PLASTICITY OF THE C15-CaAl2 LAVES PHASE AT ROOM TEMPERATURE

Martina Freund, Institut für Metallkunde und Materialphysik, RWTH Aachen University
freund@imm.rwth-aachen.de
Doreen Andre, Institut für Metallkunde und Materialphysik, RWTH Aachen University
Pei-Ling Sun, Institut für Metallkunde und Materialphysik, RWTH Aachen University
Nicolas J. Peter, Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf
Sandra Korte-Kerzel, Institut für Metallkunde und Materialphysik, RWTH Aachen University

Key Words: Plasticity; Laves phase; Nanoindentation; Microcompression; Room temperature

Magnesium is a promising material for light-weight applications but its application is strongly limited because of its low room temperature ductility and low creep resistance. By alloying with Al and Ca, the cubic $CaAl_2$-, the hexagonal $CaMg_2$- and the $Ca(Mg,Al)_2$- Laves phases form, which positively influence these properties.
Due to their complex packing, the macroscopic deformation of these phases at low homologous temperatures is strongly limited. In order to overcome this restriction and to study their mechanical properties and mechanisms of plasticity, nanomechanical testing, such as nanoindentation and micropillar compression were applied by the authors.

For the cubic $CaAl_2$ phase, nanoindentation tests revealed a constant hardness of 5.9 ±1.2 GPa and indentation modulus of 120.3 ± 17.9 GPa for all tested orientations. Slip traces in the vicinity of indents were correlated with the crystal orientation and the majority of observed slip traces corresponded to the {111} and {112} planes. However, it needs to be taken into account that the {111} and {112} planes are very similar in their alignment and can overlap, impeding the analysis for some specific orientations. The majority of all observed cracks corresponded to {112} planes which was further verified by TEM analysis. Additional micropillar compression tests further allowed to obtain the critical resolved shear stress values for the corresponding slip systems. The observed slip planes in micropillar compression have been evaluated to also be {111} and {112} planes in $<1\bar{1}0>$ direction and the CRSS has been calculated as 0.97 ± 0.03 GPa and 0.96 ± 0.03 GPa, respectively.

TEM analysis furthermore allowed to determine the Burgers vector to be ½ <110> for the {111} slip planes in the vicinity of nanoindents using the g*b criterion. Further TEM investigations identified {112} as favorable orientation for cracking.