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The formation mechanism of metastable Al_6(Fe, Mn) phase in die-cast Al-Mg alloys

The formation, 3D morphology and growth mechanism of Al_6(Fe, Mn) phase were studied in Al-Mg-Mn-Fe alloys processed by high pressure die casting (HPDC). Thermodynamic calculation indicates that Al_6(Fe, Mn) phase in the HPDC Al-Mg-Mn-Fe alloys is a metastable phase. The experimental results confirm that Mn addition in the alloy suppresses the transformation from metastable Al_6(Fe, Mn) phase to stable Al_{13}(Fe, Mn)$_4$ phase under nonequilibrium solidification conditions. Energy-dispersive spectroscopy (EDS) analysis of extracted particles reveals that the average Mn/Fe atomic ratio in the Al_6(Fe, Mn) phase decreases as the Mn/Fe atomic ratio in the melt decreases. It is also found that the Al_6(Fe, Mn) phase grows to form two elongated prism morphologies: rhombic prism (equilibrium morphology, bounded by {110} and {002}), and rectangular prism (growth morphology, bounded by {002}, {200} and {020}). The primary Al_6(Fe, Mn) phase shows hollow structure and the eutectic one is in the form of fine solid particles. The growth mechanism of Al_6(Fe, Mn) phase is also elucidated according to the crystallographic rules and the morphological characteristics of Al_6(Fe, Mn) phase.

Recent Publications

1. Ji S, Yan F and Fan Z (2015) Development of a high strength Al-Mg_2Si-Mg-Zn based alloy for high pressure die casting. Materials Science and Engineering: A 626:165–174.
2. Zhu X, Wu Y, Li C, Li P, Qiao H, et al. (2014) The dispersive orientated-precipitation of AlP on alumina film and its effect on the primary Si gathering behavior in the Al–Si alloy surface layer. Cryst Eng Comm 16(25):5583–5590.

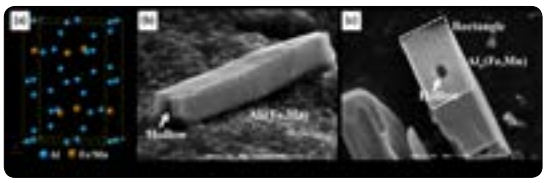

Figure 1: (a) Crystal structure and 3D morphologies of Al_6 (Fe, Mn) phase.

3. Zhu X, Jiang W, Li M, Qiao H, Wu Y, et al. (2014) The effect of Mg adding order on the liquid structure and solidified microstructure of the Al-Si-Mg-P alloy: an experiment and *TT*study. Metals 5(1):40–51.
4. Ji S, Yang W, Gao F, Watson D and Fan Z (2013) Effect of iron on the microstructure and mechanical property of Al-Mg-Si-Mn and Al-Mg-Si diecast alloys. Materials Science and Engineering: A 564:130–139.
5. Das A, Ji S and Fan Z (2002) Morphological development of solidification structures under forced fluid flow: A Monte-Carlo simulation. Acta Materialia 50(18):4571–4585.

Biography

Shouxun Ji is currently a Lecturer at BCAST. Before rejoining Brunel in October 2010, he was a Manager at Arcadia, leading a team working on various projects to develop products and managing supply chains. Prior to that, he was the Chief Engineer of BCAST specialized in semi-solid processing of rheo-die casting, rheo-extrusion and rheo-twin roll casting. He is focusing on developing lightweight materials and structures for the automotive industry, including purpose developed aluminium and magnesium alloys with improved ductility, strength, modulus, or thermal conductivity, and the hybrid structures using different materials. He is also working on new materials for aerospace application, such as materials for explosive cords and high strength casting materials for aircraft. Meanwhile, he is in charge of all the equipment specification, planning and supply in the AMCC 1 and 2 programmes.

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