Time-resolved observations of a domain wall shape using the magnetooptical Kerr effect in amorphous microwires

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Amorphous glass-coated microwires (AGCMs) are composite materials [1] with unique magnetic properties, such as high magnetic softness and large permeability. The high sensitivity of domain-wall mobility and critical field makes these materials ideal candidates for various types of sensors [2], capable of simultaneously measuring multiple physical quantities. However, a key prerequisite for their functional stability is a detailed understanding of the internal spin structure.

In our previous work, we developed a unique experimental technique for three-dimensional imaging of surface magnetization in microwires [3]. The method employs the magneto-optical Kerr effect (MOKE) combined with a special excitation scheme, which creates an effective one-dimensional potential well. The domain wall is stabilized by two opposing magnetic fields, resulting in a periodic back-and-forth motion of the wall.

In the present contribution, we extend this technique by incorporating in situ detection of changes in the internal magnetic flux using a pick-up coil. While MOKE provides information about surface domain-wall deformation, the pick-up coil enables estimation of the internal domain-wall structure. First, a mathematical framework for calculating the electromotive force (EMF) signal induced in the pick-up coil is presented. Spatial imaging of the surface domain-wall shape reveals two typical types of domain-wall distortions. In highly magnetostrictive alloys (e.g., FeSiB), mechanical torsional stress leads to screw-like distortions of the domain wall. In contrast, microwires with reduced magnetostriction exhibit an almost undistorted domain-wall shape. In both cases, magnetostriction plays an essential role, as the mechanical distortion is always smaller than the corresponding domain-wall distortion. Furthermore, a comparison between pick-up-coil signals and MOKE observations confirms that internal domain-wall pinning does not lead to the formation of a conical structure, as predicted by some theoretical models. Finally, our results are compared with magneto-optical imaging obtained using a MOKE microscope.

References:

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