Emerging Guidelines for the Design of Novel Organic Semiconductors

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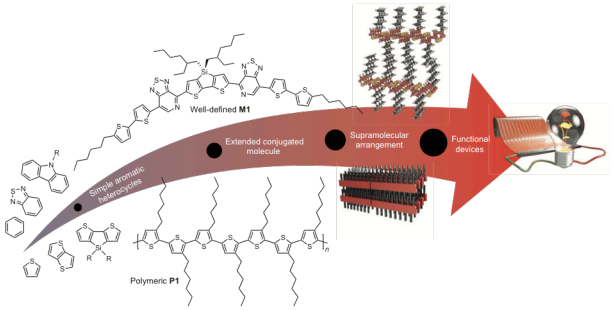
This presentation will cover some emerging ideas in our laboratories for designing organic semiconductors with properties that make them relevant for the fabrication of organic field effect transistors and transparent solar cells. In particular, we will discuss regioregular conjugated polymers. When processed atop nanostructured substrates under slow solvent evaporation, it is possible to obtain thin films with a very high degree of structural order that can be used to fabricate p-type thin film transistors with very high mobilities. We will discuss how to control charge injection in these devices through both polymer structure design, and through the intentional addition of traps that are specific for either holes or electrons. The end result is that one can convert an ambipolar organic



A general synthetic methodology will also be provided that can be applied for the preparation of more complex polymer architectures, for example a backbone comprised of CPDT-PT-IDT-PT repeat units (CPDT = cyclopentadithiophene, IDT = indacenodithiophene, PT = pyridyl[2,1,3]thiadiazole) and strictly organized PT orientations, such that the pyridyl N-atoms point toward the CPDT fragment. When incorporated into bulk heterojunction solar cells, the CPDT-PT-IDT-PT copolymer, namely PIPCP, is noteworthy because the open circuit voltage is particularly high for a donor polymer with a band gap < 1.5 eV. One therefore finds very low energy losses relative to the optical gap of the semiconductor. How PIPCP is capable of achieving current generation under limiting thermodynamic conditions was examined through a combination of structural and optical characterization techniques. An overall perspective of the mechanism will be discussed.