PhD project in the Functional Materials Group at the University of Warwick

Functional Properties of Ferroic Domain Walls

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Backgrounds: Ferroic and especially multiferroic materials have been intensively investigated in the last years for their exciting properties mostly given by the potential coupling between magnetic, electric and elastic properties. Domain walls (DWs) that usually occur in these materials are intrinsically two dimensional nano-objects which usually possess different properties than the host material. Historically, DWs properties were simply disregarded, as the research focused on the control and behaviour of the domains themselves. Boundaries between domains were dismissed as minor microstructural components of little significance. Only very recently has been shown that DWs might show functional properties different than the host material. They might be polar while the host material is not[1], conductive[2], or even superconductive when the surrounding is insulating.[3]

One of the most important effects discovered was related to enhanced electronic transport at the domain walls. Metallic properties, 2D electron gas and spin transport [4] have been claimed, but so far little has been done to achieve an in-depth characterisation of the electronic transport at the DWs.

The project: The project will seek primarily to understand electronic transport and conduction mechanisms at the ferroic domain walls, as well as other functional properties such as spin or heat transport. The research program proposed in this PhD will comprise

I. Identifying most appropriate both macroscopic and nanoscopic characterisation methods to determine the targeted functional properties of DWs.
II. Developing of these characterisation methods based on our new low-temperature vector magnetic field and light assisted scanning probe microscope. We specifically aim to develop time-of-flight and nano-Hall experiments to map carrier charge density, mobility and diffusion coefficient at domain walls.

To discuss this project further contact:

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References:

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[3] A. Aird, M. C. Domeneghetti, F. Mazzi, V. Tazzoli, E. K. H. Salje, J. Phys. Cond. Matter. 1998, 10, L569.
[4] J. H. Lee, I. Fina, X. Marti, Y. H. Kim, D. Hesse, and M. Alexe, Advanced Materials 26, 7078 (2014).