Towards supramolecular design of organic semiconductors

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Organic molecules with extended π-conjugation can display unusual electronic properties, traditionally associated with solid state inorganic materials. Manipulating a molecular structure, one can design organic metals, semiconductors or superconductor, magnetic, non-linear optical and lasing materials and even combine several of these properties in a single material. Such behavior of "π-functional" materials has already led to a number of technologies, eg. organic light-emitting diodes (OLED), field-effect transistors (OFET) and photovoltaics (OPV). However, the optimization of these properties and the performance of corresponding devices relies not only on a fine-tuned molecular structure but also on a difficult-to-control supramolecular organization in the solid state. Achieving such control, via molecular engineering of the building blocks, studies of their self-assembly by scanning probe and diffraction methods will be the focus of this lecture.

I will discuss how a combination of molecular, supramolecular, and nano/mesoscopic structure of organic semiconductors affects their electronic properties and device performance. I will describe our approaches to control the co-assembly of donor and acceptor semiconducting molecules, on surfaces (studied by STM) and in 3D crystals (studied by XRD). Finally, I will present our related work on synthesis of epitaxially ordered molecular wires and two-dimensional conjugated polymers by surface-confined polymerization.