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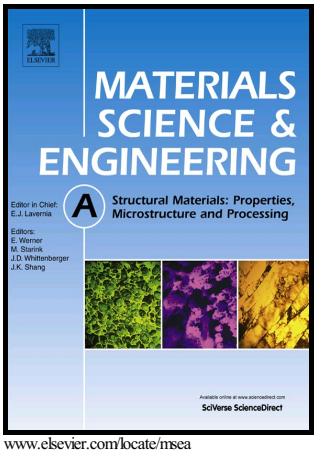

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Microstructural modification and its effect on strengthening mechanism and yield asymmetry of in-situ TiC-TiB_2/ AZ91 magnesium matrix

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Abstract

The application of AZ91 magnesium alloy is limited because of dendritic β-$Mg_{17}Al_{12}$ phase which degrades mechanical properties and causes high tension to compression yield asymmetry (R). To overcome this, a severe plastic deformation (SPD) based hybrid process has been implemented in this study, to develop in-situ AZ91+TiC-TiB_2 composite. This results in redistribution of β-$Mg_{17}Al_{12}$ phase on the grain boundaries along with notable grain refinement. The combined effect of in-situ reinforcement and grain refinement due to SPD process resulted in simultaneous enhancement of strength and ductility. Further, intense grain refinement and presence of TiC-TiB_2 reinforcement in the grain boundary region is found to increase the stress concentration along the grain boundary which hinders twin nucleation and significantly reduces the R value from 1.42 (as-cast condition) to 1.04 (SPDed in-situ composite). The underlying mechanism of significant property enhancement in the developed material has been correlated with the tension and compression tests and microstructures.

Keywords: *In-situ magnesium matrix composite, Friction stir processing, Microstructural properties, Strengthening mechanism, Tension-compression yield asymmetry.*

1 Introduction

Magnesium (Mg) alloys are widely used in numerous structural and engineering application because of their inherent properties like low specific gravity, high specific strength and recyclability [1,2]. Among all Mg alloys, AZ91 (Mg-9Al-1Zn) is a commonly used Mg alloy due to its unique properties like good castability, corrosion resistance and hardenability [3]. However, the low/moderate strength, poor ductility and tension-compression yield asymmetry limit its applications in structural field.