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Imaging the Magnetization Process in Silicon Steel using Polarized Neutrons

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Ferromagnetic metals are commonly used as high performance magnetic core materials. Especially for application in transformers, grain oriented (GO) silicon steels stand out due to their uniaxial magnetic properties, which are founded in their strongly textured crystal structure. Since most techniques for investigating magnetic properties integrate over large sample volumes (magnetization and magnetic susceptibility) or are restricted to the sample surface (Kerr-effect microscopy), it is challenging to obtain information on the local bulk properties. In this regard, polarized neutron imaging (PNI) is a perfectly suited method. It combines the spatial resolution of imaging with the magnetic interaction of the neutron spin. By evaluating changes in the spin-polarization, effects of magnetic order and disorder can be analysed. The technique has seen substantial developed in recent years, with applications such as visualizing large magnetic domains or magnetic vector-fields. Here, we present a study of the magnetization process of a GO silicon steel sheet, while also focusing on the experimental setup, since PNI has high demands towards the magnetic field setup. We have combined finite element and ray tracing simulations to model the magnetic environment as well as its impact on the neutron polarization. Our results show how PNI can be used to understand the magnetization process in a ferromagnetic material with a focus on the impact of macroscopic inhomogeneity.

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