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Effect of Modifier on Mechanical Properties of Aluminium Silicon Carbide (Al-SiC) Composites

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Abstract

The silicon carbide particle reinforced aluminum matrix composites are expected to have many applications in aerospace, aircraft, automobile and electronic industries. Aluminium Silicon Carbide (Al-SiC) is also used for Advanced Microelectronic Packages. In this study, effect of different weight percentage of strontium on microstructure and mechanical properties of Al-SiC composite and Al-12Si (LM6) was investigated. In this research, scanning electron microscope equipped with EDS was used to define how modifier effect on microstructure. To fabricate Al-SiC composite, 10 wt% silicon carbide and different percentages (0.02, 0.5) Wt % of Al-10Sr was added to Al-11.6Si (LM6) by using vortex method for mixing the particles. The influence of adding different amount of Al-10Sr (0.01, 0.02, 0.5) Wt% on mechanical behavior of aluminum was also examined. The results found that UTS for aluminum increased by adding SiC and Sr. It was observed that the tensile for the composite did not increase dramatically. It was concluded the weak interface between particles and matrix, decreased the UTS. On the other hand strong interface between particles or fibers in the matrix showed high stiffness and strength but typically a low resistance to fracture.

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1. Introduction

In recent years, the development of lightweight Aluminium alloys improves the quality of the material in aerospace, automotive industries. Al-Sic composite materials have distinctive set of material characterization which are appropriate for all "electronic industries usage" which is needing "thermal management". [1]. It is identified that reinforcing of Aluminium alloys with discontinuous second phase particles offers high strength, high modulus,

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larger wear resistance and desirable thermal expansion. Nowadays Aluminium-Silicon alloys mostly can use in electronic industries, aerospace due to their good casting ability, lightweight, brilliant corrosion resistance, and lower coefficient of thermal expansion [2]. Strontium, as an alloy modifier which can be useful in refining the microstructure in grain size and reducing porosity in LM6.Strontium is reported to be effective, which can have positive influence on the forming of porosity, but lower effects on reducing the number of visual porosity in the samples.LM6 alloy is basically a hypoeutectic Al-Si alloy (naturally contains of 11.5wt% Si, less than 12.6wt% Si of eutectic composition) with little copper content (<0.1 wt%).

By brittle reaction layer at their surface through processing the UTS of the fibre and particles can be reduced, and as result decreasing of the ultimate strength of the composite will happened. it is reported by some researchers that multi axis surface stiffness in MMCs reduced the ductility of matrix of AMC. There is optimum amount of adding particles to fabricate composites by increasing 10 to 15 % of SiC to the aluminum the tensile strength will decrease [3,4]. Effective reinforcement needs well bonding filler and matrix, principally for short fibers. Chemical bonding, inter-diffusion, van der Waals bonding, and mechanical joining are the contents of the Interface mechanisms refer to filler–matrix bonding. On the other hand strong interface between particles or fibers in the matrix show high stiffness and strength but typically a low resistance to fracture, i.e., the features of the interface are affecting on brittle behavior. resistance to creep, fatigue [5-10]. Good wettability between matrix and particles is also increase the tensile of composite [8.11].

2. Experimental Procedure

LM6 (Aluminium) was melted at 700°C in the electrical induction furnace The desired amount of LM6 weight measured by digital balance. Based on the capacity of each pattern and mold, exact amount of Aluminum can be defined. It will take around 1 hour to melt LM6 completely inside the furnace. The second step for this experiment is adding Al-10Sr.After melting completed then 0.01, 0.02, 0.5 (wt) % Sr is weight and added to the molten Aluminium. It is important to noted that the Strontium is not pure in this experiment so due to the amount of Sr in the Al-10Sr Alloy the desired amount of alloy will be defined.

For the first and second experiment, the Strontium has been hold for 10 min, however, for the third experiment, it has been hold 15 min. The molten metal poured to ladle then poured to the sand mold as shown in Figure 1. The sand consisted of silica sand, sodium silicate, calcium and water, which mixed, in the mixer. Pouring temperature was less than 650 °C but still above melting temperature [7].

LM6 Aluminium was melted at 750°C in the electrical Induction furnace. Preheating of 10% Wt silicon carbide at 800°C was done for one hour to eliminate moisture and gases from the surface of the particulates The SiC powder poured into metal cup, and then it is kept for 1 hour inside the muffle furnace. The maximum temperature for this furnace is 1000 °C. In this research, it is selected 800 °C in 1 hour. After that, the furnace opened carefully, particles poured into the melting Aluminium, and mixing for the particles is performed [6].

The main problem during fabrication of MMCs is to acquire homogenous dispersion of the ceramic particles by applying low cost equipment for commercial applications. A stir casting setup, consisted of an Induction Furnace and a stainless steel mixer assembly, was applied to synthesize the metal matrix composite as shown in Figure 1.The vortex method is one of the cost-effective approaches which is used in distribution of particles in molten metal.

Figure 1. Preparing composite by Vortex method