DYNAMIC OBSERVATION OF SECONDARY RECRYSTALLIZATION IN CROSS-ROLLED SILICON STEEL BY SYNCHROTRON X-RAY TOPOGRAPHY

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Introduction

Dynamics of secondary recrystallization of cross-rolled silicon steel, in which Cube({100}<001>) and Goss-type({110}<110>) textures evolve, was investigated by in situ observation utilizing synchrotron x-ray topography. Grain growth behavior is strongly affected by grain boundary characteristics and temperature; Cube grain starts to migrate at lower temperature than Goss-type grain. The analysis of primary texture shows that Cube grains and Goss-type grains have a high frequency of Σ7 and Σ9 boundaries to the matrix, respectively. The mechanism can be explained by the assumption that secondary grains grow selectively due to the higher frequency of coincidence boundaries and Σ7 boundary is mobile in the lower temperature range compared with Σ9 boundary.

Experimental Procedure

Primary recrystallized specimens were annealed in the temperature gradient to evolve some secondary grains in the higher temperature region and then they were quenched. Among the secondary grains, Cube and Goss-type grains were selected and grain growth behavior of these secondary grains was observed in situ by the dynamic x-ray topography system [1].

Results and Discussions

Fig.1(a) shows the grain growth behavior of Cube secondary grain at 1040 °C . Though the migration of secondary grain is locally neither uniform nor stationary due to the retarding force by subboundaries in the secondary grain, it principally depends on its orientation and temperature. Fig.1(b) shows the temperature dependence of grain growth velocities. It can be seen that the secondary recrystallization temperature, i.e. the onset temperature of grain growth, is different between the two grains. Cube grain starts to grow at 980 °C and Goss-type grain at 1020 °C . The relative migration ratio of Cube grain to Goss-type grain, which is a parameter representing selective growth, takes large values in the temperature range from 980 °C to 1020 °C and decreases as annealing temperature increases. This feature implies that the secondary recrystallization temperature is the crucial parameter of selective growth. It was reported that selective growth of secondary grains depends on the grain boundary characteristics between the secondary grain and primary recrystallized matrix and coincidence boundaries take an important role [2-4] and that special characteristics of coincidence boundaries exist in a finite temperature interval and the transition temperature from a special boundary to a non-special boundary depends on the type of coincidence boundary [5].

Our result can be explained by the assumption that Σ7 boundaries should be mobile in the lower temperature region in comparison with Σ9 boundaries. These results coincide with the report on the transition temperatures of coincidence boundaries[5].

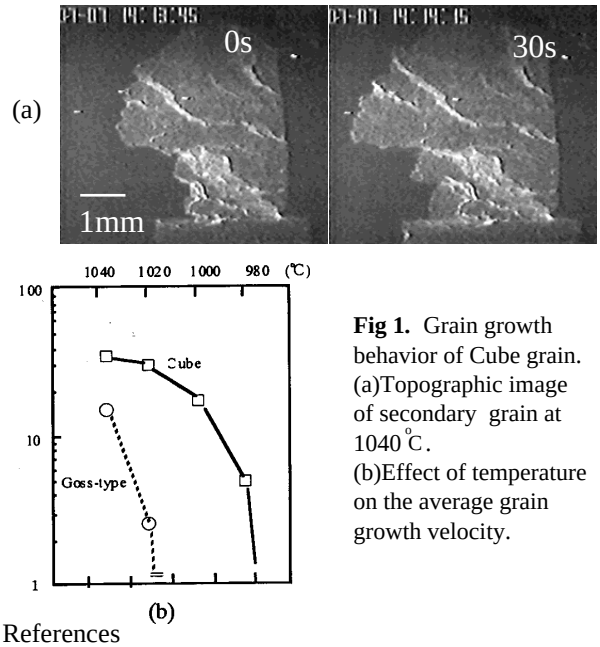

Fig 1. Grain growth behavior of Cube grain. (a)Topographic image of secondary grain at 1040 °C . (b)Effect of temperature on the average grain growth velocity.

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