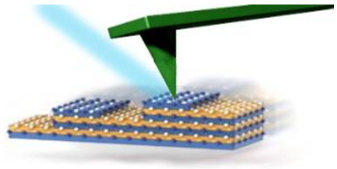
Dislocation-based functionalities in perovskite oxides

Functional Materials Group



MSc by Research (self-funded)

Extended defects, such as dislocations, are usually seen as detrimental to most functional materials. These extended defects are notorious for obliterating carrier mobility or inducing trapping centres in semiconductors, light scattering in optical materials and devices, pinning in ferroic materials, etc. For these reasons special care is usually paid to obtain almost dislocation-free crystals and films. Dislocation core is a structural defect that defines the dislocation itself and extends over few unit cells within the crystals. This region is associated with large strain filed and, due to perturbed Bloch periodicity, shows a different electronic structure than the host crystal. This has been recognised already in early times when Shockley has pointed out that a bonding defect line aligned with the edge dislocation brings about one-dimensional electron conduction.[1]

The present project aims to investigate the influence of the dislocation on electronic transport in perovskite oxides such as, dielectric $SrTiO_3$, ferroelectric $PbTiO_3$, and potentially Titanium dioxide. 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 strain and strain gradients at the dislocation core with induced photovoltaic or other functionalities.[2]

The effective work will involve thin films growth, layer transfer and atomic bonding followed electronic characterisation. High quality epitaxial perovskite thin films will be grown of oxide functional materials by pulsed laser deposition (PLD) and basic characterization which will include structural, ferroelectric and semiconductor measurements. Water soluble buffer layers will allow detaching of these ultra-thin layers and atomic (glueless) bonding to dissimilar crystals. The obtained samples with dislocation networks will be characterised by investigating electronic transport, magneto-electric transport, and photo-electric properties. Especially, local photoelectric properties with nanometre resolution using existing Photo-AFM (atomic force microscope) and time resolved Photo-AFM will be employed to characterise single dislocations.[3]

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] W. Shockley, "Dislocations and Edge States in the Diamond Crystal Structure," *Phys. Rev*. **91**, 228 (1953).
[2] M. M. Yang, D. J. Kim and M. Alexe, "Flexo-photovoltaic effect", *Science* 360, 905 (2018).
[3] M. Alexe and D. Hesse, "Tip-enhanced photovoltaic effects in bismuth ferrite", *Nature Communications*, 2:256 (2012)