ICSMA19 Metz, France, June 26 - July 1, 2022
International Conference on Strength of Materials

On the mechanistic origin of the enhanced strength and ductility in Mg-RE alloys

Henry Ovri[a], Jürgen Markmann[a], Hajo Dieringa[b], Erica Lilleodden[c]

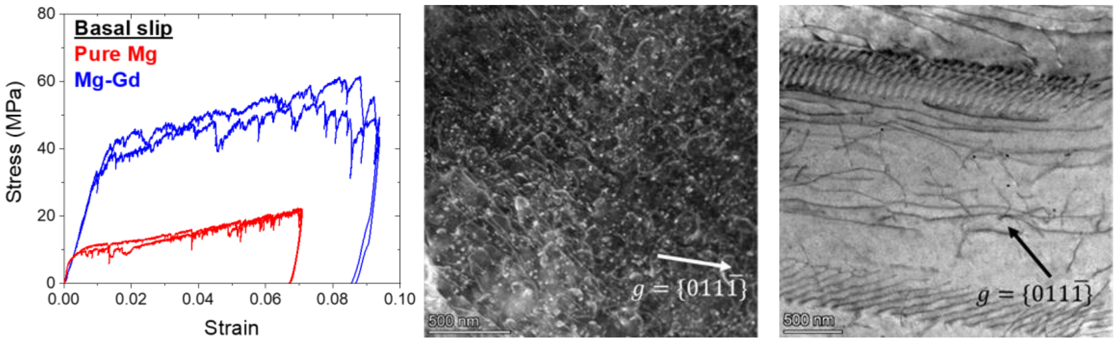
[a]*Helmholtz Zentrum Geesthacht, Institute of Materials Mechanics, 21502 Geesthacht, Germany.*

[b]*Helmholtz Zentrum Geesthacht, Institute of Material and Process Design, 21502 Geesthacht, Germany.*

[c]*Fraunhofer Institute for Microstructure of Materials and Systems, 06120 Halle, Germany.*

[a]*henry.ovri@hereon.de*

A number of experimental and modelling efforts show that low concentrations of rare earth (RE) solutes in Mg enhances the room temperature ductility and weakens the deleterious basal texture that occurs during sheet forming of classical wrought Mg alloys. However, the mechanistic origin(s) of the improved ductility and texture weakening are still been debated because of gaps between the prediction of these models and experimental results. In order to gain insights into the underlying governing mechanisms, we carried out in-depth dislocation-strength characterization of micropillars made in single crystals of pure Mg and a Mg–0.75 at% Gd alloy oriented for twinning, pyramidal- and basal-slip. We observed significant increase in both basal and twinning CRSS, along with a fourfold decrease of the pyramidal/basal CRSS (P/B) ratio due to Gd addition. Moreover, deformation mechanisms in both material systems were essentially the same except in the basal orientations, where slip was found to be wavy in pure Mg but planar in the alloy. We show that these observations are mediated by Gd-rich short range ordered (SRO) clusters in the alloy, and demonstrate that these SRO mediated changes will lead to increased strength and $\langle c + a \rangle$ activity, and ultimately improvements in ductility, in polycrystalline Mg-Gd alloys.



(a) **(b)** **(c)**

Figure 1: (a) : Representative engineering stress vs strain response of micropillars oriented for basal slip in pure Mg (in red) and the Mg-Gd alloy (in blue). Two beam STEM images of dislocation structures in the basal orientation of (b) pure Mg (c) Mg-0.75 at.% alloy

Keywords: Mg-RE, microcompression, planar slip, wavy slip, STEM, SAXS