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Magneto-optical Analysis of Magnetic Microstructures

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The rich world of magnetic microstructure or magnetic domains, extending from visible dimensions down to the nano-scale, forms the mesoscopic link between the fundamental physical properties of a magnetic material and its macroscopic properties and technical applications, which range from films for computer storage technology to magnetic cores for electrical machinery. Hysteresis phenomena, energy loss in inductive devices, noise in sensors, or the magnetoresistive properties of modern spintronic devices can be decisively determined by the peculiarities of the underlying magnetic microstructure, especially by irreversibilities in the magnetization process. Therefore any development and optimization of magnetic materials, which is usually accompanied by the measurement of magnetization curves, requires an understanding of the underlying domains and their reaction to magnetic fields, which, in most cases, can only be gained by direct imaging.

In my presentation I will give a review of magnetic domains, supported by domain observation using Kerr microscopy. After a brief introduction to magnetic energies, I will demonstrate using various examples how these energies act together in the formation of domain patterns. The examples include magnetic films as well as bulk magnetic materials with different strength and symmetry of magnetic anisotropy. It will be shown how domains adapt to increasing specimen thickness (domain branching) and decreasing grain size (nanocrystalline materials and films). Most challenging is the analysis of hidden (internal) domains and processes in bulk material. They are relevant for material performance and their analysis requires surface imaging in combination with domain modelling and some volume-sensitive imaging method. Aside from their scientific and technical relevance, magnetic microstructures are also aesthetically appealing, an aspect that will be part of the presentation.

Biography

Rudolf Schäfer received the diploma degree and the Ph.D. degree from the University of Erlangen-Nürnberg (Germany) in 1985 and 1990, respectively. He then joined the IBM Research Center in Yorktown Heights (USA) and the Forschungszentrum Jülich (Germany) as a Postdoc in 1991 and 1992, respectively. In 1993 he moved to the IFW Dresden (now Leibniz Institute for Solid State and Materials Research Dresden, Germany) where he became head of the department "Magnetic Microstructures" in 2002. In 2011, Dr. Schäfer was appointed honorary professor for Magnetic Materials at the Institute for Materials Science at Technical University Dresden. His areas of interest span magnetic materials with a focus on magnetic microstructures and domain imaging by Kerr microscopy. He has published more than 130 technical articles in peer-reviewed journals, including book chapters, and together with Alex Hubert he has coauthored the textbook "Magnetic Domains". Prof. Schäfer currently chairs the technical committee for "Magnetic Imaging" of the IEEE Society. !