New Molecular and Polymeric Materials and Fabrication Methodologies for Flexible Organic Transistors

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The general design and synthesis of new oligothiophenes and arenes functionalized with a variety of phenacyl, alkylcarbonyl, and perfluoroalkylcarbonyl is presented. These organic semiconductors exhibit low-lying LUMOs allowing efficient electron injection/transport. Organic field-effect transistors (OFETs) fabricated by conventional methods exhibit electron mobilities as high as 2 cm^2 V^-1 s^-1 for vapor-deposited films and 0.25 cm^2 V^-1 s^-1 for solution-cast films with current modulation > 10^8.

Furthermore, these materials are compatible with new classes of nanoscopic layer-by-layer self-assembled multilayers (SAMT) and crosslinked polymeric blend (CPB) gate dielectrics developed in our group. These dielectric materials are fabricated conveniently via solution-phase methodologies at very low temperature (< 110 °C) and exhibit very low leakage currents (< 10^-8 A cm^-2), high breakdown fields (> 3 MV cm^-1), very high capacitance values (up to 2500 nF cm^-2) and are fully compatible with both electron- and hole-transporting organic (and inorganic) semiconductors. OFETs and complementary inverter devices operating at very low voltages have been fabricated. Finally, a new methodology for device fabrication is presented.