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Organic Semiconductors and Nanodielectrics for Flexible, Low Voltage Thin-Film Transistors

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Molecular materials scientists are skilled at designing and constructing individual molecules with the goal of imbuing them with predetermined chemical and physical properties. However, the subsequent task of rationally assembling them into organized, functional supramolecular architectures with precise, nanometer-level control of bulk opt-electronic properties presents another level of challenge. In this lecture, synthetic and computational approaches to addressing such problems are described in which the ultimate goal is the fabrication of flexible electronic circuits employing unconventional materials classes and unconventional fabrication techniques. The issues here concern not only the rational design, realization, and understanding of high-mobility p- and n-type organic semiconductors, but also robust enabling nanoscopic gate dielectrics having ultra-high capacitance, low leakage, and high breakdown fields. In the former area, routes to and properties of, new high-mobility heterocyclic materials are described. These materials are then used to fabricate high-performance organic thin film transistors and CMOS circuits. In the latter topic, the design, synthesis, and characterization of new high-k nanoscopic gate dielectrics are described. It is then shown how these dielectrics can be employed to significantly enhance the performance of thin-film transistors and other devices fabricated from a wide variety of both organic as well as inorganic semiconductors.