

DISLOCATIONS IN LAVES PHASES – PHANTASTICAL BEASTS AND HOW TO UNDERSTAND THEM

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Key Words: Dislocations, Intermetallics, Slip System, Nanomechanics, TEM

How macroscopically hard and brittle materials deform is not well understood in many cases with not even the dominant slip systems known and no critical stresses or dislocation mechanisms available. This is true even for the most abundant type of intermetallic phase, the Laves phases. However, this knowledge is essential to improve many metallic-intermetallic composite alloys, such as Mg with an interconnected Laves network in Mg-Al-Ca alloys preventing creep.

Here, a study combining nanomechanical testing, TEM and atomistic as well as ab-initio simulations will be presented with the Mg_2Ca phase as a model Laves phase. Using indentation of suitably oriented grains, slip trace analysis and TEM at room and elevated temperature, we elucidate the dominant slip systems and their temperature dependence. A high retained strength is found even at 200 °C, which is consistent with the improved creep resistance of Mg-Al-Ca alloys with the Mg_2Ca phase at these high temperatures.

Although the most easily activated slip system in this phase is not the basal plane, it is only this plane for which a dislocation mechanism has been suggested in the form of synchroshear. How this mechanism may be modelled and which configurations of the dislocation core determine the required stress has been unraveled by atomistic modelling for the first time. Finally, we are expanding this work towards the non-basal mechanisms theoretically and towards off-stoichiometric phases experimentally and will briefly review the challenges encountered in attempting both in such complex, ordered crystals.

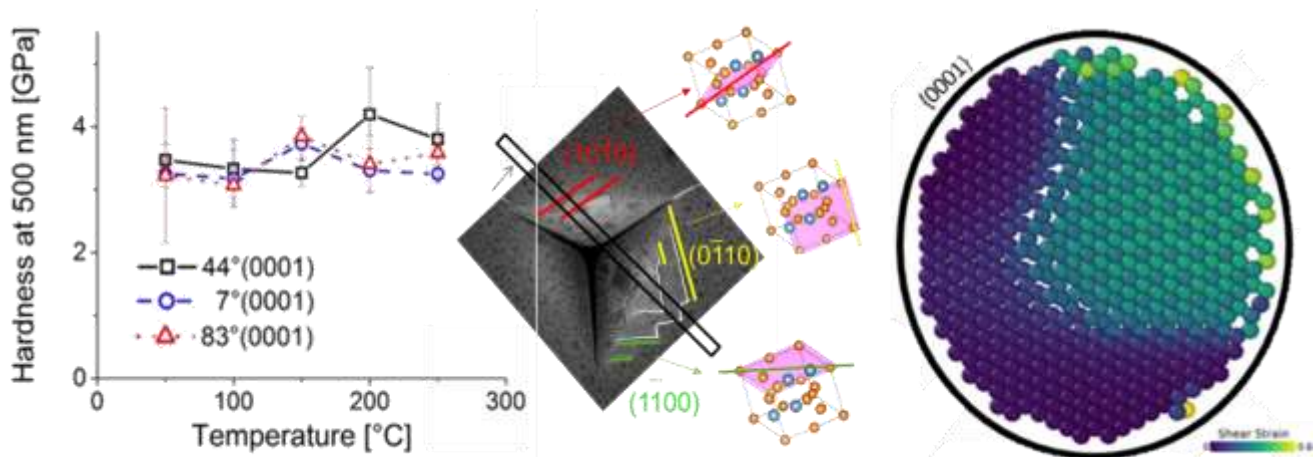


Figure 1 – Nanomechanical testing and atomistic simulation of the slip mechanisms in the Mg_2Ca Laves phase (experiments: unpublished, simulations:[1].)