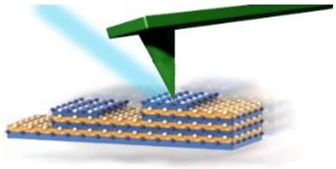

# Interface tuning in ferroelectric-2D materials transistors

Functional Materials Group

## MSc by Research (self-funded)

Electrostatic gating has been central to 2D and van der Waals (vdW) materials (2DMs) since the inception of the field: the pioneering paper [1] that kick-started the area was based on the concept of reducing the material thickness below the screening length (~Å in metals, nm in semiconductors) to realise a field effect in transport through semi-metallic graphite. This ability to dramatically modulate transport properties by a field perpendicular to the layer has been central to 2DM electronics and is a crucial tool for band engineering of 2D heterostructures (2DHS). In these, layers of metals, semiconductors and insulators are stacked with atomic precision to create new functional materials. Applied fields can change the chemical potential in each layer, and the band alignments across the stacks, in ways not possible in conventional 3D semiconductor heterostructures.

Within this concept ferroelectrics, which are materials with switchable permanent dielectric polarisation, may be a game changer. The ferroelectric polarisation, which can be as high as 0.5 electrons per unit cell, can induce massive fields in contiguous materials and change non-volatilely the band alignments and electron transport. This is at the core of ferroelectric field effect transistors (FeFET), seen as the ideal non-volatile memory element with a switching speed at the DRAM level, low power and practically infinite switching cycles.

The present project aims to investigate the influence of the interface between the ferroelectric and 2D material by studying the electronic transport in the latter. Three terminal devices (transistors) based on ferroelectric perovskite oxides such as $BaTiO_3$ or $PbTiO_3$, and 2D semiconductors such as WSe2 or MoS2 will be fabricated and characterised. Different properties including electronic conductivity, Hall mobility, and/or photovoltaic effect at both macroscopic and microscopic /nanoscopic level will be explored. One major aim is to correlate the interface quality, quantified by defect density, with functional properties and device performance.

The effective work will involve deposition of high quality epitaxial thin films of oxide functional materials by pulsed laser deposition followed by transfer of atomically thick semiconductors, device (FeFET) fabrication followed by a complex study of the electronic transport. This may involve developing of time-resolved photo-electric effect to quantify the interface defect density and local electronic properties using AFM (atomic force microscope).

As an MSc (by Research) student, you will be trained to use the existing state-of-the-art equipment including pulsed laser and sputtering deposition, microelectronic and nano fabrication as well as basic and dedicated characterization techniques which includes structural, semiconductor and ferroelectric measurements. Such an MSc puts you as a student in a strong position when applying for PhDs globally, having already been exposed to a whole variety of the state-of-the-art facilities Warwick has to offer.

To discuss this project further contact:

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**References**

[1] K. S. Novoselov *et al.*, *Science* **306**, 666-669 (2004).