Electronic Structure of Semiconducting Polymer Field Effect Transistors with Mobility ≥ 100 $cm^{2/}$ V-s

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As a result of the quasi-one-dimensional transport pathways of charge carriers along the backbone, charge transport in polymer semiconductors is limited by their nanomorphology. Structural disorder, arising from the high degree of conformational freedom of polymer chains (causing chain folding, torsion, and structural defects) lead to electronic localization. Thus, highly aligned polymer packing with minimized structural disorder is needed for achieving high mobility in conjugated polymers. Our recent progress toward this goal using nanogrooved substrates to obtain chain alignment of PCDTPT and its fluorinated derivative (see below for structures) has enabled a study of the electronic structure (band structure and density of states) using Angle Resolved Photoemission Spectroscopy (ARPES). The ARPES results reveal a quasi-one-dimensional electronic structure with band effective mass of m* =0.1 me. This small value of m*, implies the possibility of achieving high mobility transport ($\mu=e\tau/m^*$). We have demonstrated FETs with mobilities in excess of 100 cm2/Vs. The aligned polymer thin films exhibited strong anisotropy, showing more than 10-fold higher mobility for transport along the oriented chain direction (parallel to the nanogrooves).