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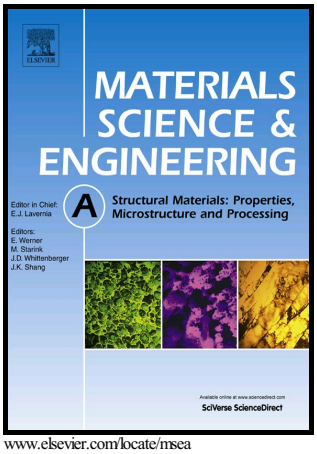

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Strain-rate sensitivity of die-cast magnesium-aluminium based alloys

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Abstract

The strain-rate effect in die-cast magnesium-aluminium based alloys under quasi-static strain rates ranging from 10^{-6} to 10^{-1} s^{-1} was investigated. The strain-rate sensitivity was shown to decrease with increasing aluminium solute level in the matrix. Microstructural examination by electron backscattered diffraction (EBSD) revealed that deformation twinning is more active in the alloys with lower strain-rate sensitivity. It is suggested that the decrease in strain-rate sensitivity with increasing aluminium solute level is likely due to dynamic strain ageing from the interaction between aluminium solute and dislocations. The correlation between strain-rate sensitivity and ductility in AE44 is briefly discussed.

Keywords: Magnesium alloys; Strain-rate sensitivity; Dynamic strain ageing; Twinning; Die-casting

1. Introduction

Magnesium (Mg) tends to show pronounced strain-rate sensitivity in mechanical testing due to the hexagonal close packed crystal structure [1]. Strain-rate sensitivity has been observed to be high in pure Mg [2] and strain-rate sensitivity decreases with increasing aluminium (Al) content in high-pressure die-cast Mg-Al based alloys [2, 3]. The high strain-rate sensitivity in high-pressure die-cast Mg alloys with lower Al content led to an increase in work hardening rate and tensile to yield ratio at higher strain rates, with a corresponding increase in energy absorption at higher strain rates [3]. Stanford et al. [4] showed that the strain-rate sensitivity of an extruded Mg-1Al alloy is 30% lower than that of pure Mg at 10^{-4}-10^{-1} s^{-1}. The alloy was solution treated indicating that strain rate effect is also independent of processing conditions.

In contrast, Aune et al. [5] studied the behaviour of die-cast AM50 (Mg-5Al-0.3Mn, wt.%), AM60 (Mg-6Al-0.3Mn) and AZ91 (Mg-9Al-1Zn) alloys at 15-130 s^{-1}, but did not