Multiferroic van der Waals epitaxial hybrids

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Since the discovery of record spin coherence properties of graphene during the last decade, two-dimensional (2D) materials have brought fresh prospects for spin electronics and information processing.[1] Moreover, because of their atomically thin structure and reduced electric screening, new properties and functionalities are expected to emerge when exploiting the interactions of a 2D layer placed in contact with other nanomaterials, including functional thin film. These heterostructures and hybrids are now an original field of research at the forefront of basic nanoscience and applied nanotechnology.

This Ph.D. project explores novel nanoelectronic and spintronic devices, taking advantage of 2D materials interfaced in van der Waals heterostructures with europium oxide epitaxial thin film, a ferromagnetic insulator. Our team recently demonstrated a new approach to grow epitaxial Europium oxide over a graphene layer.[2] Our transport measurement revealed that graphene becomes ferromagnetic by interfacial proximity effect, due to hybridization of the orbitals, confirming previous theoretical predictions.[3]

This Ph.D. project ambitions going further while exploring the uncharted system of *multiferroic van der Waals heterostructure*. Our preliminary results indicate that multiferroic (being both ferromagnetic and ferroelectric) EuO thin film can be grown over graphene under specific conditions. The PhD students will explore the growth of these hybrid layers and their structural and physical properties (ferroelectric polarization, magnetic moments….). Moreover, he/she will extend the study to other 2D materials such as transition-metal dichalcogenides, and study their potential for in-memory computing applications.

The PhD candidate will work within the DMONS department of IPCMS, which has developed a strong track record in 2D materials, epitaxial thin films, and nanoelectronics/spintronics devices. He/She will develop skills in nanofabrication, nanoelectronics, and low temperature magneto-transport measurements. He/She will interact with an international team and will benefit from on-going collaborations with high level national and international laboratories.

References :

[1] J. F. Dayen, et al., Applied Physical Review 2020, 7, 011303.

[2] S. Pandey, S.et al. , Phys. Rev. B 2023, 108 (14), 144423.

[3] HX Yang et al., Physical review letters 2013, 110 (4), 046603.