Magnetic Annealing of Cold-Rolled Aluminum Sheet

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Introduction

The grain growth kinetics of Al-1%Mg was investigated by EBSD measurements after annealing in the presence of and without a magnetic field. The sample's grain diameter frequency distributions were compared between magnetically annealed samples and their counterparts annealed without field.
The goal of this investigation was to establish if magnetic annealing could accelerate grain growth kinetics of magnetically isotropic aluminum and thereby confirm that the proposed mechanism in [1] and [2] is in fact responsible for the accelerated recovery and recrystallization kinetics observed in an aluminium alloy 3103 in experiments in 2005 and 2006.

Experimental Procedure and Results

Samples were annealed in a salt bath at temperatures between 375°C and 450°C at times ranging between 10s and 60mins, respectively. Magnetic annealing was carried out by applying a magnetic field of 17 Tesla. The grain diameter evolution was compared between magnetically and conventionally annealed samples of otherwise identical parameter sets. The below diagram Fig 1a) exemplifies the frequency distribution of grain diameter of a sample annealed at 425°C for 3 minutes with and without field. Accelerated grain growth caused by the magnetic field would be reflected in a shifting of the weight of the frequency distribution to larger grain diameter values. However, the nearly identical evolution of grain diameters for both samples indicates that the magnetic field has little effect, if any, on grain growth kinetics in the used alloy composition.

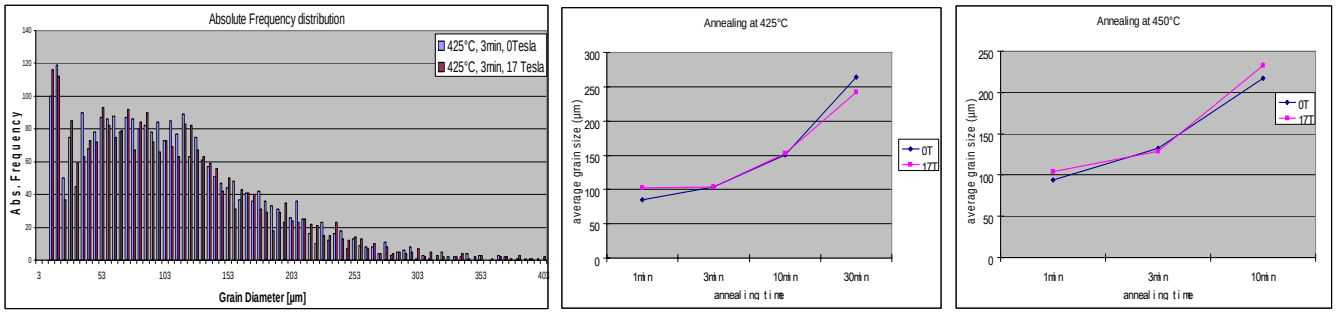

Fig 1: a) Frequency distribution of grain diameters, average grain diameter at b) 425°C and c) 450°C, annealed with and without field

This is affirmed by the diagrams in Fig 1b) and c) above showing the average grain sizes of samples annealed at 425°C and 450°C with and without magnetic field. Regarding the average grain diameters, there does not appear to be a tendency towards accelerated grain growth in the magnetic field, since the values found in magnetically annealed samples do not continuously exceed the average observed in conventionally annealed samples.

Conclusions

Grain growth in an Al-1%Mg alloy is not accelerated by the magnetic field. However, in the more complex alloy AA3103, in which accelerated recovery and recrystallization had been observed, this mechanism could indeed be valid due to more complicated microstructural interactions with the magnetic field. Therefore, to find the cause for the results obtained in [1] and [2], a new series of grain growth experiments should be conducted using the alloy AA3103 in which accelerated RX kinetics was found.

Acknowledgements

Financial support from Deutsche Forschungsgemeinschaft (Grant MO-848/6-2) and Dr. Scott T. Hannah's and Bobby Joe Pullum's support are gratefully acknowledged

References

[1] Scripta Mat. 54 (2006), pp. 2161
[2] Scripta Mat. 55 (2006), pp. 995