SUJET DE STAGE DE MASTER

2ème année

Internship offer

Laboratory: Laboratoire de Physique et d'Etude des Matériaux (UMR 8213 - ESPCI ParisTech-CNRS-UPMC)
Web site : http://www.lpem.espci.fr/spip.php?rubrique4
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Persons in charge of the internship: Dr. Brigitte Leridon (LPEM-ESPCI) / **Dr. Clément Barraud** (Laboratoire MPQ (UMR 7162 - Université Paris Diderot))
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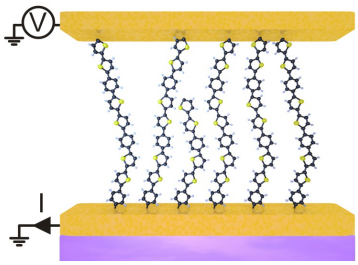
Hybrid molecular devices combining superconductors, magnetic materials and molecules

A quest in molecular electronics is to reduce electronic devices into a connected single molecule. In the last decades, electrical functions such as diodes, optical switches and memories have been demonstrated, using hybrid devices with molecules. Some fundamental questions however remain concerning for instance charge and spin transport through the organic environment and especially through the interfaces. Even more puzzling is the transport of Cooper pairs, when two superconductors are coupled through a thin molecular layer.



In this project, we propose to experimentally study the quantum transport properties of hybrid junctions[3] embedding electro-grafted polythiophene molecules between two electrodes. Those two electrodes will be either both superconducting or both ferromagnetic or superconducting and ferromagnetic. The grafting process allows a strong chemical coupling between the molecule and the

metal. The deep impact of this coupling on the particle/charge/spin injection properties is one of the subjects of this fundamental research.

The student will perform the microfabrication of the device; from the photolithography process to the thin film deposition of different materials (metal or semi conductor). The grafting process will be done at the ITODYS lab (Dr. P. Martin from the NEC team). The student will then characterize the hybrid heterostructures getting therefore accointed to different techniques: Atomic Force Microscopy (AFM) at the MPQ laboratory, Superconducing Qantum Interference Device (SQUID) magnetometry at the LPEM at ESPCI and X-ray Photoelectron Spectroscopy (XPS) at the ITODYS lab. Finally, the student will be able to study the fundamental properties by measuring the transport through the heterostructure at low temperatures (at about 2K) and under a variable magnetic field at the LPEM (ESPCI).

For this project, we are looking for an excellent and highly motivated student as the use of different techniques in different labs requires to be polyvalent, quick-to-react, experiments-oriented and well-organized. A background in solid-state and quantum physics will be an asset.

Do not hesitate to contact us for more information.

[1] M. Ratner, Nat. Nanotechnol. **8**, 378 (2013).
[2] S. V Aradhya and L. Venkataraman, Nat. Nanotechnol. **8**, 399 (2013).
[3] T. Fluteau, C. Bessis, C. Barraud, M.L. Della Rocca, P. Martin, J.-C. Lacroix, and P. Lafarge, J. Appl. Phys. **116**, 114509 (2014).

Methods and techniques: micro-patterning (MPQ, ESPCI), SQUID magnetometry (ESPCI), low temperature transport experiments (MPQ, ESPCI).

Possibility to go on with a PhD ? Yes