

BINARY COMPOUND ORGANIC SEMICONDUCTORS

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The transition from the study of single-component materials to binary organic semiconductors (as the inorganic semiconductor field moved to embrace III-V and II-VI compounds after the initial focus on elemental semiconductors) seems to offer the material properties unexpected and unpredictable by computer modeling or current theoretic predictions.

While significant number of inorganic semiconducting materials has been established for device applications, the development of organic binary compounds has largely stalled. This seems to be strange regarding quantities of commercial available organic molecules and apparently unlimited number of possible new molecules synthesized in organic chemists' laboratories.

Among the less-explored, binary compound organic semiconductors are those composed of two different organic molecules, in which one molecule acts as a donor and the other as an acceptor. These organic charge-transfer salts offer the opportunity to tune the band gap by the choice of materials with appropriate HOMO and LUMO levels. Charge transfer between the two molecules in the solid state generally results in a crystal whose band gap is smaller than that of either parent material, and band widths that may produce high carrier mobility (or even metallic conduction). Some materials, like single crystals of TCNQ-parylene, produced in the NTU laboratory, exactly support the thesis of small gap formation due to charge transfer between acceptor and donator molecules.

The potential technological significance of organic semiconductors lies in their application in electronic devices, sometimes referred to as "plastic electronics." These materials have the potential advantages of being low cost, lightweight, and mechanically flexible while providing all the functionality necessary for devices such as displays, solar cells, and the electronics that drive them. We seek to combine the possibility to form new materials from organic molecules with exploration of their physical properties, and to identify the most promising candidate materials for application in electronic devices, light-emitting diodes and solar cells. In this purpose, we grow single crystals of organic

semiconductors and study the physical properties on well characterized samples of single crystals