PLASTIC DEFORMATION AND ANISOTROPY OF LONG-PERIOD-STACKING-ORDERED STRUCTURES IN MG-ZN-Y ALLOYS

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Wider application of magnesium alloys as light-weight structural materials requires improvement of strength and toughness. Recently, Mg-Y-Zn and Mg-RE-Zn alloys containing long period stacking ordered (LPSO) structures have received considerable attention, due to their potential to possess excellent mechanical performance at ambient and elevated temperatures. Sharing the same basal plane of α-Mg, LPSO structures are periodically stacked along the c-axis of the hexagonal crystal structure forming so-called 10H, 14H, 18R and 24R structures. LPSO structures are also chemically ordered where Y/RE and Zn atoms replace the positions of Mg atoms in neighboring (0001) planes. The underlying deformation mechanisms of LPSO structures and their co-deformation with α-Mg leading to a concomitant increase of strength and ductility with respect to pure Mg and most commercial Mg alloys are not understood yet. Therefore, we performed micro-pillar compression experiments on 7°(0001), 46°(0001) and 90°(0001) oriented α-Mg and 18R LPSO micro-pillars to investigate the deformation and co-deformation mechanisms of Mg-LPSO alloys. Electron backscatter diffraction-assisted slip trace analysis and post-mortem transmission electron microscopy analysis showed predominant deformation by basal <a> dislocation slip in 46°(0001) and 7°(0001) oriented micro-pillars in both phases, LPSO and α-Mg. In 90°(0001) oriented micro-pillars (1-100)[11-20] prismatic slip was predominantly activated during the early deformation stages. With increasing strain, the formation of kink bands, shear bands and (-211-4)[-4223] deformation twins was observed. The activation energies of basal <a> and prismatic <a> slip are higher for 18R LPSO than for α-Mg. These results shed light on how LPSO structures deform plastically and might be used to purposely design microstructure and texture of Mg-LPSO alloys in the future.

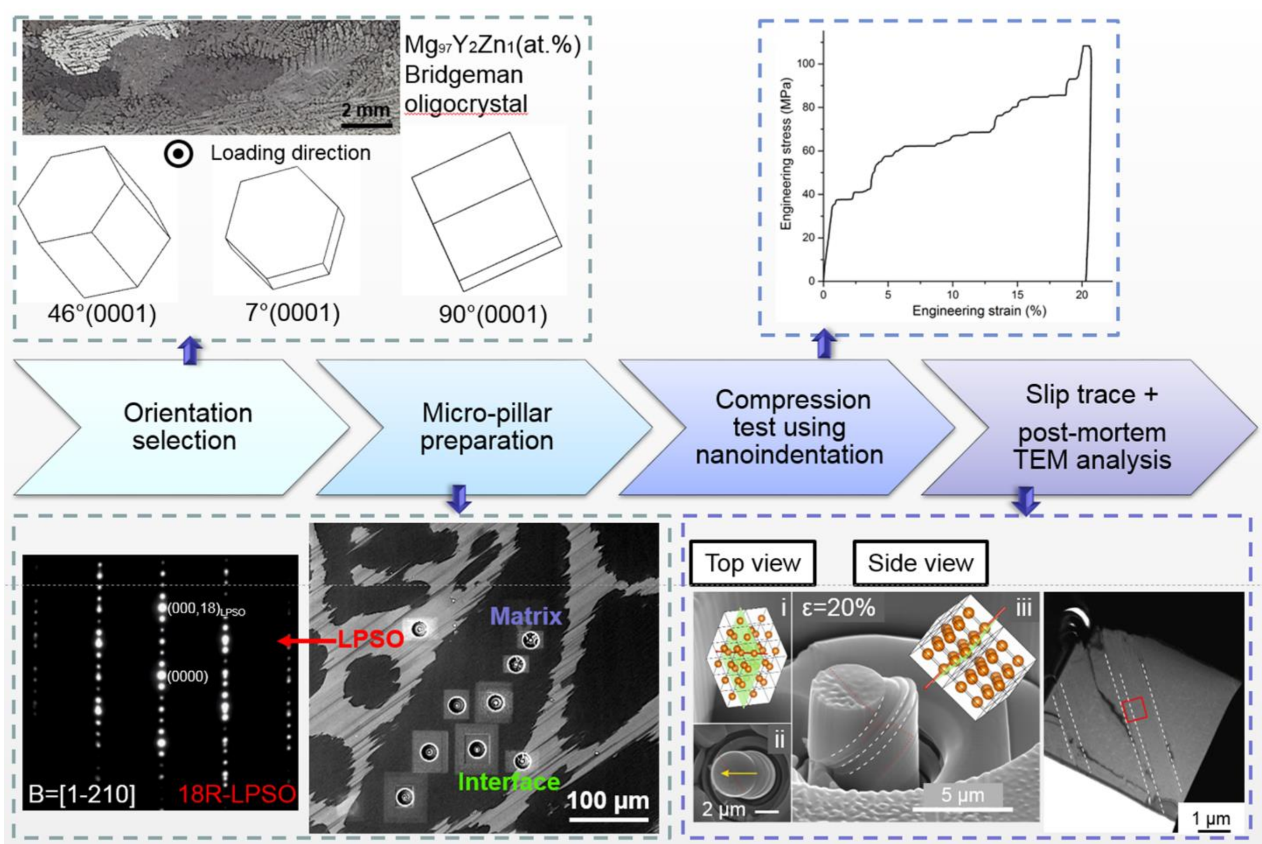

Figure 1 – Micro-pillar compression, slip trace analysis using SEM/EBSD and dislocation analysis using TEM