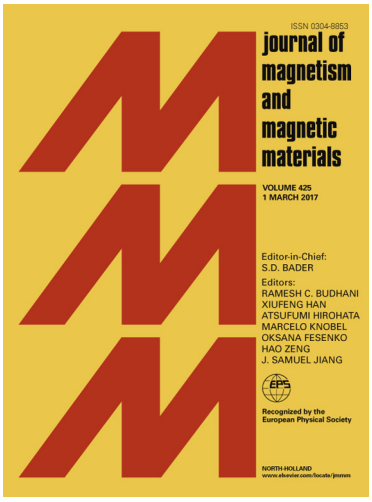

Through-Process Characterization of Local Anisotropy of Non-oriented Electrical Steel Using Magnetic Barkhausen Noise

Youliang He, Mehdi Mehdi, Erik J. Hilinski, Afsaneh Edrisy

PII: S0304-8853(17)33069-X
DOI: https://doi.org/10.1016/j.jmmm.2018.01.023
Reference: MAGMA 63601

To appear in: *Journal of Magnetism and Magnetic Materials*

Received Date: 27 September 2017
Revised Date: 15 December 2017
Accepted Date: 10 January 2018

Please cite this article as: Y. He, M. Mehdi, E.J. Hilinski, A. Edrisy, Through-Process Characterization of Local Anisotropy of Non-oriented Electrical Steel Using Magnetic Barkhausen Noise, *Journal of Magnetism and Magnetic Materials* (2018), doi: https://doi.org/10.1016/j.jmmm.2018.01.023

Through-Process Characterization of Local Anisotropy of Non-oriented Electrical Steel Using Magnetic Barkhausen Noise

Youliang He[1*], Mehdi Mehdi[1, 2], Erik J. Hilinski[3], Afsaneh Edrisy[2]

[1]CanmetMATERIALS, Natural Resources Canada, Hamilton, ON, Canada L8P 0A5
[2]Department of Mechanical, Automotive, and Materials Engineering, University of Windsor, Windsor, ON, Canada N9B 3P4
[3]Tempel Steel Co., Chicago, IL, USA 60640-1020

*Corresponding author: youliang.he@canada.ca

Abstract

Magnetic Barkhausen noise (MBN) signals were measured on a non-oriented electrical steel through all the thermomechanical processing stages, i.e. hot rolling, hot band annealing, cold rolling and final annealing. The temperature of the final annealing was varied from 600°C to 750°C so that the steel consisted of partially or completely recrystallized microstructures and different levels of residual stresses. The angular MBN_{rms} (root mean square) values were compared to the texture factors in the same directions, the latter being calculated from the crystallographic texture measured by electron backscatter diffraction (EBSD). It was found that, in the cold-rolled, hot-rolled and completely recrystallized steels, the angular MBN_{rms} followed a cosine function with respect to the angle of magnetization, while in partially recrystallized state such a relation does not exist. After cold rolling, the maximum MBN_{rms} was observed in the rolling direction (RD) and the minimum MBN_{rms} was in the transverse direction (TD), which was inconsistent with the magnetocrystalline anisotropy as indicated by the texture factor. After hot rolling, the maximum and minimum MBN_{rms} values were observed in the TD and RD, respectively, exactly opposite to the cold-rolled state. If the steel was completely recrystallized, the maximum MBN_{rms} was normally observed at a direction that was 15°-30° from the minimum texture factor. If the steel was partially recrystallized, both the magnetocrystalline anisotropy of the material and the residual stress contributed to the angular MBN_{rms}, which resulted in the deviation of the relationship from a cosine function. The relative strength of the two factors determined which factor would dominate the overall magnetic anisotropy.

Keywords: Non-oriented electrical steel, magnetic Barkhausen noise, texture factor, rolling, annealing, anisotropy, EBSD.