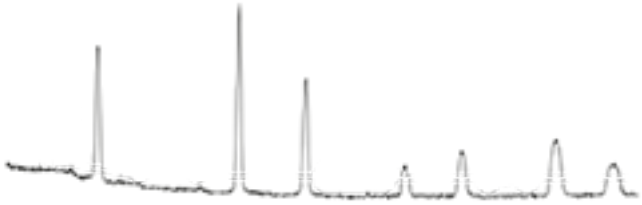

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Targeted use of residual stress in electrical steel to increase energy efficiency

Friday, 3 June 2022 11:10 (20 minutes)

The magnetic flux guidance in an electric engine is usually achieved by introducing cutouts in the electrical steel (ES) sheets that make up its core. However, these cutouts create thin structures, reducing the mechanical strength of the ES sheets and limiting the achievable maximum rotational speed and therefore the energy efficiency of the engine.
Residual stress in ES sheets reduces the mobility of magnetic-domain walls due to the magneto-elastic effect. This can be utilized to create a novel type of magnetic flux barriers relying on the local decrease in magnetic permeability introduced by embossing of the ES sheet. Such barriers do not compromise the structural integrity of the sheets.
The influence of various embossing parameters on the residual stress state was calculated by Finite-Element simulations and probed using neutron grating interferometry (nGI). In nGI the dark field image (DFI) maps ultra-small-angle neutron scattering as resulting from the interaction of the magnetic moment of the neutron with the magnetic domain structure in the bulk of the sheet sample. In an applied magnetic field, a change in the domain size therefore results in a change of the DFI signal. Hence, enabling the visualization of the local distribution of magnetization.
Prototypes of magnetic flux barriers based on the magneto-elastic effect show similar flux guidance as traditional barriers while the mechanical strength is comparable to unworked ES.
In this presentation we will give a comprehensive overview of the effect of residual stress on the magnetic properties of electrical steel as well as show the applicability of nGI to probe such materials.

Primary authors: SCHAUERTE, Benedikt (Institut für elektrische Maschinen, RWTH Aachen); GILCH, Ines (Lehrstuhl für Umformtechnik und Gießereiwesen, Technische Universität München); SEBOLD, Simon (MLZ); SCHULZ, Michael; NEUWIRTH, Tobias

Presenter: SEBOLD, Simon (MLZ)

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