Modelling the quasi-static and high-strain rate deformation behaviour of magnesium alloy AZ31

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Abstract

In hexagonal close-packed (hcp) metals, plastic deformation is accommodated by different slip and twinning systems. Various factors affect the activation of the deformation mechanisms: alloy composition, grain size, temperature of deformation, strain rate and loading direction. The multiplicity of deformation mechanisms that can be activated and the dependence on loading conditions explain the observed asymmetry and anisotropy on the hardening behaviour and texture evolution. It is therefore important to be able to characterise these deformation mechanisms for specific loading conditions to gain a thorough understanding of the mechanical behaviour of hcp materials.

Modern microscopy techniques, such as electron backscatter diffraction (EBSD), enable the quantitative analysis of twinning which is an important deformation mechanics for magnesium alloys. These characterisation techniques allow a better understanding of the way materials deform and provide valuable information for predicting their behaviour. For example using such techniques one can determine the different twinning modes that have contributed to deformation but also the volume fraction of material that has twinned. These microscopy techniques have enabled modellers to better understand the contribution of twinning in the hardening behaviour of the materials and to devise schemes to incorporate the effects of twinning on the hardening response or/and texture evolution of hcp materials.

In this work we are investigating the deformation behaviour of magnesium alloys AZ31 under quasi-static and high-strain rate loading. The high-strain rate experiments were carried out using a Hopkinson bar and the microstructure of the deformed samples was measured using EBSD. The experimental results were used to calibrate and test the robustness of a strain-dependent visco-plastic self-consistent crystal plasticity model.

Keywords: Magnesium, Crystal Plasticity, High strain rate deformation, EBSD

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