Study of the effect of precipitates and temperature on texture evolution during deformation of AZ80 magnesium alloy

J. Jain,[1] M. A. Gharghouri,[2] W. J. Poole,[1] and C. W. Sinclair[1]

[1] Department of Materials of Engineering, The University of British Columbia, Vancouver, B.C., Canada, V6T 1Z43

[2] Canadian Neutron Beam Center, National Research Council Canada, Chalk River Laboratories, Chalk River, Ontario, Canada, K0J 1J0

The complexity in the plastic behaviour of magnesium and its alloys, especially at low-temperature, limits their widespread application. For instance, the nature of deformation twinning can be influenced by the presence of second phase particles, as suggested by various researchers [1-3]. In addition, the relative importance of the various slip and twinning systems change with temperature [4, 5]. The objective of the current work is to study the effects of precipitates and temperature on slip and twinning behaviour. In this context, a study of texture development offers useful insights into the active deformation mechanisms.

In this study, AZ80 (Mg-8wt.%Al-0.5wt.% Zn) magnesium alloy was tested in uniaxial compression at 77K and 293K. The material was tested in the supersaturated solid solution condition and in a precipitated state with a high volume percentage (10-11%) of β ($Mg_{17}Al_{12}$) phase. The initial texture of the material was weak (maximum intensity 2.4 m.r.d) and the average grain size was 32 μm. The deformation experiments were stopped at intermediate strain levels (e.g. 2%, 5% etc.) for texture measurements. The texture measurements were carried out on the E3 spectrometer at the Canadian Neutron Beam Centre. The wavelength was 2.2 Å and the cross section of the beam was 25.4 mm × 25.4 mm. Four pole figures, $\{0001\}_{Mg}$, $\{10\bar{1}0\}_{Mg}$, $\{10\bar{1}1\}_{Mg}$ and $\{10\bar{1}2\}_{Mg}$, were measured in each case from which the ODF was obtained. The W200 harmonic coefficient of the ODF, which is a measure of <c> axis strengthening along the normal direction (compression direction), was used in a preliminary analysis.

Fig. 1a shows the true stress - true strain response of solution treated AZ80 alloy tested in uniaxial compression at 77K and 293K. The corresponding W_{200} coefficients are plotted as a function of true strain in Fig. 1b. A detailed quantitative analysis to estimate the twinning volume fraction as a function of strain is in progress. Nevertheless, the measured texture results match well with the experimental stress-strain curves. The W200 coefficients for both temperatures vary similarly. The plots can be divided roughly into two regions (Fig.1b). Region I exhibit rapid texture change, which can be attributed to significant twinning. On the other hand, region II corresponds to a plateau, where there is little change in texture; likely related to a change of deformation mechanism from twinning to hard non-basal slip mechanism, and basal slip in the re-oriented twinned regions.

Fig. 1c shows the true stress true strain response of solution-treated and aged samples tested in uniaxial compression at 293K. The corresponding W_{200} coefficients are shown in Fig. 1d. The values of W_{200} at 2% and 5% strain are lower for the aged sample than for the solution treated sample. This can be attributed to the difference in twinning behaviour. Preliminary analysis suggests that precipitates lower the scale and fraction of twinning in the aged alloy.

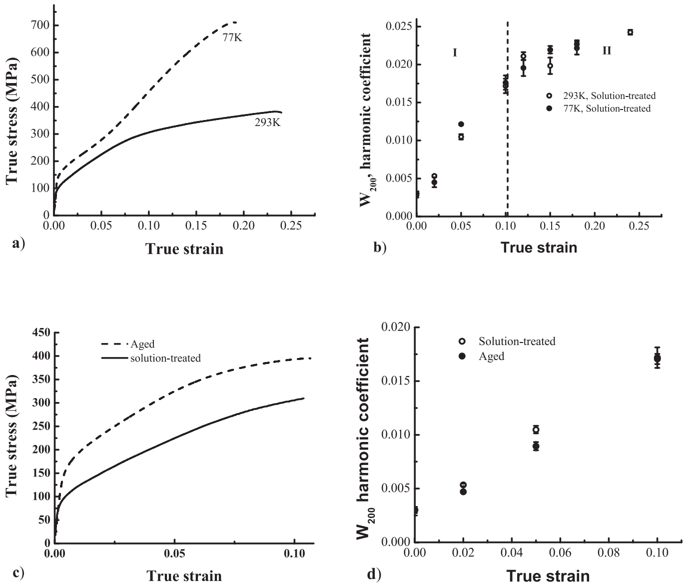

Fig 1. (a) True stress-true strain curves for solution-treated AZ80 tested at 77K (dashed line) and 293K (solid line) and (b) the corresponding W200 harmonic coefficients of the ODF (c) true stress-true strain response of solution treated (solid line) and aged (dashed line) AZ80 alloy tested at 293K and (d) the corresponding W200 harmonic coefficient of the ODF.

References

[1] J. B. Clark, *Acta Metall.*, 16 (1968), 141-152.

[2] M. A. Gharghouri, G. C. Weatherly and J. D. Embury, *Phil. Mag A*, 78 (1998), 1137-1149.

[3] J. Jain, J. X. Zou, W. J. Poole and C. W. Sinclair, *TMS Magnesium technology*, 2009, 503-508.

[4] B. C. Wonsiewicz and W. A. Backofen, *Trans. Metall. Soc. AIME*, 239 (1967), 1422-1431.

[5] B. Bhattacharya, *PhD thesis*, McMaster University, Hamilton, Ontario, Canada, 2006.