EFFECTS OF COOLING RATES ON THERMAL PROFILES AND MICROSTRUCTURE OF ALUMINIUM 7075

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ABSTRACT

The effects of different cooling rates on thermal profiles and microstructures of aluminium 7075 are presented in this paper. The 7075 alloy was heated in a graphite crucible to 750 °C. In the experimental work two thermocouples were used to record the temperatures at the centre and 30 mm from the centre of the graphite crucible. A slow cooling rate condition was achieved by placing the crucible into a chamber with Kaowool insulation. A higher cooling rate was achieved by placing the crucible in open atmosphere with controlled air flow over the crucible. The slow and high cooling rates were 0.03 °C/s and 0.4 °C/s respectively. The Data Acquisition (DAQ) system implemented using LabVIEW software was used to record the temperature-time profiles. The enthalpy of phase change at each temperature was estimated from the cooling curves. The changes of cooling rate were directly related to phase transformation including at liquidus, eutectic and solidus temperatures. The dendritic coherency point (DCP) was determined from analysis of the temperature difference between two thermocouples. The formation of DCP was found to be delayed with use of the slow cooling rate. DCP occurred at 615.2 °C (0.75 fraction solid) for the slow cooling rate and at 633.1 °C (0.3 fraction solid) for the higher cooling rate. The microstructure features were also found to alter significantly with the different cooling rates used. The microstructure was more spheroidal for the slow cooling rate compared with the higher cooling rate.

Keywords**:** Semi-solid metal; Thermal profile; Aluminium 7075; Dendritic coherency point; Spheroidal microstructure.

INTRODUCTION

In recent years, there is an increasing interest in producing near-net-shape product with semi-solid metal (SSM) forming routes. It offers production with lower amounts of porosity defects, lower filling time and no hot tearing problems. In addition, it also allows for increased productivity that contributes to production cost per unit saving. Since the discovery of SSM behaviour in 1971 with the noting of the viscosity reduction within semi-solid state upon shearing, the technology has advanced significantly (Spencer et al., 1972, Yang et al. 2014). Mechanical stirring using rotating impellers were used to produce laboratory scale feedstock production (Brabazon et al., 2003,