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Effect of NaCl as a space holder in producing open cell A356 aluminium foam by gravity die casting process

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Abstract

Gravity die casting is the technique which enables fabrication of open-cell A356 aluminium foam as a suitable absorber material with good quality performance. A356 aluminium alloy was used with varies amount of sodium chloride (NaCl) particles as a space holder to fabricate the aluminium foam using gravity die casting. Microstructural analysis, porosity and density were investigated in this study. As the addition of the NaCl space holder increases, porosity increases leading to decreasing density of the foam. Aluminium foam with 30 wt.% NaCl showed moderate porosity among the others foam.

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Keywords: open cell foam ; normal casting ; space holder ; microsturucture

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1. Introduction

Modern research in engineering is focused on developing new materials and composites for the purpose of producing structural elements of lower density and equal performances. Lighter elements are used in structures for the purpose of weight reduction and saving of energy. In order to achieve this goal, metal foams have been developed.

The casting technique is well suited for the production of uniform and fine open-cell foams of lower melting-point metals such as aluminium[1]. Given its low cost[2], its chemical inertness in contact with aluminium, its relatively high melting point and its ease of dissolution in water, sodium chloride (NaCl) is often used as the preform or space holding filler material for aluminium foams.

When metallic foams are used at an elevated temperature in the interconnect applications, the relatively high thermal expansions of the metals would be problematic, causing thermal stress which may lead to failures of the components. For that, casting process is one of the possible approaches to improve physical and thermal properties of Al foams[3].

2. Experimental procedures

A356 aluminium alloy was prepared using Al-Si ingot containing 11.5 wt.% Si. Then pure aluminium and pure magnesium were added with Al-Si ingot to form composition of A356 aluminium alloy. The materials were melted in graphite crucible placed into the bottom loading furnace at 850ºC with temperature increment rate of 25ºC/minutes for about two hours to homogenize the molten mixture and then soaking at 680ºC for 30 minutes. After mixing, a uniform distribution of particles in the molten aluminium was acquired. The molten aluminium alloy was cast into cylindrical mild steel mold of 200 mm in length and 50 mm in diameter producing A356 aluminium alloy. Then, the chemical compositions, microstructure and phase identification of A356 aluminium alloy were determined by XRF, optical microscope and XRD, respectively. A356 aluminium alloy foam then was prepared according to the composition listed in Table 1.

Table 1 : Composition ratio of salt to melt mixture

Ratio (NaCl : A356 Alloy)	0.2 : 1	0.6 : 1	1 : 1
Normal casting (in grams)	10 : 50	30 : 50	50 : 50

In order to prepare A356 aluminium alloy foam, the prepared A356 aluminium alloy is placed in graphite crucible and melted at 850ºC in the melting furnace for about two hours. Then, the molten A356 aluminium alloy was cooled down to 680ºC. At the same time, NaCl salt particles were weighted according to its ratio and preheated at 680ºC for 15 minutes in a heating furnace before added in the molten A356 aluminium alloy. Then, the NaCl was added according to the ratio as shown in Table 1. The salt/melt (NaCl/A356 alloy) mixture was manually stirred for one minute to distribute the NaCl particles uniformly in the molten A356 aluminium alloy. During casting process, argon gas was purged at 1.0 l/min for one hour to ensure a homogenous distribution of NaCl in the composite. The molten of A356 aluminium alloy containing NaCl was left to cool down in the crucible at room temperature for 30 minutes. Then, the sample with round-shaped NaCl/A356 composite was removed out from the crucible. All the samples of NaCl/A356 composite were leached in water at 90ºC for about 1 hour per sample to remove NaCl particles, producing open-cell aluminium foams.

Morphology and microstructure of NaCl particles and open cell A356 aluminium foams were studied through optical stereo zoom microscope Kunoh Robo and scanning electron miscroscopy (SEM). Density measurement of A356 aluminium foam with different amount of NaCl was performed using densitometer.