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Formation of globular structure in A357 aluminum alloy via a near-liquidus casting (NLC) route

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Abstract
A near-liquidus casting (NLC) route is applied to prepare A357 aluminum alloy with a globular structure. The method is cost-effective and based on the melt pouring with low superheat level followed by isothermal re-heating treatment in the semi-solid region. This study describes the effect of both casting temperature and re-heating time on the evolution of globular structure in A357 Al alloy. To do so, molten alloy is poured directly into a cylindrical mold at various temperatures of 625°C, 635°C, 645°C and 655°C. Then, the specimens are re-heated at 590°C for different time of 10, 20, 30 and 40 min. The microstructural development of specimens after re-heating stage is investigated. The primary α-Al dendritic phase in the conventional cast alloy is transformed into globular shape in NLC-processed specimens only after re-heating treatment. Increasing both casting temperature and re-heating time change the size and shape factor of globules. The results show that the optimum combination of pouring temperature and re-heating time is found to be 625°C and 30 min, respectively. The mechanisms behind the microstructural evolution are proposed.

Keywords*:* Near-liquidus casting (NLC), A357 Al alloy, Re-heating treatment, Shape factor.

Introduction
A357 is a casting grade aluminum alloy containing silicon and magnesium as the main alloying elements. It has wide applications in automotive, marine and other sectors due to its excellent combination of properties such as good fluidity, low coefficient of thermal expansion, high strength-to-weight ratio and good corrosion resistance as well as their high tensile, impact and fatigue properties after heat treatment [1,2]. For these reasons, it is essential to develop better understanding of the microstructural characteristics of this alloy.
Efforts are still being made by technologists to further enhance the mechanical properties of Al-Si alloys by controlling their microstructure using suitable casting procedure and heat treatment [3,4]. Also, extensive research works have been conducted in recent years to study the effect of modifier elements on the microstructure and mechanical properties of Al-Si alloys [5-7].
It is well documented that microstructure is one of major factors influencing the mechanical properties of aluminum alloys [8,9]. In conventional casting routes, the morphology of the growing solid-liquid interface is in the form of dendritic. However, the need for producing near net shape components for high performance applications has drawn attentions to new techniques such as semi-solid casting (SSC) [10,11]. SSC is a special die casting process where metal alloys are processed at a temperature above their solidus but below their liquidus. The processing of