EXPLORING 2D MATERIAL/ORGANIC HETEROSTRUCTURES AS PLATFORM FOR NOVEL ORGANIC SPINTRONICS DEVICES.

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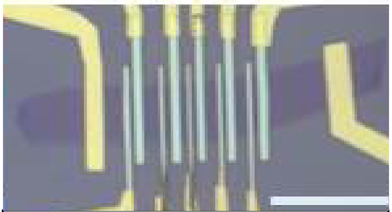
Because of their atomically-thin structure, high surface to volume ratio, and reduced electric screening, new properties and functionalities are expected to emerge when exploiting the interactions of 2D materials placed in contact with other nanomaterials, including molecules or functional thin films[1–3] (3D). These hybrid 2D materials are now an original field of research at the forefront of basic nanoscience and applied nanotechnology, providing new sets of possibilities to tailor device functions and novel physical properties[4,5].

This PhD project explores novel nanoelectronics and spintronics devices, taking advantage of 2D material interfaced with organic systems. On one side, we want to take advantage of the unique properties of 2D material including large area processability[6], long spin diffusion length[7] or high spin orbit coupling[8], unique surface sensibility (2D material are 2D electron gas directly exposed to their environment), electrostatic tunability and electric field transparency (they are thinner than their Thomas Fermi screening length)[4]. On the other side, we will exploit the multi functionality of organic systems, including electric/magnetic tunability and optical addressability.

Main challenges are to unveil new charge and/or spin-dependent transport properties at play in these systems. This includes understanding the interfacial properties triggered by electronic and magnetic coupling, and demonstrating novel device architectures based on these properties. Here, the nature of the elements constituting the 2D-organic heterostructures and the nature of the interfaces will be the adjustable parameters.

Research directions includes : (i) 2D material (incl. graphene and magnetic 2D crystals) in interaction with switchable molecules (incl. spin crossover nanomaterial), (ii) graphene lateral spin valve interfacing high mobility organic thin film, (iii) novel device architecture exploiting dual electric/ magnetic addressing of the 2D hybrid electronic and magnetic state (this includes insulating magnetic substrate to induce proximity magnetism, for more information, please contact JF Dayen).

This PhD subject is experimental. It will build on the many techniques of fabrication and characterization at IPCMS and StNano. The candidate will work within the Nanodevice team of IPCMS, which has developed strong track record in 2D materials and organic devices. He/she will develop skills in nanofabrication, nanoelectronics, optoelectronics and low temperature magneto-transport measurements. This PhD subject will suit to a candidate interested in experimental work, with a pronounced interest for nanofabrication in cleanroom environment, electrical measurements, combined with a good knowledge of solid state physics. He/She will interact with an international team, and will benefit from collaboration with high level national and international laboratories.



Optical image of 2D material spintronics device made in our team (scale bare=10µm).

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