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EVALUATION OF HARDNESS OF ALUMINIUM/GRAPHITE PARTICULATE COMPOSITE FABRICATED BY STIR CASTING ROUTE

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Abstract

Aluminum metal matrix composites (AMCs) are demanded almost in every engineering field due to their excellent mechanical and physical properties. Fabrication of AMCs with low cost of manufacturing had always been a challenge for the researchers. Many fabrication techniques were adopted but were not suitable for producing low cost AMCs. Stir casting and Compocasting which adopts the liquid metallurgy route for the fabrication of AMCs, are very cost effective fabrication process for manufacturing aluminum metal matrix composites and gaining global popularity day by day. Liquid metallurgy rote follows the dispersion of reinforcing particles into the vortex of the molten metal. Many researchers adopted different methods of dispersing these particles to increase the dispersion and wettability with the molten metal matrix so as to achieving a uniform distribution of reinforcement within the matrix. This paper deals with the evaluation of mechanical properties of AMCs fabricated by stir casting of high purity aluminum with graphite particulate. The objective is to develop a conventional low cost method of producing MMCs with homogenous dispersion of material.

Keywords: AMCs, graphite, stir casting, composite *etc.*

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1. INTRODUCTION

Metal matrix composites are being extensively in engineering applications in a broad way because of their excellent mechanical and physical properties [1-2]. Aluminum is first choice of the researchers due to the matter of fact that it is most abundant metal and is known for its light weight and excellent strength. Aluminum and its alloys are broadly used as a main matrix element in composites. With the development of AMCs, Cast Iron and steel are being replaced progressively [3-5]. These innovative materials developed new dimensions for modern material science and provided opportunities to design a custom-made new material depending on the application. The variation is countless as it gives options to develop new material with existing material system of Metal, Non Metal and Ceramics. The property of this newly designed material depends upon its constituent's material.

AMCs are developed mostly for their use in Automotive, Aerospace, Marine and structural applications. With these different engineering field applications, the objective of employing the AMCs also changes. Automotive and Aerospace applications have the highest priority of high strength to weight ratio [6-7]. Marine applications have the priority of good corrosion resistance and Structural applications gives highest priority to Strength parameter. Thus selection of reinforcing material is very crucial and totally application based. Aluminum reinforced with graphite particulate is suitable for low load applications.

For the fabrication of AMCs, stir casting route is most promising and is being practiced worldwide. It is being used commercially because of its simplicity, flexibility and suitability for mass production. Its attractiveness is principle which follows conventional liquid metallurgy rote where particulate reinforcing particles are dispersed in the vortex of molten metal. In preparing metal matrix composites by the stir casting method, there are several factors which require high attention. Uniform distribution of the reinforcing material, wettability of reinforcing particles with matrix, porosity in the cast metal matrix composites, and chemical reactions between the reinforcing material and the matrix are such factors which

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play important part in producing AMCs with superior quality. In order to achieve the optimum properties of the metal matrix composite, the distribution of the reinforcement material in the matrix alloy must be uniform, and the wettability or bonding between these substances should be optimized.

2. EXPERIMENTAL PROCEDURE

2.1 Materials/Equipments.

The graphite powder used as reinforcement material and high purity aluminium rod are purchased from a chemical. Graphite powder of 600 microns is used.
The equipment used in this study includes Stir casting machine, weighing machine, sieve, electric furnace for preheating purpose, preheated mould, lathe machine, Brinell Hardenss machine.

2.2 Specimen Preparation

Aluminium metal matrix composite used in the present study is fabricated by liquid state processing or liquid metallurgy route using stir casting machine. Al rods properly washed and dried in sun is charged into the crucible which is properly coated with paint to avoid any contamination or sticking phenomena of Al with crucible surface. The charge is heated upto 700°C till all the Al rods are melted in the crucible. It took around 1 hour to melt the metal rod completely. The reinforcement particles are preheated to a temperature of 100°C for 30 minutes before incorporating them into the melt. When the melt is ready, hexachloro ethane tablets are added as degassing tablets to reduce the porosity [5]. Stirring of melt is done at a constant rpm of 250 by using a motor driven stainless steel stirrer which is lowered slowly upto two-third of the height of the melt in the crucible measured from its bottom. The preheated graphite is charged into the melt very slowly at a rate of 1-2 grams/min. The molten metal is stirred at constant rpm throughout for a period of 5 minutes after the addition of graphite. The mixture is poured into the mould which is also preheated to 550°C for 30 minutes to achieve uniform solidification of the mixture. Four specimens of different weight fractions were fabricated using the same method.

2.3. Evaluation of hardness

The hardness was measured according to ASTM E10 by using Brinell Hardness Tester at load of 500 kgf using 10 mm steel ball indenter for a detention period of 15 sec. The readings were taken at different sites of the specimen and average of these values is used.

3. RESULT AND DISCUSSION

The variation of hardness of composite with different weight fractions of reinforcement is shown in figure (1). Hardness increases first with increase in weight fraction of reinforcement and then decreases sharply with further increase in weight fraction of reinforcing particles. It may be attributed to change in the grain size of aluminium matrix. Increase of hardness is due to presence of more fine grains compared to that of pure aluminium. With further increase in the reinforcement fraction, these fine grains might have grown to coarse grains due to induction of softening effect caused by graphite.

Table-1: Variation of Hardness with Reinforcement weight fraction.

S.No	Material System	Hardness (BHN)
1	Al + 1% Graphite	21
2	Al + 3% Graphite	32
3	Al + 5% Graphite	41
4	Al + 7% Graphite	18

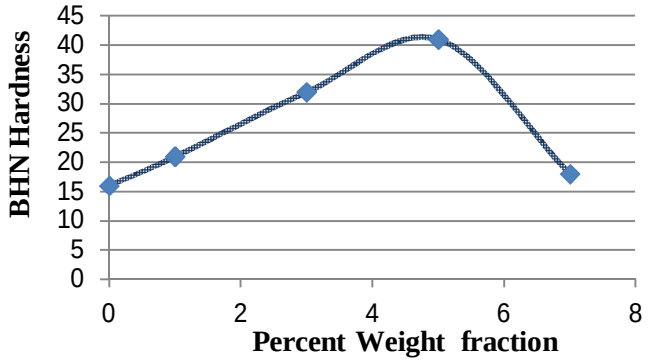

Fig-1: Variation of Hardness with % weight fraction of reinforcement.

4. CONCLUSION

It is possible to fabricate low cost aluminum metal matrix composites by using stir casting machine. It is observed that hardness of Composite first increases and then decreases with increase in reinforcement weight fraction. In case of using graphite as reinforcement, higher fraction is not suitable. It is better to use weight fraction at around 5%.

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