Effect of laser scribing on the core losses and magnetic domain structure

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The present research investigated the influence of laser scribing process on the core losses by magnetic domain refinement. The experimental material was represented by conventional Fe-3%Si and 0,27mm thickness grain oriented electrical steel. Laser scribing involves a laser beam striking the surface of the steel transverse to the rolling direction in order to induce micro tensile stress that refines the magnetic domain, reducing the spacing between domain walls. Consequently, the portion of the anomalous loss is also reduced. Epstein samples were submitted to laser treatment at different angles, in order to understand the behaviour of domain structure and its influence on the magnetic properties. The samples, after scribing, have shown a reduction in total magnetic loss up to 10% and nucleation of new 180º domain walls.

Keywords: Laser scribing; magnetic domain, magnetic properties, grain oriented electrical steel, domain viewer.

1. Introduction

Grain oriented electrical steel (GOES) is mainly applied on the core of transformers that are responsible for transmitting power between generation and distribution systems. The growing global demand for efficient electrical power equipment strongly drives the development of steels with lower magnetic losses and higher permeability.

The laser scribing treatment of GOES has proven to be an effective technique to enhance their magnetic properties. The use of local micro tensile stress along the rolling direction on the surface of GOES reduces the size of the 180º magnetic domain by changing the magnoelastic and magnetostatic energy of the material. Anomalous losses decrease with decreasing 180º wall spacing and increase with increasing amount of 90º domains [1,2].

2. Results and discussion

The greatest reduction in total losses was observed with laser scribing at 0º, corresponding to the transverse direction of the sample, reducing the core loss more than 10%. The amount of domain walls is shown in Figure 1. After laser treatment was observed the domain refinement. From 10º onwards, the efficiency of magnetic domain refinement is significantly impacted. This suggests that the tensile stress applied by the laser is no longer effective enough to refine the spacing between the walls, as observed in Figure 2. At 90º, corresponding to rolling direction, there was an increase in losses, reaching an increase of up to 5%.

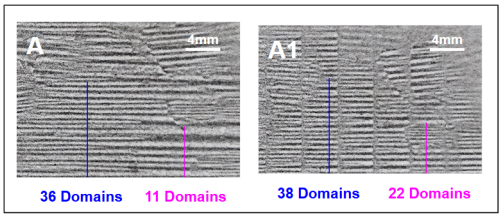

Figure 1: Amount of domain walls before (A) and after (A1) laser treatment at transverse direction.

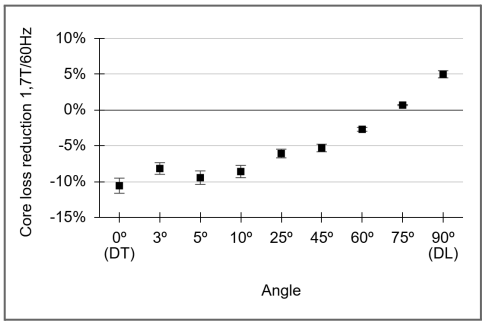

Figure 2: Reduction of total magnetic loss as a function of the laser scribing angle.

References

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