Molecular Engineering of Organic and Nanostructured Devices

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Molecular and nanoscale electronic materials are being aggressively pursued for a wide range of applications - - from, for example, low-cost, large-area, flexible macroelectronics and optoelectronics to post-CMOS alternatives for high performance nanoelectronics, chemical and biological sensors, and thermoelectrics. In this talk, I will describe the electronic, optical, and chemical properties of solution-processable organic thin films and nanocrystal and nanowire assemblies that make them exciting materials for these applications. I will give examples in which molecular engineering at interfaces can be used to tailor charge injection and transport in these materials and their devices. In organic transistors, energetic barriers at the metal electrode-semiconductor interface gives rise to undesirably high contact resistances. We have shown that self-assembly of molecular monolayers at the metal-semiconductor interface dramatically reduces the barrier to charge injection and allows the fabrication, on polymer gate dielectrics, of ambipolar devices and complementary circuits, such as high gain inverters. In chemically synthesized PbSe nanowires, as synthesized nanowires assembled in the channels of transistors show hole conductivity. Exposure to molecular charge-transfer dopants are used to change the carrier type, transforming p-type into n-type transistors. In organic and nanostructured materials and devices understanding and engineering interfaces may dramatically affect their behavior.