INSTITUT DE PHYSIQUE ET CHIMIE DES MATERIAUX DE STRASBOURG
23, rue du Loess, 67034 STRASBOURG Cedex 2

Séminaire AXE 1/5 - Sciences et Matériaux Quantiques/Matériaux (multi-) fonctionnels et technologies frugales

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Emma Bryan

Imperial College London
e.bryan21@imperial.ac.uk>

Engineering molecular orientation for organic electronic quantum devices – the role of scanning probe techniques

Pentacene is appealing for quantum applications because of its photogenerated spin-polarised triplet state, which can be exploited in various ways, from increasing the quantum efficiency of OPVs to enabling optically addressable spin states for quantum sensing applications. Molecular orientation and interfacial order are critical parameters in enabling these quantum and molecular electronic technologies, where anisotropic charge, exciton and spin transport can strongly influence device behaviour. Our group has developed templating materials that control molecular alignment in organic semiconductor thin films, including PTCDA for phthalocyanines and copper iodide for pentacene. This talk presents polyvinylidene fluoride as a ferroelectric templating layer for influencing the orientation of pentacene. The strong dipole moment of PVDF induces pentacene to adopt a predominantly flat-lying structure, while local polarisation can be patterned using piezoresponse force microscopy. The resulting molecular orientation is characterised using Kelvin probe force microscopy and Raman spectroscopy, providing insight into the coupling between ferroelectric polarisation, interfacial electrostatics and molecular assembly. Flat-lying pentacene films exhibit approximately three times higher out-of-plane mobility than films in which the molecules adopt an end-on orientation, as measured using conductive atomic force microscopy and eutectic gallium–indium top electrodes. These results demonstrate a route to controlling vertical charge transport through electrically configurable molecular interfaces. The ability to engineer molecular orientation and transport using a ferroelectric template is relevant to hybrid quantum and molecular devices in which local electrostatic control, low-dimensional transport and reconfigurable interfaces are required. Potential applications include organic spintronic structures, ferroelectrically controlled quantum-device interfaces, molecular tunnelling junctions and switchable electronic components integrated with quantum sensing platforms.

Contact : Martin Bowen (martin.bowen@ipcms.unistra.fr)