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Abstracts

Influence of residual and external stress on the Villari effect and magnetostriction in high-silicon electrical steel sheet

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Mechanical stress has a severe effect on the magnetic properties of electrical steel. Commonly, mechanical stress deteriorates the magnetic properties, i.e., increases loss and impairs magnetization but under certain, limited conditions, applied stress can also have a beneficial effects on the magnetic properties. In [1], [2] and [3] a characteristic, strong decrease of loss with tensile stress for different materials and conditions is observed for small stress, followed by a steady increase. Still, at medium tensile stress, the loss is smaller compared with the unloaded state. For [1] and [3] this effect is limited to samples in transverse direction relative to the rolling direction. The influence of mechanical stress is therefore complex. It depends on a number of factors including the direction of applied or induced stress, the magnitude of the stress and intrinsic material properties like the mechanical strength or the magnetostriction [4]. In this context the magnetostriction is of significant importance, because it has a determining effect on the way the material reacts to stress with either a positive or negative change in characteristic magnetic values. In order to further understand occurring effects and material behavior the interactions of magnetostriction of electrical steel sheets and externally applied stress has to be identified and studied.

In this paper the effect of stress relief annealing on the magnetostriction behavior of two fully-finished 2.4 wt.% Si and 2.9 wt.% Si is studied. The results give insight to the role of initial stress state of the steel sheets on the anisotropy in the as-delivered state and further, on the stress dependency of the sheets. To allow a comprehensive observation, samples in 0°, 45° and 90° relative to the rolling direction (RD) are studied. The magnetostriction is determined in the unloaded state for the non-annealed and annealed samples. Both sample sets are then magnetically analyzed in respect to changes in their behavior under low and medium tensile stress. With this experimental approach, the interdependencies between magnetostriction and magnetic properties can be further studied and the role of initial stress state of industrially manufactured steel sheets can be evaluated.

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