HIGH RESOLUTION IMAGING OF DOMAIN WALLS AND VORTEX CORES IN FERROMAGNETIC NANOSTRUCTURES

M. Kläui[1], J. Kimling[1], O. Boulle[1], F. Junginger[1,3], D. Backes[1,2], L. J. Heyderman[2], F. Nolting[2], T. Kasama[3], R. Dunin-Borkowski[3] and U. Rüdiger[1]

1. Fachbereich Physik, Universität Konstanz, Universitätsstr. 10, D – 78457 Konstanz, Germany
2. Paul Scherrer Institut, CH - 5232 Villigen, Switzerland,
3. Department of Materials Sciences, Pembroke Street, Cambridge CB2 1RF, UK

The details of the spin structure of domain walls and vortex cores have recently become the focus of intense research. This is not only due to improved measurement techniques that now allow one to image the magnetization configuration on the nanoscale but also due to the fundamental physical questions associated with domain walls, such as the wall type and width dependence on the geometry [1,2], the intrinsic domain wall magnetoresistance and domain wall propagation induced by spin-polarized currents [3].

Micromagnetic simulations predict two types of domain walls [4] depending on the geometry of the element (transverse walls for narrow and thin rings) and vortex walls for thick and wide rings [1,4,5].

Using electron holography and photoemission electron microscopy (XMCD-PEEM), we obtain high-resolution images of the spin structure of the domain walls, which allows us to determine the wall type and the wall width for different ring geometries [1,5,6]. In a comprehensive study we investigate systematically more than 40 different geometries of Co and Py rings. We determine the phase transitions between the different domain wall types as a function of the geometrical parameters [5].

The evolution of the domain wall width as a function of the geometry has stirred much interest, since large magnetoresistance effects are directly related to the wall width. By exploring the domain wall widths as a function of geometry we have found a superlinear dependence of the width on the structure width, and a more subtle dependence on the thickness and outer diameter for the two wall types [6]. To study domain walls and vortex cores with sub-100 nm dimensions, we use electron holography, which allows for magnetic imaging at a scale of a few nm. Such high resolution imaging allows us to probe the behaviour of domain walls in nanometer lateral constrictions and in particular quantitatively measure the width of a vortex core [7].

References:

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