INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 4, Issue 3)
Available online at: www.ijariit.com

Studies on microstructural and hardness properties of aluminum metal matrix composites

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ABSTRACT

The Al7075 alloy matrix materials possess mechanical properties with the addition of B_4C particulates as reinforcement with varying weight percentage. Stir casting is used for preparing composite workpiece. Composites were adopted for microstructural studies and hardness survey. The hardness properties are examined for the composite materials and revealed that hardness increases with increase in weight percentage of reinforcement.

Keywords: *Aluminum alloy, Microstructure, Hardness*

1. INTRODUCTION

When compared to metals, the hybrid Aluminum Metal Matrix Composites are extensively used in many areas where weight and strength are of most important factors. The main advantage of particulate reinforced composite are its different strengthening mechanisms and their formability [1, 3]. The HAMMCs possesses high coefficient of thermal expansion with lesser density [4]. Due to their excellent mechanical properties HAMMCs are widely used in automobile industries [5]. HAMMCs can be fabricated by stir casting process. Homogeneous mixing can be obtained by selecting appropriate processing parameters like stirring speed, time and temperature of the molten metal, preheating temperature of the mould and uniform feed rate of the particles [6, 7]. Among the various aluminum alloys, 7075 is best opted choice to prepare metal matrix composites due to its better formability characteristics. [8] The addition of SiC and B_4C particles into the aluminum matrix increases the hardness and their mechanical properties. In particulate reinforced HAMMCs, reinforcement is added to the matrix of the bulk material to increase its stiffness and strength [9].

2. MATERIALS SELECTION

In this paper, B_4C particulates reinforced with Al 7075 matrix composite is selected. The nominal chemical composition of Al 7075 alloy is given in Table 1. Hardness of the specimens was measured using Brinell hardness tester by applying a load of 100 kgf and the average hardness from 10 different data of the experiments was considered.

Table 1: Chemical composition of Al7075 by weight percentage

Elements	Si	Fe	Cu	Mn	Ni	Zn	Ti	Mg	Cr	Al
% wt	0.06	0.18	1.62	0.074	0.05	5.62	0.049	2.52	0.22	Balance

Preparation of Aluminum Metal Matrix Composites (HAMMCs)

Stir casting technique is used to fabricate Al 7075 alloys with varying weight percentage of B_4C reinforcement. The stirrer is used to stir the molten metal in semi solid state. The melt was maintained at a temperature of 800˚C for one hour. Vortex was created by using a mechanical stirrer. Two specimen Al7075 reinforced with 3% B_4C and 7%B_4C, were made with the same procedure. Hardness measurements were carried out on the specimen. Specimen were tested using Brinell hardness tester machine. A load of

100 Kgf for a period of 25 seconds was applied with a ball indenter of 10 mm diameter. The test was carried out at five different regions. Hardness was determined by measuring the indentations diameter produced. The average of all the five readings was taken as the hardness of the composite. The specimen faces were metallographically polished.

3. MICROSTRUCTURAL STUDY

The procedure involves grinding of composite aluminium surfaces manually by 240, 320, 400, 600 grit silicon carbide papers and then polishing them with alumina using disk polishing machine. This preparation technique created considerable surface relief between hard and soft aluminium matrix. The polished samples were cleaned ultrasonically with acetone and methanol solutions. The obtained micrographs reveal an excellent bond between the matrix alloy and the reinforcement. From the fig it has been revealed that the particle distribution are uniform throughout the matrix due to constant speed of the stirrer. Microstructure analysis of these specimens shows that the B_4C particles are uniformly distributed in the matrix. Presence of porosity around the B4C particles was seen due to wetting behavior of aluminum alloy. The good bonding between the aluminum alloy and particulates was observed. The uniformly distributed particulates within the matrix and dendrites are also seen. Grain boundaries are clearly seen with some precipitates in the grains.

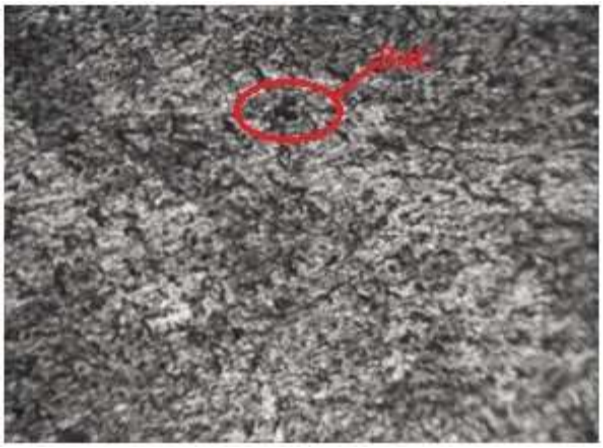

Fig. 1: Al7075 3% B_4C

Hardness Survey

Hardness test was carried out using Brinell hardness tester with six indentations of each sample and then the average values were used to calculate hardness number. A considerable increase in hardness of the matrix was seen with the addition B_4C particles. The hardness of HAMMCs increases with the weight fraction of particulate in the alloy matrix. It is observed that with increased weight % of reinforcement in the matrix alloy, there is a significant improvement in the hardness of the composites.

4. CONCLUSION

Hardness increases with considerable increase in B_4C particles. Microstructure reveals the uniform distribution of B4C particles.

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