Effect of Cold Rolling Conditions on Texture, Microstructure, and Magnetic Properties of Grain Oriented Electrical Steel

Ozdal Taner[1], M. Farahani Sohrab[2], Teodorescu Mihaela[2], Zaefferer Stefan[1, *]

[1]*Department of Microstructure Physics and Alloy Design, Max Planck Institute for Sustainable Materials GmbH, Max-Planck Street 1, 40237, Dusseldorf, Germany*
[2]*Thyssenkrupp Electrical Steel UGO S.A.S Rue Roger Salengro- B.P. 23- 62330 Isbergues, France*
E-mail: t.ozdal@mpie.de

Grain Oriented Electrical Steels (GOES) are soft magnetic materials with nominal composition Fe-Si 3wt.%, and they are mainly used as the core material of transformers. In order to increase the energy transition efficiency of the transformer, total core loss including hysteresis, eddy current, and anomalous losses of the electrical steels should be minimized. The key practices to ameliorate the magnetic properties of GOES are the strict control over the composition, microstructure, and crystallographic texture of the final processed material. In this context, <001> crystal direction is desired to align parallel to the magnetic flux in transformer cores. Industrially, this is best realized by the Goss texture {110}<100>. GOES are characterized by their large grain size in several centimeter range and sharp texture which are achieved by the abnormal growth of Goss oriented grains occurring during the secondary annealing stage. Extensive efforts have been devoted for decades to decrease the deviation from Goss texture down to 3° in high permeability grades.

In this study, the effects of two different cold rolling procedures, with small (RouteI) and large (RouteII) working cylinders, on the texture, microstructure, and magnetic properties of GOES are investigated. Electron Backscattered Diffraction (EBSD) technique together with novel Spherical Indexing methodology is adopted for microstructural and microtextural investigation. In the study; initial materials for two cold rolling mills, final cold rolled materials by RouteI and RouteII, and final processed materials are investigated and compared regarding their microstructural, microtextural and magnetic properties. Large scale EBSD results prove that although the initial materials before cold rolling are identical, cold rolled sheet processed with RouteI and RouteII show alterations in their overall texture and spectral distribution of point to point misorientation values. In the final processed state, substantial differences are observed in their magnetization and power loss values of the GOES sheets processed by RouteI and RouteII.