# Master 2 Experimental Research Internship

**Academic Year 2024/2025**

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## Exploring proximity effect in molecular – graphene interfaces

In today's research framework the question of the imprint of technology on our environment is of high importance. Yet a lower imprint technology should not be at the expanse of the performance. The very large class of organic molecular materials offers an opportunity to reduce environmental imprint while offering new performance opportunities in energy storage or communication devices. Among them, the relatively confidential family of oxocarbic acids shows remarkable (anti)ferroelectric properties. In these molecular crystals, the ferroelectricity is remarkably high and the rate of transition is particularly fast [1]. Nevertheless, their use in nanotechnologies is hampered by the lack of understanding of the (anti)ferroelectric switching mechanism and the difficulties in integrating them in nanodevices.

To circumvent these difficulties, we offer to investigate interfacial effects in oxocarbic – graphene systems. Thanks to its very high sensibility to its dielectric environment, graphene is the perfect platform to transduce the (anti)ferroelectric state of the oxocarbic layer into a change of conductance for an easier integration into today's technology [2]. The change of electrical polarization in a croconic acid layer (ferroelectric) or in a squaric acid layer (antiferroelectric) is expected to tune the conduction path of graphene as a function of crystallographic and orientational degrees of freedom.

This master 2 project aims thus at investigating this electric proximity effect in between two class of materials of high future perspectives (molecules and graphene). The aim is to unravel the dielectric anisotropies in the (anti)ferroelectric layer and the specificities of the ferroelectric switching transition.

The study will focus on two molecular systems (ferroelectric croconic acid and antiferroelectric squaric acid) commercially available. The master student will be involved in the UHV growth of oxocarbic acid onto graphene, the clean room lithography process and the transport measurements for having a complete picture onto the research chain on that topic.

The experimental results of this internship will be a perfect first step for a future PhD project aiming at developing electronic devices based on this unraveled proximity effect. This research project offers extensive skills opening opportunities for academic/industrial career: UHV technology, clean room skills, transport and device measurements.

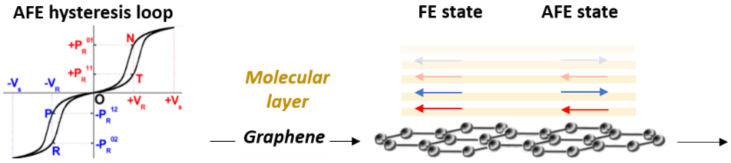


*Figure 1: hysteresis loop of an antiferroelectric materials and scheme of two potential dielectric configurations of a molecular layer on graphene.*

[1] S. Horiuchi et al. *J. of Phys. Soc. Jap.* 89, 051009 (2020)
[2] N. Kostantinov et al. *J. of Mat. Chem. C* 9, 2712 (2021)