Activation of Slip Modes during Tensile Testing of Mg-3Al-1Zn Sheet

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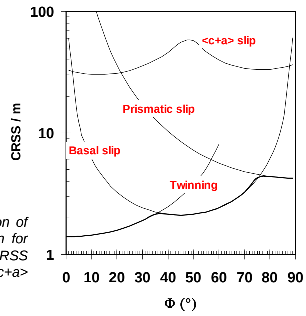
Introduction

The poor formability of magnesium sheet at room temperature is believed to be due to the lack of enough independent deformation modes. Basal, prismatic and second order pyramidal (<c+a>) planes are important in deformation by slip [1]. Single crystal studies have shown [2] that the critical resolved shear stresses (CRSS) for the non-basal modes are considerably higher than for basal slip. However, small amounts of non-basal slip have been seen after room temperature deformation of pure magnesium [3].

It has been mentioned the necessity of considering prismatic and/or second order pyramidal slip in crystal plasticity models for the simulation of the mechanical response of Mg-3Al-1Zn (AZ31) at room temperature. In recent work by current authors [4], a semi-analytical Sachs model was developed for the flow stress of AZ31. the minimum values obtained for *CRSS/m* for different modes for uniaxial tension. The analysis in presented figure predicts prismatic slip for orientations with a c-axis within 15 deg of perpendicular to the tensile direction.

The activation of non-basal slip at room temperature in AZ31 has also some support in TEM observations but not much work appears to have been done electron back scattering diffraction (EBSD). The present work aims to use this technique in conjunction with line trace analysis to determine deformation mode activity.

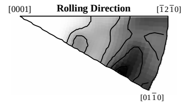


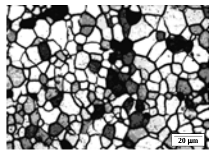
Predictions of the values for CRSS/m as a function of the inclination of the c-axis to the stress direction for tension. The calculations were made assuming CRSS ratios for basal slip, twinning, prismatic slip and <c+a> slip of 1:0.7:2:15.

Experimental Technique

Material

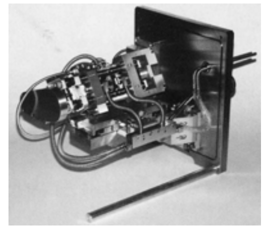
Rolled Mg-3%Al-1%Zn (AZ31)

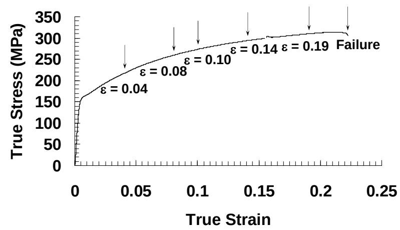




Tensile Test

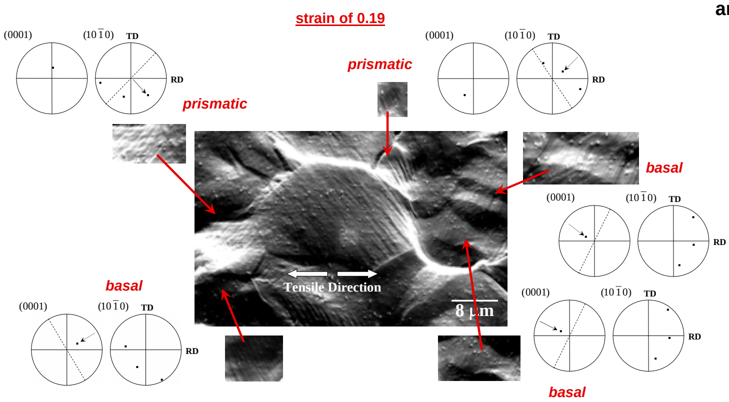
In-situ tension/compression machine in SEM equipped with EBSD camera

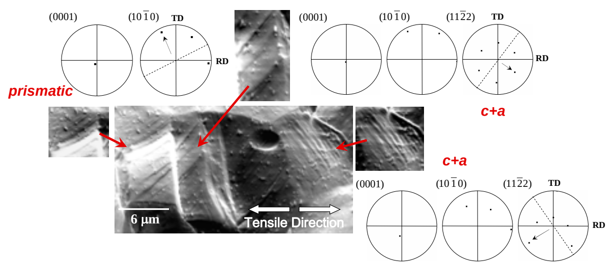


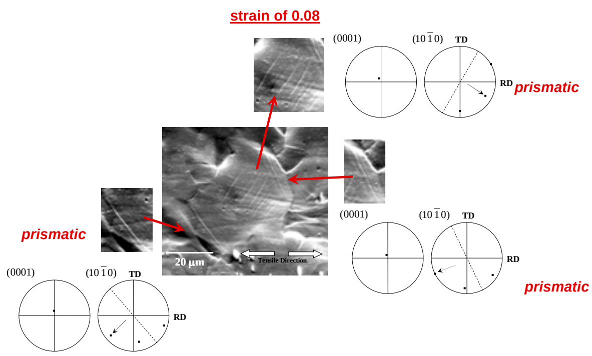


Stress-strain curve of rolled AZ31 (velocity of 5×10-4 mm/s), showing strains at which microscopic analysis was performed.

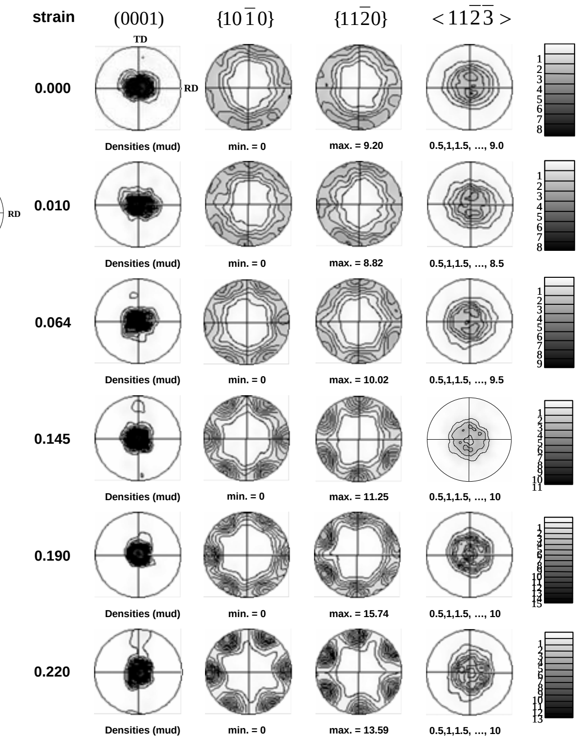
Examples of the Active Slip Systems during Deformation of Rolled AZ31



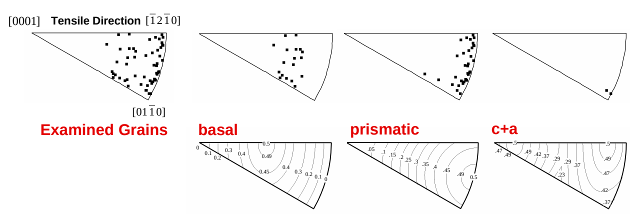




Pole Figures Corresponding to the As-received Rolled AZ31 and Different Strains during Tensile Testing at RT



Dependency of Active Slip System on Grain Orientation



Inverse pole figures of the tensile direction along with iso-curves of the maximum Schmid factor for orientations in which basal, prismatic and c+a slip were observed.

Active slip systems with higher Schmid factor and lower CRSS.

Conclusion

The present work provides evidence for the operation of significant levels of prismatic slip during tensile straining of AZ31 sheet at room temperature.

Acknowledgements

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References

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[2] B. C. Wonsiewicz, W. A. Backofen, Trans. Metall. Soc. AIME 1967, 239, 1422-1431.

[3] F. E. Hauser, P. R. Landon, J. E. Dorn, Trans. Am. Soc. Metals 1958, 50, 856-883.

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