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The trap DOS in small molecule organic semiconductors: A quantitative comparison of thin-film transistors with single crystals
WOLFGANG KALB, SIMON HAAS, KURT PERNSTICH, THOMAS MATHIS, BERTRAM BATLOGG, Laboratory for Solid State Physics, ETH Zurich, Switzerland — Our study shows that it is possible to reach one of the ultimate goals of organic electronics: organic field-effect transistors can be produced with trap densities as low as in the bulk of single crystals. Several analytical methods to calculate the spectral density of localized states in the band gap (trap DOS) from measured data were used to clarify, if the different methods lead to similar results. We then compared quantitatively trap DOS information from the literature, correcting for differences due to different calculation methods. In the bulk of single crystals the trap DOS is lower by several orders of magnitude than in thin films. The compilation of all data strongly suggests that structural defects at grain boundaries are the main cause of "fast" traps in TFT's made with vacuum-evaporated pentacene. For high-performance transistors made with small molecule semiconductors such as rubrene it is essential to reduce the dipolar disorder caused by water adsorbed on the gate dielectric. We will discuss to what degree band broadening due to the thermal fluctuations of the intermolecular transfer integral is reflected in the trap DOS very close (<0.15 eV) to the mobility edge.

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