ETCH PIT METHOD FOR IDENTIFICATION OF PREFERENCIAL DIRECTIONS IN ELECTRIC STEEL

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INTRODUCTION

Electric steels have important work on power industry in all the world. Around 50% from electric energy yearly produced, have utility on traction engines. Some part of this energy is dissipated like "electric losses". The Fe-Si steels, developed and commercialized since 1933, have excellent magnectical properties in the direction of lamination, that make it useful in transformer core, power generators and others.

This work shows the texture characterization of a Fe-Si sheet, initially hot worked, with SEM to compare with others techniques (electron and x-ray diffraction).

For the texture characterization are usually necessary mathematical methods to confirm the etch-pits of the electric steels samples(1, 2).

EXPERIMENTAL PROCEDURES

The samples in study are supplied by the CIA. AÇOS ESPECIAIS ITABIRA - ACESITA, which was conformed by hot compression process, with one and two holding time, to simulate the Steckel process, in the Mechanical Laboratory – Metallurgical and Materials Science Engineering Department of UFMG, Belo Horizonte, MG. .

The work on the sample preparation follow the usual methods. In the stage of chemical etching, was prepared solutions which best reveals the texture structure (etch pit), by selective etching in three stages. The solutions for each stage are described bellow:

1° stage: 12 ml distilled water + 6 ml H_2O_2 + 1ml HCl

2° stage: 12 ml distilled water + 6 ml HCl

3° stage: 12 ml distilled water + 2,2 g Fe_3SO_4 + 2,2 ml H_2SO_4

Varying the time of etch from 5 to 15 s. This chemical etching, remove the crystallographic planes with low index, such as (100), (110), (111), and then consequently shaped the etch pits.

The samples was observed by SEM on the JEOL JSM 840 A, from the Institute of Physics of the University of São Paulo.

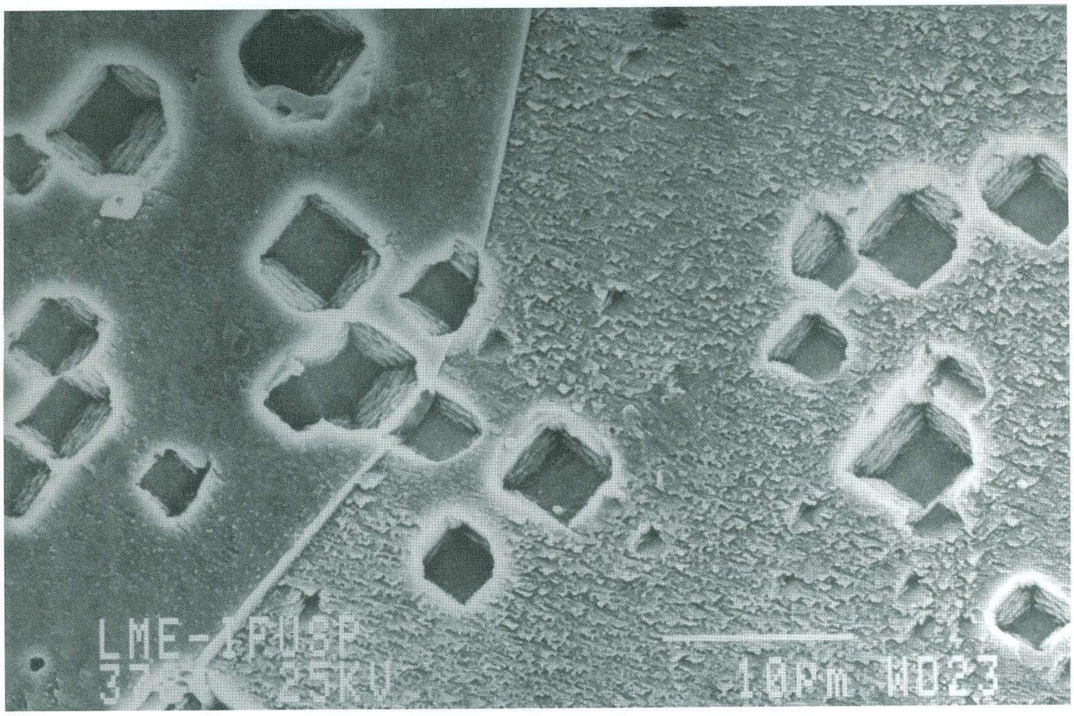

Fig 2: Grains of Fe-3%Si, with two holding time, both grains with the orientation [100]

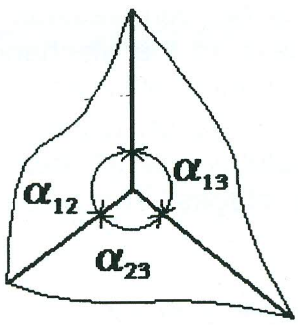

Fig. 3: Basic plan showing the measured angles

RESULTS AND DISCUSSION

The aspects of the etch pits are function of the orientations of grain surfaces. These etch pits may change in size and can be best revealed or not. Since the inner intersecting line are perpendiculars, the inner angles of etch pits are easily observed.

The SEM images show a projection from one region of hollow body in cubic shape in a parallel plane to sheet surface.

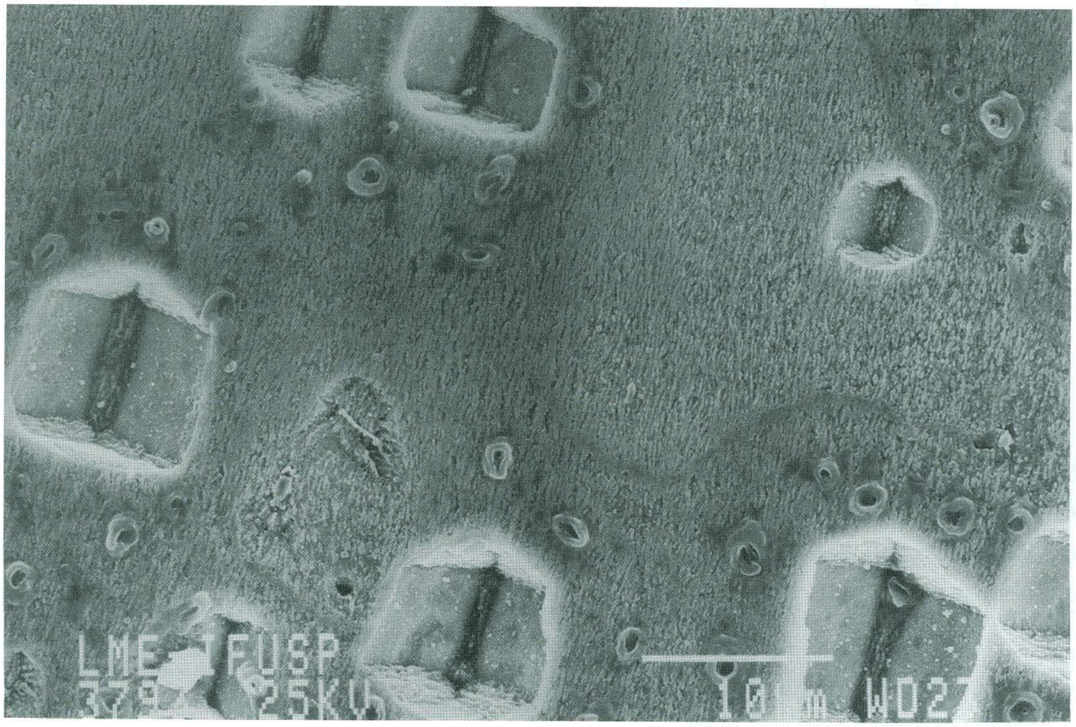

Fig. 1-Grain of Fe-3%Si with on holding time, orientation [211] (etch – pit figure).

The identification method of the grain orientation starts with the measurements of the angle of the intersections of low index planes, where is employed the equations I, II and III and compare with the theoretical table (see table 1) which contains the angles that will serve of comparison with those measured directly of etch pits.(see figure 3).

$$\cos\alpha_{12} = -\frac{|h.k|}{\sqrt{(h^2+l^2)(k^2+l^2)}} \qquad \textbf{equation I}$$

$$\cos\alpha_{13} = -\frac{|h.l|}{\sqrt{(h^2+k^2)(k^2+l^2)}} \qquad \textbf{equation II}$$

$$\cos\alpha_{23} = -\frac{|h.l|}{\sqrt{(h^2+k^2)(h^2+l^2)}} \qquad \textbf{equation III}$$

Table 1- Theoretical relation between the angles in the etch – pit figure and the corresponding orientation

ANGLES			(HKL)
120	120	120	(111)
119	119	123	(766)
119	119	122	(877)
118	118	124	(544)
118	118	123	(655)
117	117	127	(755)
117	117	126	(433)
116	116	128	(322)
115	118	127	(865)
115	115	131	(533)
109	99	152	(852)
107	97	156	(841)
105	98	157	(520)

CONCLUSION

This method, relatively simple, help us to complement others methods with the same purpose that is to verify the crystallographic orientation (texture of the material) in the steels with grains of medium and large size.

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