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

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### 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  $\text{Al}_{13}\text{Fe}_4$  phase in Al-Mg-Fe alloys. While, the addition of 0.6wt.%Mn suppresses the formation of equilibrium  $\text{Al}_{13}\text{Fe}_4$  phase. In Al-Mg-Mn-Fe alloys, all Fe-rich intermetallics are  $\text{Al}_6(\text{Fe}, \text{Mn})$  phase when Fe level is less than 2.5wt.%. When further increasing the Fe level, the primary non-equilibrium  $\text{Al}_6(\text{Fe}, \text{Mn})$  phase gradually evolves to form equilibrium  $\text{Al}_{13}\text{Fe}_4$  phase, but the eutectic phase is still  $\text{Al}_6(\text{Fe}, \text{Mn})$ . It was also found that both the eutectic  $\text{Al}_{13}\text{Fe}_4$  in Al-Mg-Fe alloys and eutectic  $\text{Al}_6(\text{Fe}, \text{Mn})$  in Al-Mg-Mn-Fe alloys are divorced from  $\alpha$ -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

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