A HYBRID STATISTICAL MODEL OF THE MAGNETIC ANISOTROPY OF GOSS TEXTURED SILICON STEEL

H. Vande Sande[1], W. Deprez[1], F. Henrotte[1], K. Hameyer[1] and L. Froyen[2]
Katholieke Universiteit Leuven, [1]ESAT- ELECTA, Kasteelpark Arenberg 10, [2]MTM, Kasteelpark Arenberg 44, B-3001 Heverlee-Leuven, Belgium

Goss textured silicon steel laminations are commonly used in the cores of electrical transformers because of their high permeability. In practice, the flux lines are parallel to the longitudinal axes of the sheets in the major part of the transformer core. Due to the Goss texture, the material behaves magnetically anisotropic [2]. With an Epstein frame or a single sheet tester, it is possible to measure the non-linear and anisotropic behaviour of the material. Due to the unidirectional character of such measurements, one cannot retrieve the direction of the magnetization vector. This paper proposes a way to determine this direction by combining the information obtained from measurements, the total energy function and the crystal orientation distribution function (CODF).
The macroscopic behaviour is the result of microscopic processes. It can be described in terms of a competition between field energy and anisotropy energy [2]. Assuming that all flux lines are parallel to the surface of the soft-magnetic sheet, the equations for these energies can be simplified. The direction of the magnetization vector in the cubic crystal, when the magnitude and direction of the applied field vector are given, is then determined by the minimum of the total energy function. The link between the microscopic and the macroscopic level is drawn by means of the CODF, which statistically expresses the fact that a perfect Goss texture does not exist in practice [3]. It is possible as well to simplify the CODF into a probabilistic function describing the distribution of the $< 001 >$ crystal axes in the surface of the sheet. By determining the magnetization direction for each fraction of crystals and averaging the result over all fractions, the direction of the global magnetization vector is obtained. In the following steps of this approach, its magnitude can be determined from the measured magnetization curves. With these elements, the magnetic anisotropy is entirely defined and all components of the permeability tensor can be computed.

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