Imaging of Magnetic Domain Dynamics at Power Frequency

R. Schaefer,[1] and I. Soldatov[1]

[1]*Leibniz Institute for Solid State and Materials Research (IFW) Dresden, Helmholtzstrasse 20, D-01069 Dresden, Germany*

In spite extensive domain studies in grain oriented electrical steel [1], there is still a lag of knowledge about the domain dynamics and flux propagation on the grain size level under application-relevant conditions, owing to a lag of suitable imaging techniques. PMOIF- [2] and Neutron Dark-field Microscopy [3] open the path for such investigations as will be reviewed.

The core of a PMOIF is a transparent magnetic garnet film with up-and-down magnetized band domains. Placed on the surface of a magnetic specimen, the stray-field emerging from poles in the sample modifies those band domains by wall motion. Imaged under low-resolution conditions leads to an averaged polar Faraday contrast in an optical polarization microscope. The contrast pattern thus reflects the pole pattern of the specimen. Compared to conventional indicator films with in-plane anisotropy, which act on the sample stray-field by magnetization rotation, the PMOIFs offer much higher sensitivity as their susceptibility is governed by wall motion in the garnet film. So, domains can even be imaged in the presence of the insulation coating on the transformer sheets, and the contrast is strong enough to allow for single-shot imaging of dynamic processes up to the 500 Hz frequency regime by using a high-speed camera.

The dark-field image (DFI) of neutron grating interferometry (NGI) is a technique that enables the spatially resolved analysis of bulk magnetic domains deep in the volume of materials and thus provides unique information. The contrast is based on the small-angle scattering of neutrons at domain walls and the consequent disruption of a predefined interference pattern. By combining a standard NGI setup with a multi-channel-plate (MCP) detector, stroboscopic imaging of (repetitive) volume domain processes becomes directly possible with a spatial resolution of 100 μm.

[1] A. Hubert and R. Schäfer: Magnetic Domains. Springer (1998)
[2] R. Schäfer *et al.*, J. Magn. Magn. Mat. 474, 221 (2019)
[3] R. Harti *et al.*, Scientific Reports 8, 15754 (2018)

Neutron imaging was performed by Ralp Harti and Christian Grünzweig at Paul Scherrer Institute in Villigen, Switzerland