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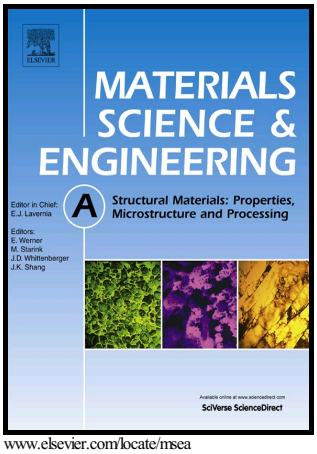

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Strengthening die-cast Al-Mg and Al-Mg-Mn alloys with Fe as a beneficial element

Xiangzhen Zhu[a], Paul Blake[b], Shouxun Ji[a*], Kun Dou[a]

[a] Brunel Centre for Advanced Solidification Technology (BCAST), Institute of Materials and Manufacturing, Brunel University London, Uxbridge, Middlesex UB8 3PH, United Kingdom

[b] Engineering Centre, Jaguar Land Rover, Abbey Road, Coventry, CV34 4LF, United Kingdom

* Corresponding author: Tel.: +44 1895 266663, Fax: +44 1895 269758, shouxun.ji@brunel.ac.uk

Abstract

The effect of Fe and Mn on the microstructure and mechanical properties of a series of Al-5wt.%Mg alloys processed by high pressure die casting (HPDC) was investigated. The Calculation of Phase Diagrams modelling (CALPHAD) was also carried out to understand the phase formation in experimental alloys. The results show that Fe can be a beneficial element in the Al-Mg and Al-Mg-Mn alloys to improve the mechanical properties. Fe only exists in the form of equilibrium $Al_{13}Fe_4$ phase in Al-Mg-Fe alloys. While, the addition of 0.6wt.%Mn suppresses the formation of equilibrium $Al_{13}Fe_4$ phase. In Al-Mg-Mn-Fe alloys, all Fe-rich intermetallics are Al_6(Fe, Mn) phase when Fe level is less than 2.5wt.%. When further increasing the Fe level, the primary non-equilibrium Al_6(Fe, Mn) phase gradually evolves to form equilibrium $Al_{13}Fe_4$ phase, but the eutectic phase is still Al_6(Fe, Mn). It was also found that both the eutectic $Al_{13}Fe_4$ in Al-Mg-Fe alloys and eutectic Al_6(Fe, Mn) in Al-Mg-Mn-Fe alloys are divorced from α-Al phases as the primary Fe-rich phases appear. The Fe-rich intermetallics significantly affect the mechanical properties of experimental alloys. Fe enhances the yield strength obviously but reduces the elongation significantly. The ultimate tensile strength is also improved by Fe addition when Fe level is less than 2.0wt.%, but it is significantly decreased with further increasing the Fe level. Moreover, the Mn addition is found to increase the volume of strengthening Fe-rich intermetallic and thus can further strengthen Al-Mg alloys.

Key words:

Aluminium alloys; Microstructure; Mechanical properties; Fe-rich compounds; High pressure die casting