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Effect of alternative magnetic field on the recrystallization of Al-Zn-Mg-Cu alloy

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Recent studies have shown that a low frequency alternative magnetic field can reduce the macrosegregation of 7075 alloy, promote the solution of alloying elements in the grains [1] and the formation and growth of the intermediate phases in Al-Mg diffusion couple [2]. To explain these, it was proposed that the magnetic field accelerates the diffusion of atoms. We report here the results of rescrystallization of an Al-Zn-Mg-Cu alloy in the presence of a low frequency alternative magnetic field to reveal the effect of low frequency magnetic field on the movement of defects.

The Al-Zn-Mg-Cu alloy ingot 100 mm in diameter was produced by a novel low-frequency Electromagnetic Casting (LEFC) [2]. Table I gives the chemical composition of the alloy.

After a two-step homogenization at 400 °C for 12 h and at 460 °C for 32 h, the ingots were hot extruded into bars, 11 mm in diameter with a three hole die, during which the deformed microstructures were obtained, as shown in Fig. 1. The specimens were treated at different temperature for different time both with ($B = 0.5$T) and without an alternative magnetic field. The frequency of the alternative magnetic field was fixed at 10 Hz. The microstructure was observed by means of optical microscopy and the grain size distribution was analyzed by IAS-4 graph apparatus.

Fig. 2a and b shows the microstructure of full recrystallization of Al-Zn-Mg-cu alloy annealed at 450 °C × 2 h + 470 °C × 1 h both with ($B = 0.5$T) and without an alternative magnetic field. The greater grain size in the presence of a magnetic field is observed as compared to the heat treatment in the absence of a magnetic field. As shown in Fig. 3, the distribution of grain size supports the conclusion and some anomaly growth grains also exist. Therefore, heat treatment with the application of the AC magnetic field promotes the nucleation and growth of grains.

When metals are plastically deformed, point defects aggregate, and dislocations are produced. Many of these defects will anneal out at different temperature ranges during subsequent annealing, and those mechanisms with the smallest activation energies will occur first.

The dislocation may participate in these processes by acting as sinks or as trapping centers and by executing

TABLE I Chemical composition of the alloy (wt%)

Zn	Mg	Cu	Zr	Fe	Si	Al
9.4	2.5	2.3	0.15	0.15	0.1	Balance

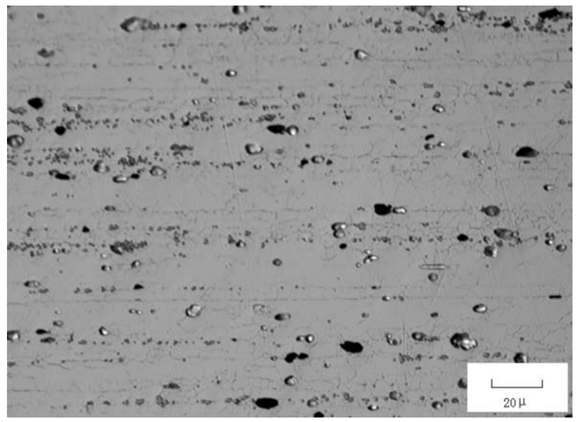

Figure 1 Microstructure of the hot extruded bars.

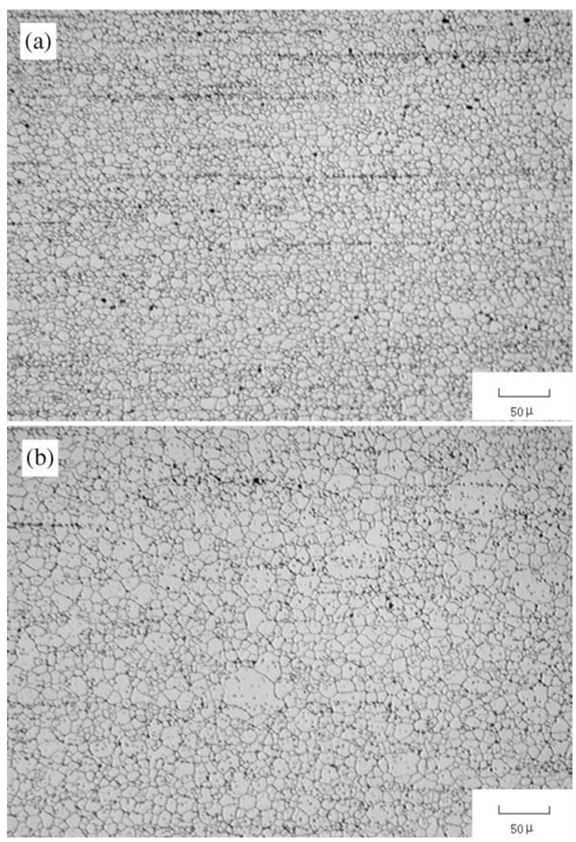

Figure 2 Microstructure of rescrystallization at 450 °C × 2 h + 470 °C × 1 h: (a) $B = 0$T and (b) $B = 0.5$T.

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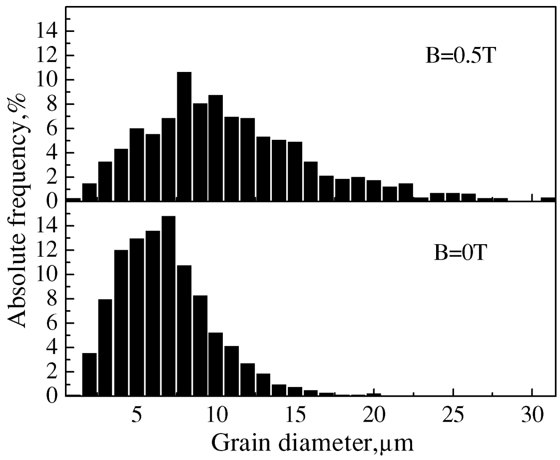

Figure 3 Distribution of grain size with and without an AC magnetic field.

small-scale rearrangements [3]. For the Al-Zn-Mg-Cu alloy employed in our experiment, the alloying elements form atmospheres around lattice defects such as dislocations and grain boundaries, and reduce the mobility of the defects as a result of the drag effect [4]. With the application of the AC magnetic field the diffusion of the alloying elements is increased and the mobility of the defects is increased through the decreasing of the drag effect. As a result, the recrystallization will be promoted through the decreasing drag effect acting on subgrain and grain boundaries [5].

References

1. B. J. ZHANG, J. Z. CUI and G. M. LU, *Mater. Lett.* **57** (2003) 1707.
2. X. T. LIU and J. Z. CUI, Submitted to *Scripta. Metall. Mater.* (May 20, 2003).
3. HIMMEL, "Recovery and Recrystallization of Metals" (Newyork, London, 1963).
4. K. LUCKE and P. STUWE, *Acta Met.* **19** (1979) 1087.
5. E. NES and J. D. EMBURY, *Z. Metallkde.* **66** (1975) 589.

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