Organized by Sevilla University

23rd SOFT MAGNETIC MATERIALS *Conference*

Abstracts

Impact of the Interaction of Material Production and Mechanical Processing on the Magnetic Properties of Non-oriented Electrical Steel

Kay Hameyer (1), Nora Leuning (1), Simon Steentjes (1), Anett Stöcker (2), Rudolf Kawalla (2), Xuefei Wei (3), Jens Dierdorf (3), Gerhard Hirt (3), Stefan Roggenbuck (4), Sandra Korte-Kerzel (4), Hannes, A. Weiss (5), Wolfram Volk (5)

(1) Institute of Electrical Machines (IEM), RWTH Aachen University, D-52062 Aachen, Germany; (2) Institute of Metal Forming (IMF), Technische Universität Bergakademie Freiberg, D 09596 Freiberg, Germany; (3) Institute of Metal Forming (IBF), RWTH Aachen University, D-52062 Aachen, Germany; (4) Institute of Physical Metallurgy and Metal Physics (IMM), RWTH Aachen University, D-52062 Aachen, Germany; (5) Institute of Metal Forming and Casting (utg), Technische Universität München, D 85748 Garching, Germany

The efficiency and performance of rotating electrical machines are largely determined by the magnetic characteristics of the fully-finished, non-oriented electrical steel sheets used for the magnetic core of the machines. In case of electrical steels with silicon contents above 2 wt.% Si the magnetic properties in the final geometry are a result of all preceding production and processing steps, because no austenitic phase transition occurs with this alloying condition. Properties are inherited over the different processing steps [1] [2] and thus, a detailed consideration of the consecutive impact on the material has to be established with further consideration of interdependencies, especially between the annealed sheet material and the mechanical processing [3]. In order to understand the processes, improve material modeling and finally deduce production strategies to improve the magnetic properties of the final laminations, a comprehensive study needs to be performed.

In this paper results of a large-scale experimental study on the production and processing of nine different material states due to different production routes and further interaction with different cutting parameters, i.e., cutting clearance and wear state of the tool are presented. Based on one 2.4 wt% Si alloy two different, homogenous hot bands with 1.0 mm and 2.4 mm thickness are produced. Three different cold rolling reductions lead to final thicknesses of 0.5 mm and 0.25mm steel strip which is annealed at 800° to 1200°C. In immediate proximity to industrial standards cutting experiments are performed on an industrial mechanical single action press with variation of cutting clearance of 3%, 7% and 14% and both a sharp and worn tool. Detailed microstructure and texture analysis of the material states according to previously established techniques in different layers over the steel cross section is applied. Thereby, the homogeneity an anisotropy in microstructure, which can vary significantly for different final states can be accounted for. Subject of this paper is the micro-macro-mapping of magnetic properties and microstructure, texture and mechanical stress due to the production process. In the end a final evaluation of strong interdependencies and distinguishable tendencies is presented.

[1] H. Pan, Z. Zhang, and J. Xie, 'Preparation of High Silicon Electrical Steel Sheets with Strong {100} Recrystallization Texture by the Texture Inheritance of Initial Columnar Grains', Metall and Mat Trans A, vol. 47, no. 5, pp. 2277–2285, Feb. 2016.

[2] S. Steentjes, N. Leuning, J. Dierdorf, X. Wei, G. Hirt, H. A. Weiss, W. Volk, S. Roggenbuck, S. Korte-Kerzel, A. Stoecker, R. Kawalla, and K. Hameyer, 'Effect of the Interdependence of Cold Rolling Strategies and Subsequent Punching on Magnetic Properties of NO Steel Sheets', IEEE Transactions on Magnetics, vol. 52, no. 5, pp. 1–4, May 2016.

[3] H.A. Weiss, N. Leuning, S. Steentjes, K. Hameyer, T. Andorfer, S. Jenner, and W. Volk, 'Influence of shear cutting parameters on the electromagnetic properties of non-oriented electrical steel sheets', Journal of Magnetism and Magnetic Materials, vol. 421, pp. 250–259, Jan. 2017.