Transmission electron microscopy in the microstructure study of electrical steel Fe-3%Si.

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Precipitation processes play a important role in the microstructure steel. TEM is usually used to investigate precipitation. The precipitation of manganese sulfide particles has been extensively studied in commercial silicon steel. The basic metallurgical principle to produce oriented texture in grain-oriented electrical steel is developed through a process called secondary recrystallization. In this process second particles phase are used as "inhibitor" of grain growth during recrystallization [1].

The aim of this work is the influence study of manganese sulfide particles precipitation in the Fe-3%Si microstructure.

Grain-oriented electrical silicon steel (Fe-3%Si) was heat treated and mechanically conformed by hot compression process. The analysis of MnS particles precipitation has been made with samples processed at different conditions. In order to study precipitation behavior of MnS particles, samples were heated at 1573K for 1800s. After the specimens were cooled down to 1373 and 1273K and hold for. 60s (first holding time) when the compression of 50% is applied, then the compression of 30% is applied during the second holding time (32, 60 and 338s), then water quenched. The characterization of grain size was carried out using optical microscopy. The study of precipitation has been carried out on the surface and the center of each sample. For TEM characterization of MnS particles an extraction replica technique has been used. The particle diameter was measured by image analyser.

Optical micrographs showed that the grain size increases with the second holding time process for the two temperatures on the two studied regions. One of the electron microscopic photografs obtained after compression test at 1273 and 1373K for 32, 60, and 338 seconds on the surface and the center of sample is shown at the top of figures 1 and 2, while the size distribution associated is displayed at the foot of this figures. The size distribution shows that particle diameter after the hot compression process decreases with the increase of the second holding time in the two studied temperatures and regions. In the center of the sample, the mean particle size is minor than in the surface for two temperatures. Possibly that in this region do not have enough defects for precipitation. The decrease of particle size with increasing holding time is possibly explained as the result of increase in the number of newly precipitated particles. This result shows that newly precipitation process prevails over growth or Ostwald ripening of precipitated [1]. However, hot compression process with two holding time provides more dislocation and defects increasing the possibility of MnS particles precipitate and providing higher MnS particle density [2,3].

References

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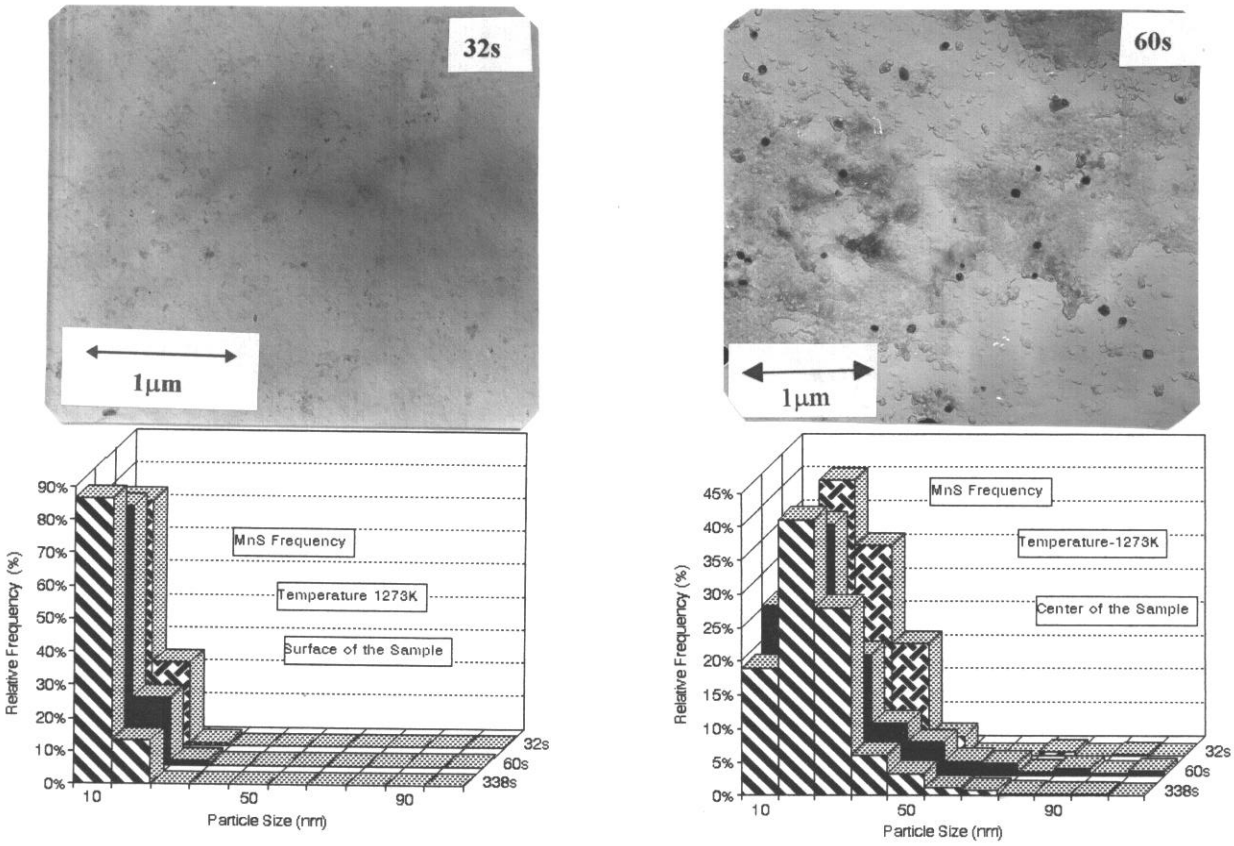

Fig.1.MnS precipitates and their particle size distribution at 1273K.

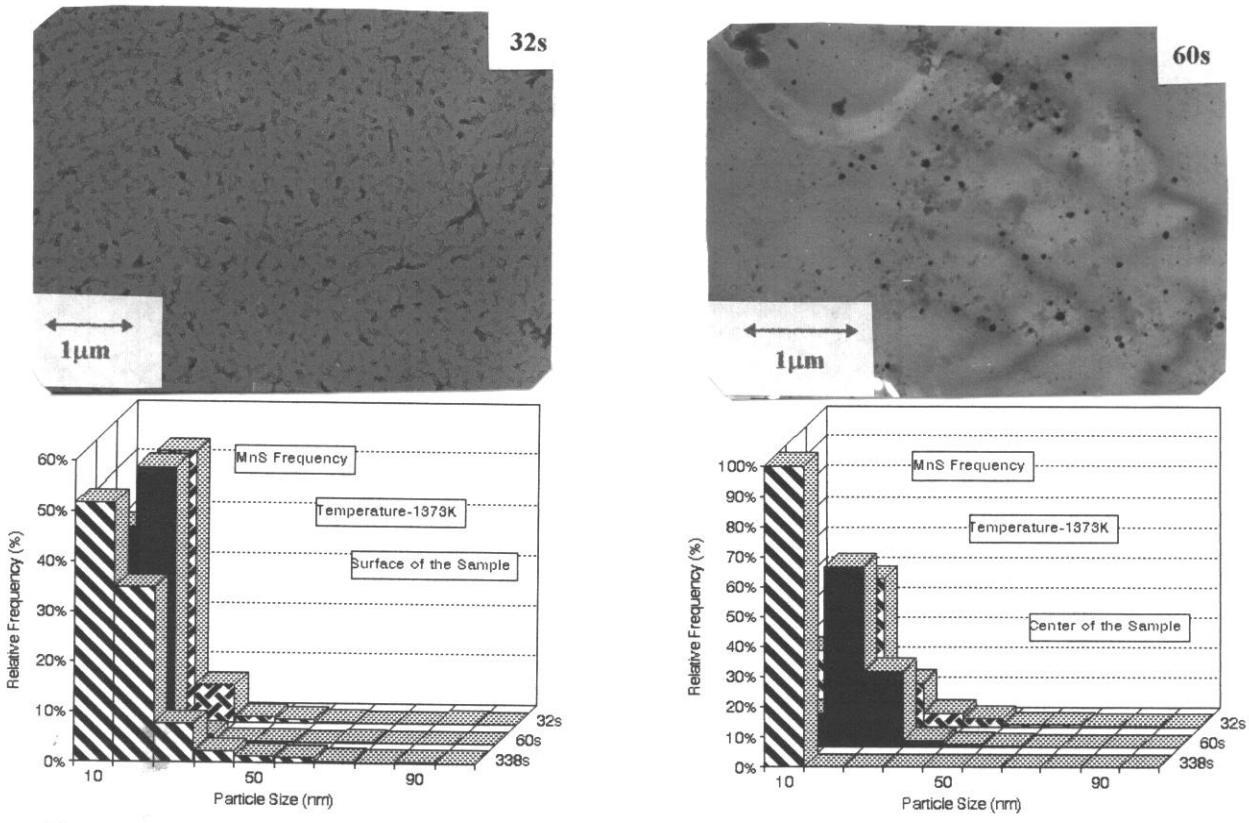

Fig.2.MnS precipitates and their particle size distribution at 1373K.