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Title(English)	Effects of Mn Containing Dispersoids and Mn Solute Atoms on the Recrystallization Behavior of an Al-Mn Alloy
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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Al-Mn alloys have a good combination of strength, ductility, formability, corrosion resistance and thermal conductivity. These alloys are widely used for the heat exchanger, can body and building materials mainly in the form of sheets. In the Al-Mn based alloys, the grain size, Mn solute atoms and Mn containing dispersoids in the matrix are known to affect strongly their microstructure and mechanical properties such as strength and ductility through the thermo-mechanical processes including homogenization, deformation and annealing treatments. However, the relationship between the thermo-mechanical process and microstructure is not still clarified. Up to now the main role of primary particles on the recrystallization behavior has been sufficiently reported, while other factors such as size, distribution of Mn containing dispersoids and Mn solute atoms are not sufficiently investigated. The present thesis focused on the effects of Mn containing dispersoids such as size and distribution and Mn solute atoms in the matrix on the recrystallization behavior of an Al-Mn alloy.

The formation and transition behaviors of the primary particles and precipitates during the homogenization treatment and cold-rolling were examined through the microstructure observation, DSC, XRD and electrical conductivity measurements. Three kinds of homogenization treatments were conducted as the heating to 600 °C with immediately water quenched (No-Holding condition), heating + holding at 600 °C for 16h with immediately water quenched (Base condition) and heating + holding + furnace cooling (Slow-Cooling condition). The No-Holding condition produces small Mn containing dispersoids with high number density and highest concentration of Mn solute atoms, the Base condition produces large Mn containing dispersoids with low number density and medium concentration of Mn solute atoms and Slow-Cooling condition is found to produce medium size Mn containing dispersoids with high number density and lowest concentration of Mn solute atoms, respectively. The large primary particles are well fragmented in the matrix and Mn dispersoids are distributed more uniformly by cold-rolling with the reduction by 90 %. Also, a number of dislocations are generated after cold-rolling. In case of the Slow-Cooling condition, dislocations are more generated due to the high number density of medium size Mn containing dispersoids.

The cold-rolled specimens were annealed with different conditions, isochronal and isothermal annealing. The effects of annealing temperature and time on the recrystallization behavior, especially on the recrystallization rate were examined through the observation of microstructure and hardness measurement. The recrystallization temperature, T_R, and time, t_R, are extremely different depending on the different homogenization treatments. The recrystallization behavior in the Slow-Cooling specimen occurs at 350 °C

for 60 s. At high annealing temperature, the recrystallization behavior completely finished and recrystallized grains appear in all specimens. However, at low annealing temperature, the elongated grains appear and grow up in the No-Holding condition even though annealing time is prolonged. In the No-Holding condition, elongated grains are clearly observed after annealing, indicating that the continuous recrystallization occurs. In the other conditions equiaxed grains are observed after annealing, indicating that discontinuous recrystallization occurs.

The role of constituent particles, especially Mn containing dispersoids, and Mn solute atoms on the recrystallization behavior, such as grain size and rate of recovery and recrystallization, is clarified. The concentration of Mn solute atoms strongly affects the rate of recovery and recrystallization. The remained Mn solute atoms affect the retardation of the recovery. Thus, the recrystallization behavior is also delayed in the No-Holding condition at low temperature. Moreover, the Mn solute atoms are assumed to play an important role to determine the continuous or discontinuous recrystallization. The Mn containing dispersoids affect both the recrystallized grain size and rate of recrystallization behavior. It is found that Mn containing dispersoids not only cause the Zener pinning effect but also contribute the particle stimulated nucleation (PSN) even though the size is smaller than 1μm.

The evaluation of mechanical properties for the specimens differently homogenized and annealed was conducted using a tensile test. The UTS after cold-rolling is higher than that after annealing treatment due to the softening effect during annealing. On the other hand, the fracture elongation is drastically increased after annealing treatment. After annealing treatment, two types of strengthening mechanisms are fond to work in the Slow-Cooling and No-Holding conditions, respectively. The extremely refined grains are achieved by the recrystallization in the Slow-Cooling condition and the dispersoids hardening is also found by precipitation at low annealing temperature in the No-Holding condition.

Accordingly, the control of the size, distribution of Mn dispersoids and concentration of Mn solute atoms by using homogenization treatment strongly influence the recrystallization behavior and mechanical properties.