MAR16-2015-000401

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

Moving Towards Domain Wall Devices in Ferroics[1]

MARTY GREGG, Queens University Belfast

Domain walls in ferroelectric, ferroelastic and multiferroic oxides are distinct functional materials in their own right. They can be conducting, or even superconducting, when surrounding domains are insulating [1, 2]; they can demonstrate magnetism when the surrounding bulk is non-magnetic [3] and they can contain ordered electrical dipoles when the matrix containing them is non-polar [4]. Since domain walls can also be created, destroyed, and controllably moved from place to place, there is an amazing opportunity for us to design new forms of devices in which functionality is actively and dynamically deployed (now you see it; now you don't). This is the essence of the emerging field known as "domain wall nanoelectronics" [5]. In time, this arena of research could change the way we think of nanoscale functional devices, moving increasingly towards agile circuitry and neuromorphic device architectures. While the control of domain wall injection, movement and annihilation has been developed rather well in the nanomagnetics community (in race-track [6] and domain wall logic [7] research), similar research has not been widely performed in nanoscale ferroelectrics, ferroelastics and multiferroics. This talk will discuss progress that has been made to date and the way in which nanomagnetics research can be used as a source of inspiration. Site-specific domain wall injection and motion control in both proper and improper ferroelectrics using inhomogeneous electric and elastic fields, as well as dielectric patterning in uniaxial ferroelectrics, will be specifically considered [8]. As will be shown, sufficient control has been developed to allow the creation of a diode for domain wall motion in ferroelectrics, for example. [1] J. Seidel *et al.* Nat. Mater., **8**, 229 (2009); J. Guyonnet *et al.* Adv. Mater., **23**, 5377 (2011); P. Maksymovych, *et al.* Nano Lett., **11**, 1906 (2011); T. Sluka *et al.* Nat. Commun., **4**, 1808 (2013); [2] A. Aird, E. K. H. Salje, J.Phys.:Condens. Matter, **10**, L377 (1998); [3] S. Farokhipoor *et al.*, Nature **515**, 379 (2014); [4] S. Van Aert *et al.* Adv. Mater., **24**, 523 (2012); [5] G. Catalan *et al.* Rev Mod Phys **84**, 119 (2012); [6] S. S. P. Parkin, M. Hayashi & L. Thomas, Science **320**, 190–194 (2008); [7] D. A. Allwood *et al.* Science **309**, 1688–1692 (2005). [8] J. R. Whyte *et al.*, Adv Mat, **26**, 293 (2014); J. R. Whyte *et al.*, J. Appl. Phys. **116**, 066813 (2014); J. R. Whyte *et al.*, Nat. Commun. **6**, 7361 (2015); R. G. P. McQuaid *et al.* Nat. Commun. (under review 2015).

[1]The author acknowledges support from the Engineering and Physical Sciences Research Council (EPSRC)