Domain-structure-induced giant magneto-impedance

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Already in 1935 it was discovered that a ferromagnetic wire changes its impedance as a function of an externally applied magnetic field[1]. Respective resistances changes have, of course, been reported much earlier[2]. The giant magneto-impedance effect (GMI), which is now widely studied, was first observed on Co-based amorphous wires in 1994[3]. The effect involves considerable changes of the complex electrical impedance of a ferromagnetic sample as a function of externally applied magnetic fields. The relative impedance change can typically amount to a few hundred percent.

We have recently discovered a variant of the GMI effect on iron whiskers with a very simple domain structure which is caused by periodic changes of the whole domain structure[4]. These changes are the result of circular magnetization reversals generated by the Oerstedt field of the transport current and are thus strongly frequency- and amplitude-dependent. A typical variation of the relative impedance change as a function of externally applied field is shown in Fig. 1.

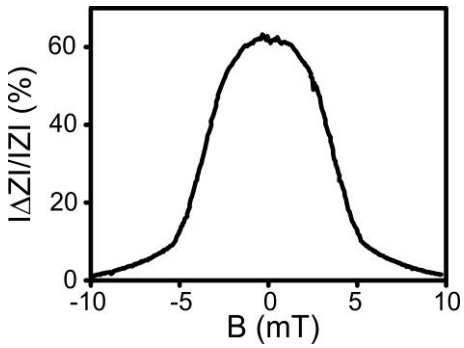

Fig. 1: Change of the relative impedance of iron whiskers as a function of an external magnetic field, applied in longitudinal direction.

AC transport measurements, MOKE investigations and micromagnetic calculations allowed us to conclude that domain configurations, as shown in Fig. 2, are present. Their interplay with the electromagnetic skin effect causes the GMI effect and makes it relevant already at relatively low frequencies.

The contribution discusses the results in detail, involves data obtained at room temperature as well as at low temperatures and focuses on the question to which extend the effect can be utilized involving nanoscale structures of technological importance.

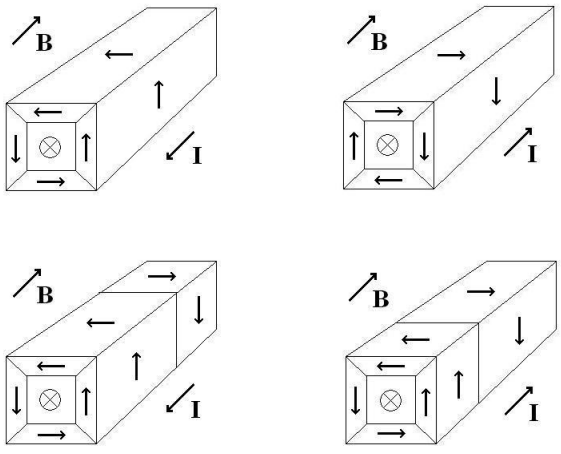

Fig. 2: Current-induced domain configuration at low (upper part) and high (lower part) frequencies.

References:

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