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GRAIN ORIENTATION CLUSTERS IN RECRYSTALLIZED 1.25%Si STEEL

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The magnetic properties of electrical steels are related to its crystallographic texture. Takashima[1] has shown that large hot-band grain size before cold rolling leads to a better final texture. To investigate details of grain orientation distribution in the final recrystallized state, this paper discusses texture and etch pit observation[2] results. A 1.25%Si steel ingot was hot rolled to 3.2mm thickness, its grain size was increased from 22 to 500µm by slight cold rolling followed by annealing. The hot-band was cold rolled down to 0.3mm and subjected to final annealing at 700^{o}C, as described elsewhere in more detail[3] .

Texture measurements were performed, using a Philips diffractometer model X'Pert XRD. Figure 1 shows an ODF section at φ_2=45^{o} (Bunge notation). Goss component is the main one, with relative intensity above 8. Two other components are also important: the {111}fiber reaches relative intensity of 5 in the (111) $[1\ \bar{2}\ 1]$ and the "cube-on-face" (001) [100] reaches intensity above 3.

Cold rolled microstructures contains the "deformation lines" described previously[4] . Those "lines" are connected to the deformation and transition bands typical of deformed steel and are preferred recrystallization nucleation sites in deformed, large hot-band grain size, materials[1]. We have found grain size distribution clusters in the recrystallized condition, as shown in Figure 2. Interrupted recrystallization experiments have shown that the recrystallization kinetics is different in each large deformed grain[3], causing clusters of different recrystallized grain sizes. This inhomogeneity must be related to differences in work hardening between different original hot-band grains, each with its own Taylor factor.

Figure 3 shows grain boundaries and etch pits in a section parallel to the sheet surface, with large grains in the upper part and small grains in the lower part. Almost all grains in the small grain cluster have etch-pits related to the Goss component, whereas the large grain region shows a rather random distribution of etch pit orientations, with the triangles of near {111} orientation side by side with the squares of the near {100} orientation. Figure 4 shows another large grain size region where many grains have square shaped etch pits of the near {100} orientations, although no precise direction orientation is defined. The fit between the ODF results and the etch pits interpretation is very good.

Figures 3 and 4 show that grain orientation clusters are an important feature of the texture distribution in cold rolled and recrystallized large grain size hot-band. They also show that the grain orientation clusters are closely associated with grain size distribution clusters. As we have shown that the grain size clusters are related to the original hot band grain orientations, the hot-band texture must have a very important effect on the final texture of the electrical steels, specially when large hot-band grain sizes are used.

An open question is the interpretation of the origin of the small grained Goss textured regions. Its small grain size can be the recrystallization product of large work hardening. So, that region should be the result of independent but similar nucleation mechanism in a large heavily worked region. On the other hand, that region may be the result of recovery, not recrystallization, of an hot-band Goss oriented grain, as that orientation has the lowest Taylor factor and so its work hardening could be minimum. Further work is needed to clarify this question.

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References

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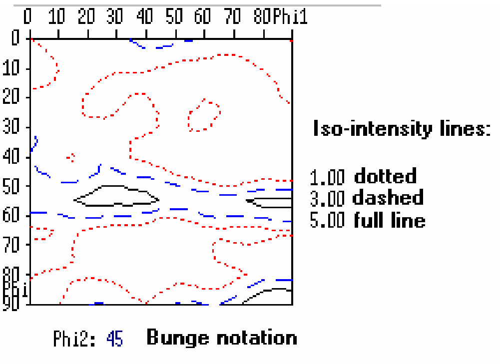

Figure 1. ODF section at φ_2=45^o of 1.25%Si steel.

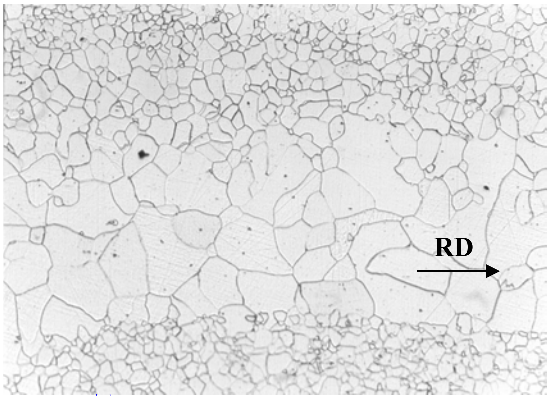

Figure 2. Section parallel to sheet surface showing cluster of large grains surrounded by clusters of small grains. Magnification 100x.

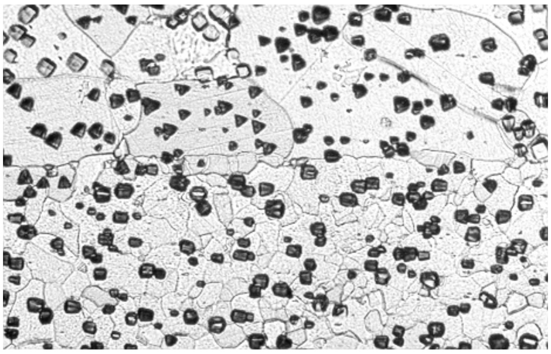

Figure 3. Etch pits show rectangles of Goss orientation in the small grain size region. Magnification 230x.

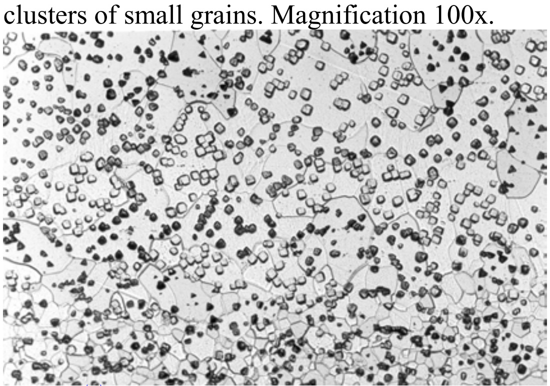

Figure 4. Etch pits show cluster of (100) fiber grains in the grain size region. Magnification 127x.

Comentário: Amostra 3529 (n.7) Foto filme 169, foto 5,

Comentário: amostra 3529 (n.7) filme 169, foto 4