IMPACT OF A MAGNETIC FIELD ON RECRYSTALLIZATION IN COMMERCIAL ALUMINUM ALLOY

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Introduction

Our experimental efforts over the last decade have proved that a magnetic field can be effectively utilized as an additional degree of control of texture and microstructure development in crystalline non-magnetic (i.e. paramagnetic and diamagnetic) magnetically anisotropic materials [1]. The impact of a magnetic field on the microstructure development, however, is not restricted by magnetically anisotropic metals but can also be observed in materials with magnetically isotropic properties.

Results

The texture in aluminum alloy AA3103 after conventional (zero field) annealing at 288, 310 and 310°C for different time was measured to be very similar to the texture of the cold rolled (71%) material, and characterized by a high intensity of orientations that compose the β-fiber: Cu-, S- and Brass-component. Magnetic annealing at 17 T dramatically changed the texture. The deformation components were much weaker than after annealing without field. Concurrently, a high intensity Cube-component ({100} <001>) developed.

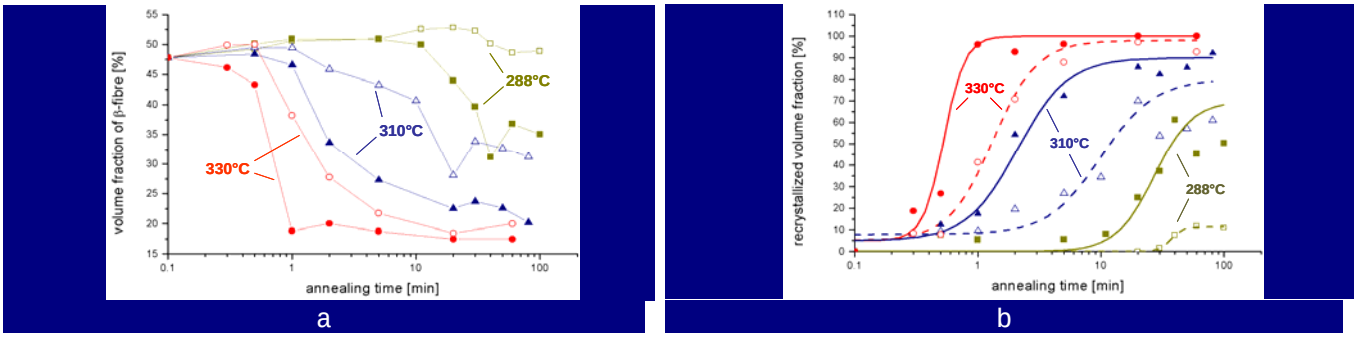

Fig. 1. (a) Volume fraction of β-fiber calculated from the ODFs vs. annealing time; (b) Recrystallized volume fraction of 71% cold rolled AA3103 vs. time of annealing at zero field (open symbols) and in a magnetic field of 17 T (solid symbols).

Figure 1a shows the development of the β-fiber with annealing time at different temperatures. The volume fraction of β-fiber orientations decreased distinctly earlier and faster during annealing in a field than without field for all three investigated temperatures. A degradation of the deformation texture components is a typical sign of the progress of recrystallization in deformed Al-alloy. Correspondingly, Fig. 1a suggests that recrystallization is promoted by annealing in a magnetic field. As seen from the temporal change of the recrystallized volume fraction, the incubation time of recrystallization during magnetic annealing is substantially decreased compared to conventional annealing (Fig. 1b). This can be attributed to magnetically enhanced recovery in the deformed aluminum alloy [2]. Moreover, the recrystallization kinetics is significantly accelerated by a magnetic field.

Conclusion

For the first time it is experimentally demonstrated by means of texture and microstructure analysis that the application of a magnetic field substantially enhances recrystallization in cold rolled commercial aluminum alloy. The observed phenomena are apparently due to a magnetically enhanced mobility of dislocations and grain boundaries that may promote recovery and nucleus growth kinetics during recrystallization, respectively.

References

[1] Molodov, D.A., Mater. Sci Forum, **467-470**, 697-706 (2004).
[2] Molodov, D.A., *et al.*, Scripta Mater., **54**, 2161-2164 (2006).