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Quantitative analysis of magnetic domain sizes in electrical steel

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Electrical steel sheets comprising the magnetic core of electrical machines suffer from energy losses during reversal of magnetization depending on the mobility of the magnetic domains, which is influenced by the treatment of the electrical steel sheet during. Residual stress induced during the manufacturing process (e.g. by blanking the sheets) causes a degradation of domain mobility due to the magneto-elastic effect. Conversely, deliberately induced residual stress may be used to guide the magnetic field. However, there is a shortage of spatially resolved techniques able to probe the magnetic domain constellation in bulk samples of technically relevant dimensions.

Neutron grating interferometry (nGI) gathers, among other things, information about ultra-small-angle-neutron scattering caused by a sample. Based on the high penetration of neutrons in electric steels and their high sensitivity to magnetic fields, nGI is the technique of choice for analysing the local effect of induced stress on the magnetic domains in a material. By varying the probed length scale and scattering direction, the correlation function of the considered sample as well as its anisotropy can be recovered and quantitative information about the domain size and shape can be extracted.

We will show how residual stress affects magnetic domains when applying an external magnetic field and discuss theoretical models applicable to describe the system.

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