ROOM TEMPERATURE DEFORMATION MECHANISMS OF THE C14 LAVES PHASE IN THE MG-AL-CA SYSTEM

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In order to improve the creep resistance of magnesium alloys and thereby increase their operating temperature, hard intermetallic phases can be incorporated in the microstructure. In particular the addition of Al or Ca to Mg results in the formation of a skeleton-like intermetallic structure at the grain boundaries. This structure consists predominately of Laves phases, which reduces the minimum creep rate by a few orders of magnitude. In bulk, these Laves phases are extremely brittle at low temperatures, limiting our understanding of the underlying mechanisms of plasticity. Additionally, the small size of the microstructural features in technical alloys make bulk-scale tests unsuitable for studying these phases. Using nanomechanical testing (nanoindentation and microcompression) in individual grains, cracking can be suppressed and plastic deformation can be observed [1]. Micropillars were milled using FIB in individual grains of a polycrystalline specimen, and orientations determined by EBSD to activate and interrogate slip systems. These data have then been combined with slip line analysis around indents. Such an approach reveals the presence of pyramidal, prismatic and basal slip at ambient conditions, with pyramidal 1st order being the predominant slip plane. Critical resolved shear stresses for these slip systems have been calculated, and TEM analysis of the deformation microstructure performed. This work therefore exemplifies how nanomechanical testing in conjunction with electron microscopy can extend the current knowledge of plasticity in macroscopically brittle crystals.

[1] S. Korte, W.J. Clegg, Studying Plasticity in Hard and Soft Nb–Co Intermetallics, Advanced Engineering Materials, 14, No. 11 (2012), 991-997