Electrical characterizations of individual supramolecular crystals at the local scale

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Abstract:

The development and improvement of organic electronic devices requires analytical tools allowing for a deep understanding of the physical properties of the materials they are made of. Bulk characterization techniques only offer ensemble-averaging information that does not take into account the heterogeneity of the samples (defects, polymorphism, grain boundaries in polycrystalline materials, anisotropy…). The fabrication of devices on every region of interest of a sample is an extremely tedious and time consuming task. There is therefore a need for developing tools to probe locally the materials. In order to study the structure-property relationship, it is also important for these tools to be adaptable to other characterization techniques allowing correlative measurements.

In this contribution, the use for electrical measurements of a nanoprobing station consisting of four IMINA® nanorobots will be presented. The nanorobots can be equipped with tungsten tips that can thus be manipulated to contact any location of a sample at will, with a precision down to 10 nm. A proof-of-concept will be given by the study of supramolecular crystals of a thienopyrroledione (TPD) - triazatruxene (TAT) derivative (figure 1a), a molecule used in photovoltaics [1]. The probes are used in the environment of a scanning electron microscope (SEM) to contact on demand single crystals in various configurations (field-effect transistors, 4-probe measurements) to measure the electrical properties (such as mobility) of individual supramolecular objects. The possibilities of development for other types of materials and in other environments will be discussed.

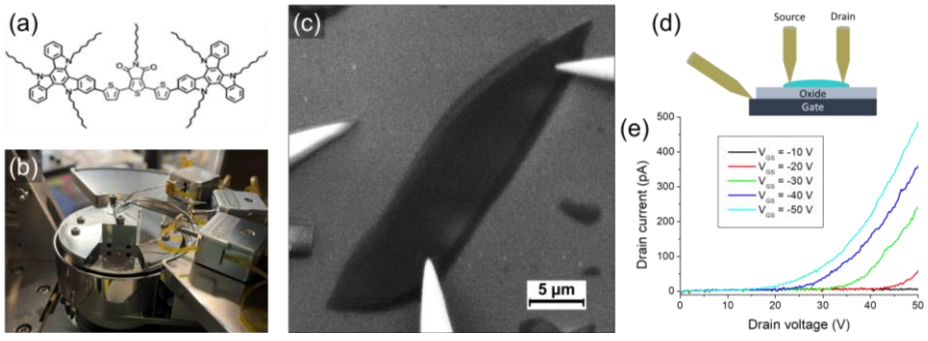

Figure: (a) structure of the TPDC8-TATC8 molecule; (b) photograph of the nanoprobing stage equipped with three robots and a sample placed on a cryo/heating module (range: -190°C to +300°C); (c) SEM image of a TPDC8-TATC8 supramolecular crystal contacted by two probes (source and drain); (d) diagram of experimental setup using three probes in a back-gate FET configuration; (e) output characteristic of a TPDC8-TATC8 crystal.

References:

[1] T. Han, I. Bulut, S. Méry, B. Heinrich, P. Lévêque, N. Leclerc, T. Heiser, Journal of Materials Chemistry C, 2017, 5, 10794.