MAR13-2012-020323

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Magneto-mechanical detection and control of the nanoscale Barkhausen effect[1]

MARK FREEMAN[2], University of Alberta and National Inst. for Nanotechnology, Edmonton, Canada

Developments in nano- and spin mechanics are driving a resurgence of interest in mechanical approaches to magnetometry. Torque methods for measurement of quasi-static magnetization or detection of spin dynamics can very fruitfully be miniaturized for application to individual magnetic nanostructures, and are complementary to magnetic force microscopy and related techniques [1]. We report a complete study of the Barkhausen effect in torsional magnetometry measurements of a micromagnetic disk. The discovery of Barkhausen noise in 1919 [2] provided the first experimental evidence of ferromagnetic domains. Within three decades elegant experiments had been performed on individual domain walls and a firm qualitative understanding had emerged [3]. Quantitative treatments of the effect have relied on statistical analysis [4], due to the collective nature of domain wall pinning by many sites. However, a vortex core effectively localizes the domain wall to the scale of an individual pining site, thereby converting the Barkhausen effect into a quantitative 2D nanoscale probe of local energetics in thin magnetic films [5]. In addition to characterization of the intrinsic disorder in a polycrystalline film, point-like tailoring of the energy landscape through low dose focussed ion beam implantation is demonstrated, and can be exploited to tune the properties of integrated magneto-mechanical devices.

[1] J.P. Davis et al., Appl. Phys. Lett. **96**, 072513 (2010) and New J. Phys. **12**, 093033 (2010).
[2] H. Barkhausen, Phys Z. **20**, 401 (1919).
[3] C. Kittel, Rev. Mod. Phys. **21**, 541 (1949).
[4] B. Alessandro et al., J. Appl. Phys. **68**, 2901 (1990).
[5] J.A.J. Burgess et al., arxiv.org/abs/1208.3797, and to be published.

[1]Supported by NSERC, CIFAR, iCORE, CRC, AITF.

[2]This work is a collaboration with Jacob Burgess, Alastair Fraser, Doug Vick, Fatemeh Fani Sani, Brad Hauer, Joe Losby, Miro Belov, Zhu Diao, Vince Sauer, Wayne Hiebert, Paul Barclay, and John Davis.