THERMAL PROFILE AND MICROSTRUCTURE ANALYSIS OF Al-Si WITH THE MAGNESIUM ADDITION UNDER DIFFERENT COOLING CONDITIONS

M. F. Mohamad Tajudin and N. A. Abd Razak
Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600 Pekan, Pahang, Malaysia

A. H. Ahmad and J. Alias
Faculty of Mechanical and Automotive Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600 Pekan, Pahang, Malaysia
Centre for Automotive Engineering, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600 Pekan, Pahang, Malaysia

S. Naher
Department of Mechanical Engineering and Aeronautics, City University of London, London EC1V 0HB, UK

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Abstract

Thermal analysis is an effective approach for studying the characteristics of materials under different temperature situations. The study implemented cooling curve analysis (CCA), complemented by computational methods for precisely evaluating the temperature variation of the molten alloy by employing two thermocouples. An aluminium alloy with 1 wt.% Mg addition was melted in graphite crucible and subjected to various cooling conditions, which included normal, slow, fast, and fastest cooling rate conditions. Normal cooling condition (A) was achieved when the crucible was allowed to cool down to room temperature. Meanwhile, the slow cooling condition (B) was achieved when the crucible was allowed to cool within the Kaowool insulator chamber. In addition, the fast (C) and fastest (D) cooling conditions were attained when the forced airflow was directed at the crucible at minimum and maximum speed, respectively. The temperature data were collected via K-type thermocouples connected to a Ni 9129 data acquisition system and DasyLab software. Cooling curves, cooling curves with baselines, dendritic coherency points, and solid fractions were then recorded using OriginPro 2019b software. The liquidus, eutectic, and solidus temperatures were determined. The microstructure of the alloy sample was characterised by optical microscopy (OM), scanning electron microscopy (SEM), combined with energy-dispersive X-ray spectroscopy (EDX), and X-ray diffraction (XRD) analysis. The results show that the high cooling rates produced smaller and more globular grain structures. The highest cooling rate condition produced smaller and globular microstructure formation at 944 μm^2 and a circularity of 0.61, respectively. Meanwhile, the slow cooling condition produced the largest grain size at 1668 μm^2 and a circularity of 0.46. The results show that higher cooling rates result in a smaller and more spherical grain structure than other cooling conditions. This underlines the significant influence of the cooling rate on the development of the microstructure during the solidification process. This comprehensive thermal analysis study has shed light on the significant influence of Mg addition and different cooling conditions on the Al-Si alloy's thermal properties and microstructure formation. The results contribute to understanding alloy solidification and may have practical implications for materials engineering and manufacturing.

Keywords: *aluminium alloy, globular microstructure, grain refinement, semisolid processing, thermal analysis*

Introduction

The versatile and skilful utilisation of aluminium alloys across the various manufacturing sectors, such as

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