Microstructure and texture evolution during uniaxial and triaxial compression of a magnesium-cerium alloy

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Abstract

Magnesium rare earth alloys with low density and good strength-to-weight ratio, show potential applications in the automobile industry due to their improved formability and weaker texture. The room temperature deformation behaviour of these alloys is characterized by deformation twinning. The present investigation aims to address the effect of strain path on the evolution of microstructure and texture in Mg-0.5wt.% Ce alloy. To this end, a combinatorial experimental and computational approach was employed to understand the micro-mechanisms of deformation. Cuboidal samples of dimension were machined from a swaged and annealed block of the alloy for uniaxial and triaxial compression to a strain of 0.09 in one direction and in steps of 0.03 in all three directions. Detailed microstructural investigation using EBSD revealed profuse extension twins during deformation, with the uniaxial sample showing a higher twin fraction at intermediate strain. In contrast, the twin fraction at a strain of 0.09 is similar for uniaxial and triaxial deformed samples. Higher grain refinement and weaker texture were obtained for multiaxial deformed samples along with texture-induced softening during a change of strain path. Mean field viscoplastic self-consistent simulations were able to successfully capture the propensity of twinning for the two samples, while full field crystal plasticity simulations based on fast Fourier transform solver implemented in the DAMASK (Dusseldorf Advanced Materials Simulation Kit) software captured the evolution of intragranular misorientation and grain fragmentation. The critical role of texture and microstructure on the operative slip and twinning systems and their mutual interactions during strain path change indicated by the combinatorial multiscale simulations and detailed microstructural characterization will be discussed.

Keywords: Deformation twinning, strain path change, crystal plasticity, Magnesium alloy, texture

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