconductors alike. This phenomenon may be caused by carrier correlations or a complete emptying of the semiconductor transport band at very high charge densities.

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