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Targeted residual stress in electrical steel –Towards novel electric drives

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Transportation, particularly motorized private transport, contributes significantly to fossil fuel con-sumption. Here, transitioning to battery electric vehicles (BEVs) is an option to reduce the con-sumption of fossil fuels. Electric drives used in BEVs require the careful guidance of the magnetic flux in the rotor. The rotor comprises a stack of non-oriented electrical steel sheets. Conventional-ly, material is removed from the sheets to create flux barriers. These removed areas reduce the mechanical strength and, hence, the achievable rotational speed of the drive, which affects its power density and efficiency. We showed that residual stress introduced by embossing, a local forming process, locally reduces the magnetic permeability. The locally reduced permeability dis-places the magnetic flux from these regions and concentrates it in other areas. Neutron grating interferometry, an advanced neutron imaging technique, is uniquely capable of mapping the magnetic flux displacement with high spatial resolution in the bulk of electrical steel.
In our contribution, we will present how nGI allowed us to verify the magnetic flux guidance by mapping the dependence of magnetic domain size and orientation on material parameters and applied magnetic field. Further, we will show our collaboration with mechanical and electrical en-gineering and an industry partner in a DFG transfer project to build more efficient electric drives using residual stress to guide the magnetic flux.

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