INSTITUTE SEMINAR

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Speaker:

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Title:

Magneto-optic Kerr microscopy for nanomagnetism

Abstract:

Magneto-optic Kerr effect (MOKE) magnetometry has been widely performed to study and measure magnetic hysteresis in ferromagnetic thin films. This technique is often preferred because it is cost effective, fast measurement time and more importantly the capability of performing the vector magnetometry. There are three configurations of MOKE magnetometry exists such as longitudinal, transverse and polar, respectively. In past few decades Kerr microscopy based on the MOKE principle has been often performed to image ferromagnetic domains.

In this talk I will give a brief overview of Kerr magnetometry and microscopy. In particular I will highlight the significance of these techniques in studying nanomagnetism. In this context I will show our recent results on four subjects which are listed below.

(i) Superferromagnetism (SFM): SFM domains in a non-percolated nanoparticle assembly are expected to be similar to conventional ferromagnetic domains in a continuous film, with the decisive difference that the atomic spins are replaced by the *superspins* of the single-domain nanoparticles. [1,2] From the domain wall relaxation measurements we can calculate the domain wall velocity and plot it as a function of external magnetic fields. The various domain wall dynamic modes such as creep, slide and the depinning transition have been clearly observed.

(ii) Magnetic antidot arrays (MALs): MALs are defects in a continuous thin film. They introduce perturbation in the thin film and hence their magnetization reversal mechanism is quite different from that of a continuous thin film. MALs are receiving intense research interest because of their potential advantages, such as lack of superparamagnetic limit to the bit size (as compared to dot arrays) [3]. We will show how the magnetization reversal process occurs in a Co MAL system studied by Kerr microscopy. [4]

(iii) Inter-layer coupling: The other topic of interest is competing inter-layer interaction effects in dipolarly coupled ferromagnetic/non-magnetic multilayers. LMOKE microscopy has been performed on $[Co\ (t_1)/Al_2O_3(t_2)]_N$ for various thicknesses of Co (t_1) and Al_2O_3 (t_2) and different number of bilayers, respectively. We will show how the inter-layer interactions lead to layer-by-layer magnetization reversal as evidenced by Kerr microscopy. [5,6] We also show how substrate rotation can produce a local dispersion in anisotropy leading to a multicontrast domain variation in the film. [7]

iv) Interplay of uniaxial and cubic anisotropies in Fe/MgO(100) epitaxial thin film: I will present a study on magnetization reversal process for Fe/MgO(001) thin films. Due to the oblique growth configuration, a uniaxial anisotropy is found superimposed to the expected four-fold cubic anisotropy. Domain wall motion images during magnetization reversal are captured by Kerr microscope which are the clear evidence of two successive or separate 90° DW nucleation depending on the angle between the applied field and easy axis i.e. <100> direction. Still now all systematic studies on magnetization reversal mechanism of epitaxial Fe/MgO(001) film were explained on the basis of theoretical models. But for the first time we are presenting the direct evidences of magnetization reversal mechanism in this system. [8]

References:

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[2] S. Bedanta *et al*. Phys. Rev. Lett. 89, 176601 (2007).
[3] N. G. Deshpande *et al*, JAP 111, 013906 (2012).
[4] Sougata Mallick and S. Bedanta (Under review).
[5] S. Bedanta et *al*. Phys. Rev. B 74, 054426 (2006).
[6] N. Chowdhury and S. Bedanta ((Unpublished)
[7] N. Chowdhury and S. Bedanta, AIP Advances **4**, 027104 (2014)
[8] Srijani Mallick, Niru Chowdhury and S. Bedanta (Under review).
