DIRECTION DES SCIENCES DE LA MATIERE,
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SEMINAIRE

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Organic single-crystal field-effect transistors

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Invité par D. Fichou

The field of plastic electronics aims at using organic materials made of conjugated molecules or polymers, for the realization of electronic devices. Progress over the last decade has been impressive, and commercial applications already exist. Despite this progress the fundamental understanding of the electronic properties of organic molecular materials has remained very limited. In part, this is because the materials used in device applications need to be produced by low-cost techniques and contain therefore a large amount of chemical and structural disorder.
In this talk I will discuss work in the area of organic single-crystal transistors that was done over the past few years. The use of single-crystalline materials –as opposed to thin-films used in practical devices- is essential to remove disorder and observe the intrinsic properties of organic semiconductors. After presenting an overview of the crystal growth and single-crystal transistor fabrication, I will briefly show that measurements performed on single-crystalline devices reveal the intrinsic properties of materials. I will then discuss several aspects of the microscopic physics of organic field-effect transistors that are different from those of devices made of conventional semiconductors. In particular, experiments show that the behavior of charge carriers at the organic/dielectric interface is very sensitive to the specific dielectric used, and a quantitative comparison with a well-defined microscopic theory shows that they form Frohlich polarons. This comparison also shows that at high carrier density (~0.1 carrier/molecule) electron-electron interactions have a large effect on the transistor characteristics.
In the final part of the talk, I will introduce a new experimental system formed at the interface between two different organic crystals. By choosing the molecules appropriately, a very large charge transfer occurs between the two materials, leading to the formation of a layer of electrons at the surface of one of the materials, facing a layer of holes on the surface of the other material. The resulting two-dimensional electron system is new and exhibits metallic behavior in a broad temperature range. Data will be shown for the case in which the two molecule are TTF and TCNQ, well-known from the field of organic charge-transfer salts, but I will emphasize that the concept has a much broader validity, and that the TTF-TCNQ interfaces are just the first example of a new class of 2D electronic systems.

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