Laboratoire d'électrotechnique et d'électronique de puissance de Lille

Master project, 2020 − 2021

To a phenomenological modeling of the magnetic hysteresis of grain-oriented materials

Supervisors: O. Messal ; A. Benabou | oualid.messal@univ-lille.fr ; abdelkader.benabou@univ-lille.fr
Univ. de Lille | L2EP
Cité Scientifique, Bât. ESPRIT
Avenue Henri Poincaré, 59655 Villeneuve d'Ascq
+33 3 62 26 82 28

Context and objective

The association − nonlinearity, anisotropy and hysteresis − makes the grain-oriented (GO) SiFe material complex in terms of its magnetic behavior which depends on the angle θ between the applied magnetic field and the rolling direction (RD) as shown in Fig.1. The aim of this Master project is to explore the ability of hysteresis models to take into account the strong anisotropy of GO SiFe materials used in electrical devices such as turbo-generators and transformers. Indeed, the design of these devices to improve their energy efficiency and also their diagnosis based on modeling, requires reliable and precise material model.

We will explore the theory of magnetic domains to reproduce the static and dynamic magnetization cycles whatever the angle θ between the applied field and RD, in unidirectional and even bidirectional regimes. The consideration of complex waveforms will also be investigated.

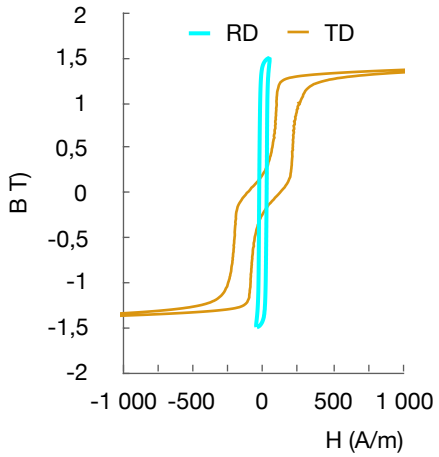

Fig.1. 50 Hz measured magnetic response of a GO SiFe material to an applied field along the RD ($\theta = 0°$) and TD ($\theta = 90°$) directions.

Key words

Anisotropy, GO SiFe materials, magnetic hysteresis.

References

L. Néel, "Les lois de l'aimantation et de la subdivision en domaines élémentaires du monocristal de fer …", J. Phys. Rad., 1944.

Hubert, R. Schäfer, "Magnetic domains: the analysis of magnetic microstructures", Springer, ISBN 978-3-540-64108-7, 2009.

C. Appino, F. Fiorillo *et al.*, "Static and dynamic energy losses along different directions in GO steel sheets", JMMM, 2020.