THE EFFECT OF HOT BAND GRAIN SIZE ON THE TEXTURE OF RECRYSTALLIZED 1.25 %SI ELECTRICAL STEELS

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The magnetic properties of steels used in electrical motors are directly related to the microstructure. In that case, one of the most influential aspects of the microstructure is the orientation of the grains, i. e., the crystallographic texture. The ideal texture for electrical steels should be formed by grains that contain <100> direction (easy magnetization direction). Thus, grains with $\{100\}$ orientations parallel to surface of sheet are preferable, while grains with $\{111\}$ and $\{112\}$ orientations should be avoided.

In the last decade, it has been found some evidence¹ in low carbon steels that nucleation at grain boundaries would lead to recrystallized grains with orientations near to {111}, while nucleation at transition bands would favor {110} or {100} orientations. Therefore, it is presumable that increasing the hot band grain size it is possible to improve the texture of electrical steels. To verify if similar behavior occurs in Si alloyed electrical steels, a 1.25% Si steel was submitted to different cold rolling reductions which were subsequently annealed, resulting in the starting hot bands A (22 μ m), B (125 μ m) and C (500 μ m). These samples were then submitted to a 88% reduction. They were recrystallized after annealing at 700°C during 5 min. The microstructure was examined by scanning electron microscope, optical microscope, and by etch-pit technique². The crystallographic texture was determined in a Philips X'Pert diffractometer by means of ODF.

Figure 1 shows recrystallization nucleus at transition bands and grain boundaries for sample C (500 μ m). (recrystallization was interrupted after 5 min at 580°C). This is an evidence that nucleation occurs in both places, perhaps simultaneously.

Figures 2, 3 and 4 shows ODFs sections $\varphi_2 = 0^{\circ}$ and $\varphi_2 = 45^{\circ}$ (Bunge notation) for the samples A, B and C, respectively. There is a drastic change between A sample to B and C samples. The texture of sample A contains as main components (8 3 3) [0 1 1], (1 1 1) [2 3 1], (1 1 3) [1 1 0], and other components that are not the most suitable for an electrical steel. The texture of B sample presents a very sharp Goss (011) [1 0 0] component together with a significant fiber {111}. The texture of C sample is very similar to B sample, but some new components, like cube on face (100) [001] appears. The texture of B and C samples seems better for an electrical steel than that of A sample, suggesting that the hot band annealing is a viable option to optimize texture in electrical steels. There is some doubt if the resulting textures are only an effect of grain boundary area. During rolling, the region near the grain boundaries accommodates more deformation than internal region. Thus, if the hot band grain size is very small, there would be less tendency to form transition bands.

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1. Ray, R. K.; Jonas, J. J.; Hook, R. E. Int. Mat. Rev., v. 39, n. 4, p 129, 1994.

2 Takanohashi et al., this conference.



Figure 1. Microstructure of sample C, when recrystallization was interrupted.



Figure 2. ODF sections $(\phi_2=0^\circ \text{ and } \phi_2=45^\circ)$ for sample A (hot band grain size = 22 µm).

Figure 3. ODF sections $(\phi_2=0^\circ \text{ and } \phi_2=45^\circ)$ for sample B (hot band grain size = 120 µm).

Figure 4. ODF sections $(\phi_2=0^\circ \text{ and } \phi_2=45^\circ)$ for sample C (hot band grain size = 500 µm).