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440 – Charge Carriers in Dynamic Ferroelectric Domain Walls

Kalani Moore[1], Lynette Keeney[2], Clive Downing[3], Michele Conroy[1] and Ursel Bangert[1]

[1]University of Limerick, Limerick, Limerick, Ireland, [2]Tyndall Institute, Cork, Cork, Ireland, [3]Advanced Microscopy Laboratory, Centre for Research on Adaptive Nanostructures and Nanodevices (CRANN), Dublin 2, Ireland, Dublin, Dublin, Ireland

Ferroelectric domain walls (DWs) are the subject of intense research at present in the search for high dielectric, gigahertz responsive materials with novel functionalities[1]. Crucial to the integration of DWs into nanoelectronics is a proper understanding of the local electronic landscape around the wall and the influence this has on the behaviour of the DW under variable electric fields. A high degree of mobility under small electric fields is especially desirable for low power applications which escape from the critical current thresholds required to move magnetic domain walls[2]. Perovskite oxides are prime candidates for tuning the thermodynamic variables affecting the energy landscape of DWs and thus controlling their orientation/charge state[3]. Here we present an investigation into the behaviour of ferroelectric DWs under dynamic fields and the specific charge carriers present at DWs.

When competing strain states and polarisation directions are either equally favourable or equally unfavourable the potential well for a given domain state can become very shallow. Thus the DWs can reorientate in reaction to any external stimulus, including the electron beam and secondary electrons generated in the sample. We show how electric field direction relative to the material's polarisation is a critical factor in DW stability and describe various strategies for tracking domain walls in-situ. The stability of DWs is affected by dynamic carrier diffusion rates in the material. We employ ATOMAP to preform atomic displacement mapping and identify charged head to head walls and neutral head to tail DWs[4]. We identify cation and anion vacancies at head to head and head to tail walls respectively. The influence of these charges on the band structure of the DW and potential conducting characteristics are discussed. Finally we discuss the structure of DWs in various perovskites and the extra complexity and opportunity offered by multiferroics and combining magnetic and electric DW properties.

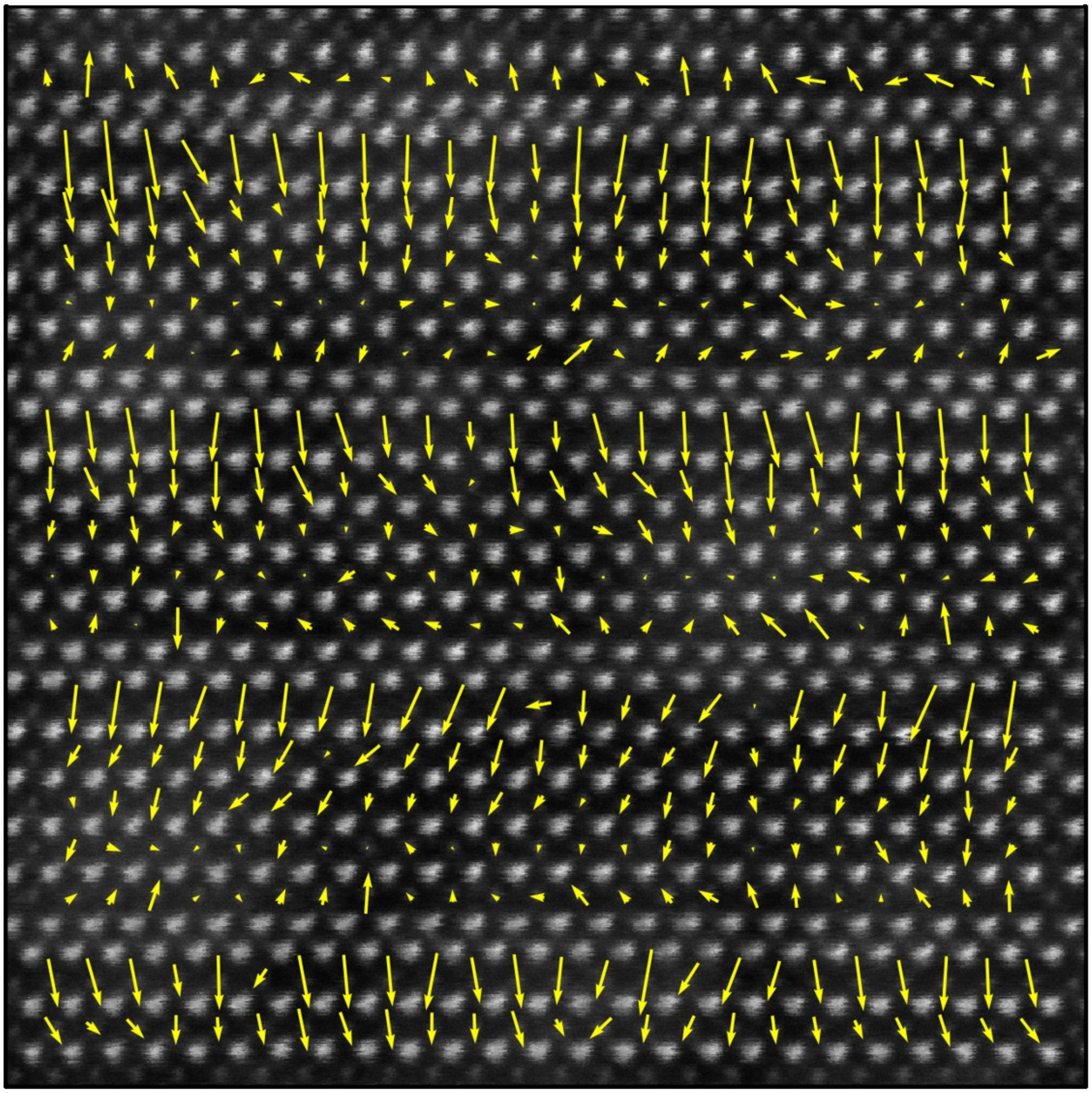

Figure 1. Figure 1: Example of strain determined, highly variable unit cell polarisation in a perovskite thin film.

References

1. Gu, Z., Pandya, S., Samanta, A., Liu, S., Xiao, G., Meyers, C.J.G., Damodaran, A.R., Barak, H., Dasgupta, A., Saremi, S., Polemi, A., Wu, L., Podpirka, A.A., Will-Cole, A., Hawley, C.J., Davies, P.K., York, R.A., Grinberg, I., Martin, L.W., and Spanier, J.E. (2018) Resonant domain-wall-enhanced tunable microwave ferroelectrics. *Nature*, **560** (7720), 622–627.
2. Parkin, S.S.P., Hayashi, M., and Thomas, L. (2008) Magnetic domain-wall racetrack memory. *Science (80-.).*, **320** (5873), 190–194.
3. Ramesh, R., and Schlom, D.G. (2019) Creating emergent phenomena in oxide superlattices. *Nat. Rev. Mater.*, **4** (4), 257–268.
4. Nord, M., Vullum, P.E., MacLaren, I., Tybell, T., and Holmestad, R. (2017) Atomap: a new software tool for the automated analysis of atomic resolution images using two-dimensional Gaussian fitting. *Adv. Struct. Chem. Imaging*, **3** (1), 9.