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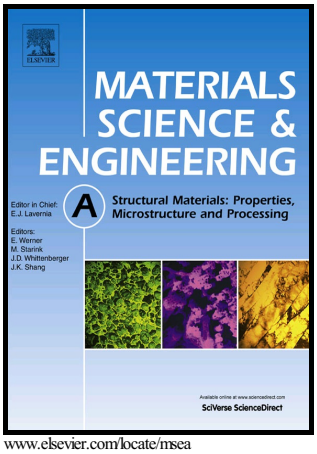

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The effect of precipitates on voiding, twinning, and fracture behaviors in Mg alloys

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Abstract — The effect of precipitates on fracture behaviors was comparatively investigated among three kinds of Mg alloys with different precipitates, *i.e.*, Mg-Gd alloy with prismatic plate-shaped precipitates, Mg-Zn alloy with $[0001]_\alpha$ rod-shaped precipitates, and Mg-Gd-Zn-Zr alloy with basal plate-shaped precipitates. By comparing the fracture behaviors of the alloys before and after aging treatment, it was evident that the presence of precipitates greatly promoted the formation of microvoids that were initiated at primary intermetallic particles. Voiding was the most accelerated in the Mg-Gd alloy, where the precipitate-dislocation interactions are the strongest. While in the Mg-Gd-Zn-Zr alloy with the weakest precipitate hardening, the precipitate-facilitated voiding was the least significant. The precipitate-dependent voiding suppressed the twinning behaviors, causing the volume fraction of deformation twins decreased in turn from Mg-Gd-Zn-Zr to Mg-Zn, and finally to Mg-Gd alloys. The tensile ductility of present Mg alloys approximately scaled with the volume fraction of deformation twins, and was highly sensitive to the precipitates. The fracture scenario of present Mg alloys was proposed that the voiding suppressed twinning and the competition between voiding and twinning can be mediated by precipitates. In the Mg-Gd-Zn-Zr alloy with limited voiding, the twinning dominated the deformation process and concomitantly resulted in a great ductility. The formation of microvoids or the fracture of primary intermetallic particles was quantitatively analyzed by applying a Weibull model, where both the alloy strength and the volume fraction of primary intermetallic particles were considered to rationalize the remarkable difference in fracture behaviors among the present three Mg alloys. Furthermore, the coupling contribution of precipitates and twins to the work hardening was modelled in the aged Mg-Gd-Zn-Zr alloy that displayed a large room temperature tensile ductility of ~ 13.5%.

Keywords: Magnesium alloys; Precipitates; Twin; Ductility; Fracture mechanism

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