DOMAIN RECONSTRUCTIONS OF G.O. SiFe UNDER ROTATIONAL MAGNETIZAION WITH DC BIAS

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The rather few investigations on magnetic domain reconstructions during rotational magnetization (RM) - as being typical for T-joints of transformer cores - tend to be restricted to single grains (e.g. [1]). In closer studies of polycrystalline highly grain oriented (HGO) SiFe, we found that grains react in very individual ways which indicates that statistical methods are needed for industrially relevant conclusions. As well known, RM involves the formation of oblique domains (ODs), which are magnetized in [010] or [100], i.e. out of plane. ODs are the reason for very high values of magnetostriction (MS), in special if DC-bias is involved as a further parameter. The present paper presents results for HGO samples, comparing the biased case with the non-biased one.

Experiments were made by means of a rotational single sheet tester (RSST) for the synthesis of 20 induction vector positions $\boldsymbol{B}(\psi)$ (with ψ the rotation angle) as arising during a period of steady-state RM of elliptic type. The axis ratio a was varied between 0 and 0.5, according to industrial conditions. Domain configurations on polished samples with ZnS-evaporation were studied by means of Kerr effect method with software contrast enhancement. Averaging over several grains and samples, respectively, statistical evaluations were based on the determination of area portions OD which are characterized by oblique domain patterns, as a function of ψ.

Fig.1 shows a function $OD(\psi)$ for a period of RM with super-imposed DC-bias acting in rolling direction (RD). The instant of $\psi = 0$ corresponds to the de-loaded case thus revealing mere bar domains ($OD = 0$). Rotation of $\boldsymbol{B}$ to the transverse direction (TD) causes a rising amount of ODs (domain image A for ψ = 20°). Maximum OD is reached at 160°. As a specific mechanism, further rotation to the saturated position 180° (image B) is characterized by a very sharp "jump" to $OD = 0$, followed then by a re-jump up to OD = 80% (image C).

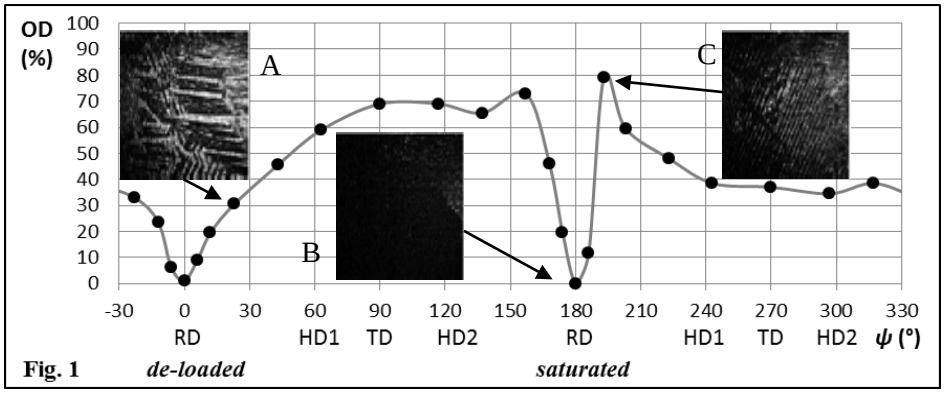

Fig. 1

A priori, the corresponding domain reconstructions occur in complex ways which are governed by distinct hysteresis. But as a significant finding, the results indicate that processes of sharp annihilation and generation of oblique domains are involved, in special in cases of DC-bias. This should have consequences on anomalous eddy current losses, but also on MS. The peak-to-peak intensity of the latter should not be affected. However, the discontinuous "jumps" offer an explanation for the finding that both RM and DC-bias tend to increase the higher harmonics of MS. Thus they have relevance for audible noise, considering the human ears high sensitivity to harmonics.

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[1] TIUNOV, V. – FILIPPOV, B.: Dynamics of the Domain Structure and Magnetic Losses of Fe-3% Single Crystals in Rotating Magnetic Fields, *Phys.Met. Metallogr.* **102**-3 (2006), 259-267.

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