Organic single-crystal transistors and interfaces

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Abstract

The field of plastic electronics aims at exploiting the unique properties of organic semiconductors based on conjugated molecules and polymers to realize new types of electronic devices. For this reason, most research focuses on the study of devices produced with techniques that are compatible with low-cost mass production. As a result, the material employed are affected by considerable structural disorder and contain large concentration of chemical impurities that make it virtually impossible to explore the intrinsic electronic properties of organic semiconductors. Therefore, despite impressive technological progress, our physical understanding of these properties has remained limited. In this talk, I will discuss a different approach based on materials of the highest possible quality –namely pure single-crystals- to study the intrinsic electronic transport properties of organic semiconductors using field-effect transistors and related devices. These devices have led to the clean observation of different physical phenomena, such as increasing carrier mobility with lowering temperature, observation of the Hall effect, mobility anisotropy, and the formation of interfacial polarons in transistors with highly polarizable dielectrics. They have also given important insight in the investigation of different important aspects of organic devices, e.g. contact resistance, the characterization of Schottky barriers, and charge transfer at metal/organic interfaces. The results obtained so far indicate that, despite the fact that much remains to be understood, devices based on high-quality single molecular crystals enable the discrimination of extrinsic effects from the intrinsic properties of organic semiconductors.