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Solidification Analysis in Permanent Mould Casting of Aluminium Alloy LM6 Reinforced Titanium Carbide Particulates Metal Matrix Composites

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Abstract. Permanent mould casting was used as the production technique to produce the metal matrix composites (MMCs) specimens. Thermal measurements during the casting process were recorded. Based on these data, solidification graphs were plotted to understand the solidification characteristics. Solidification analysis was performed by interpreting the parameters drawn from the solidification graphs. Parameters such as; nucleation primary alpha phase temperature, liquidus arrest temperature, eutectic growth temperature and solidification time were identified. The results showed that addition of titanium carbide particulates (TiCp) into the aluminium-11.8% silicon alloy (LM6) have affected various time and temperature parameters of its solidification properties. These in turn will have an influence on the mechanical property of the MMCs.

Introduction

Demand of metal matrix composites (MMCs) utilisations are especially for high temperature, high strength and high stiffness materials such as in turbine engines and other applications. MMCs are always more expensive than the most conventional materials they are replacing. As a result, they are found where improved properties and performance can justify added cost [1].

Metal matrix composites (MMCs), like the monolithic metals and alloys, the characteristics of the cast MMCs are largely dependent on the solidification behaviour which is dictated by the thermo-physical properties of the reinforcement, matrix materials and the mould [2][3]. Previous work showed that the solidification rate increases with the introduction of particles reinforcement. It reaches a maximum point and decrease with increasing particles reinforcement. This is due to the lower heat transfer within the solidifying melt owing to the reduced effective thermal diffusivity of the material system. Introduction of ceramic particles into the metal alloy reduces the liquidus temperature. Research conducted on solidification of MMCs had found that the solidification time of primary dendrites is affected because of the presence of the ceramic particles. Studies of MMCs have indicated that various solidification have an effect on the microstructure and the mechanical properties of the cast MMCs [4]-[6].

The objective of the present study is to investigate the solidification parameters of aluminium-11.8% silicon alloy (LM6) reinforced titanium carbide particulates (TiCp) metal matrix composites.

Materials and Methodology

Permanent mould casting process was employed to produce the MMCs specimens. Besides producing as-cast LM6, reinforcement TiCp of 5, 10, 15, 20, and 25 volume percentages were added to the LM6 matrix. Reinforcing an aluminium alloy with ceramic material yields a composite that displays physical and mechanical properties of both the metal matrix and reinforcement. The toughness and formability of aluminium can be combined with the strength of reinforcement material [6]. A copper mould was used to produce the specimens via gravity casting. The mould