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Effect of reinforcement of LM6 with SiC on mechanical behavior of Metal matrix composites

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Abstract: -- **A phrase heard often in recent years, advanced composite materials like Al/SiC metal matrix composite is gradually becoming very important materials in auto and aerospace industries due to their superior properties. The present study examines the mechanical properties of aluminium LM6/SiC Silicon carbide reinforced particles metal-matrix composites (MMCs) by varying weight fractions of SiC. For these LM6/SiC reinforced particles, MMCs are fabricated by stir casting method at air atmosphere. The MMCs are prepared in the form of bars with varying the reinforced particles by weight fraction ranging from 3 %, 5 % & 7 %. The reinforced particles size of SiC is 150µm. The microstructure study shows that the distribution of particles becomes better with increasing weight fraction of SiC. The Mechanical properties like Hardness (HRB), BHN & Wear resistance are investigated on prepared specimens of MMCs. It was observed that the hardness & wear resistance of the composite is increased gradually.**

Keywords — Aluminium, SiC, Metal Matrix Composite, stir casting, weight fraction

I. INTRODUCTION

Aluminum is the most abundant metal and the third most abundant chemical element in the earth's crust, comprising over 8% of its weight. Aluminum alloys are broadly used as a main matrix element in Composite materials. Aluminum alloys for its light weight, has been in the net of researchers for enhancing the technology. The broad use of aluminum alloys is dictated by a very desirable combination of properties, combined with the ease with which they may be produced in a great variety of forms and shapes [1]. Discontinuously reinforced aluminium matrix composites are fast emerging as engineering materials and competing with common metals and alloys. They are gaining significant acceptance because of higher specific strength, specific modulus and good wear resistance as compared to ordinary unreinforced alloys. Reinforcing particles used in this study are silicon carbide particles which are added externally [2]. Aluminium alloy (LM6) is used in Marine, Automobile, Aerospace industries. One of the main drawbacks of this material system is that they exhibit poor tribological properties. Hence the desire in the engineering community to develop a new material with greater wear resistance and better tribological properties, without much compromising on the strength to weight ratio led to the development of metal matrix composites [2]. Silicon carbide is a compound of silicon and carbon with a chemical formula SiC. Silicon carbide was originally produced by a high temperature electrochemical reaction of sand and carbon. Silicon carbide ceramics with little or no grain boundary impurities maintain their strength to very high temperatures, approaching 1600°C with no strength loss. It is an excellent abrasive and has been produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties. It is used in abrasives, refractories, ceramics and numerous high-performance applications [2]. Composites are engineered or naturally occurring materials made from two or more constituent materials with significantly different physical or chemical properties that remain separate and distinct within the finished structure. The bulk material forms the continuous phase that is the matrix (e.g., metals, polymers) and the other acts as the discontinuous phase that is the reinforcements (e.g., ceramics, fibers, whiskers, particulates). While the reinforcing material usually carries the major amount of load, the matrix enables the load transfer by holding them together [3].

In this study an attempt has been made to fabricate a Hybrid Composite from commercial silicon carbide. Aluminium alloy (LM6) is used as matrix material for the fabrication of LM6-SiC hybrid composite material. Methods available for the production of Hybrid Composites are powder metallurgy, spray deposition, liquid metal infiltration,

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squeeze-casting, stir-casting. Though various processing techniques available for particulate or discontinuous reinforced metal matrix composites, stir casting is the technique, which is in use for large quantity commercial production. This technique is most suitable due to its simplicity, flexibility and ease of production for large sized components. Hence stir casting method is used in this study [4]. The objective of present work is to produce hybrid composites of LM6/SiC by stir casting method, and to study of wear behavior of LM6-silicon carbide MMCs.

II MATERIALS

The materials used in this present investigation are LM6, SiC. Here the grain size of the SiC is 150µm. Chemical composition of LM6 is given in Table 1. The matrix material used in the present investigation was pure aluminium. The different weight fraction of silicon carbide particulate aluminum alloy composite was used for this investigation. The equipment used includes a crucible furnace, stainless steel stirrer (powered by a motor), gravity die, a thermocouple, heat treatment furnace, Wear testing machine and hardness testing machines. Final metal matrix composite material undergoes the fabrication and testing methods as stated below:

a) Stir casting method
b) Hardness test
c) Wear test

III. EXPERIMENTAL METHODOLOGY

The synthesis of metal matrix composite used in the study was carried out by stir casting method. A stir casting setup, Consisted of a Induction Furnace and a stainless Steel stirrer assembly, was used to synthesize the composite. The stirrer assembly consisted of a stirrer, which was connected to a variable speed vertical motor of 600 rpm by means of a steel shaft. The stirrer was made by cutting and shaping a Stainless Steel block to desired shape and size manually. Graphite crucible of 0.5 Kg capacity was placed inside the furnace [4]. The graphical representation of stir casting was shown in Fig.2.

Fig 1 Design and fabrication of die

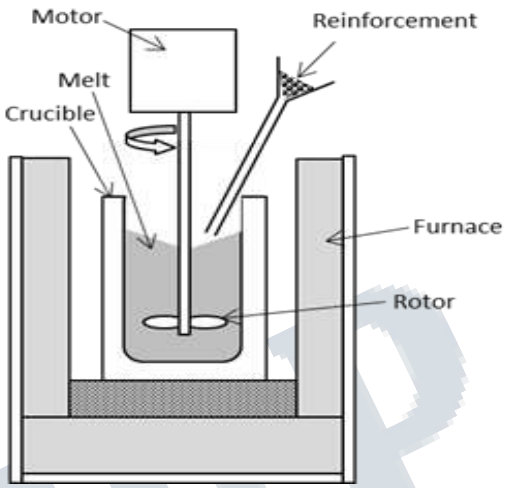

Fig 2 Stir casting method

LM6 (Aluminium) was melted at 720°C in the Induction furnace. Preheating of reinforcement (silicon carbide at 350°C) was done for one hour to remove moisture and gases from the surface of the particulates. The stirrer was then lowered vertically up to 4 cm from the bottom of the crucible [4]. The speed of the stirrer was gradually raised to 600 rpm and the preheated reinforced particles were added into the melt. The speed controller maintained a constant speed of the stirrer, as the stirrer speed got reduced by 100 rpm due to the increase in viscosity of the melt when particulates were added into the melt. After the addition of reinforcement, stirring was continued for 3 to 8 minutes for proper mixing of prepared particles in the matrix. The melt was kept in the crucible for approximate half minute in static condition and then it was poured in the die shown in fig 1 [4]. The value of the Sic varied by 3%, 5% & 7%. By this process three sets of specimens were prepared for each test.

IV. RESULT AND DISCUSSION

A) Wear Test

A cylindrical pin of size 8mm diameter and 24mm length Hybrid composite specimens were prepared and loaded in a pin- on -disc wear testing rig as shown in Fig.3. Before testing, the surface of the specimens was polished by using 1000 grit paper. Wear tests were carried out at room temperature for 5 and 10 minutes.

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Fig3 A picture showing a component tested on wear testing machine.

Wear, the progressive loss of material from the sliding surfaces of the elements of a tribo system can be determined in terms of weight loss. Material properties of the sliding elements, applied load and disc speed determine the wear rate. The result of wear test is shown in below Table 2. By these result we can see that the wear resistance is increased by increase in addition of Sic in a LM6-SiC Hybrid composite.

B) Hardness Test

The hardness of the samples was determined using Brinell and Rockwell hardness testing machine which is shown in fig 4. In Brinell the load applied was of 187.5 kgs and 2.5 mm ball indenter. In Rockwell the load applied is of 100 kgs and 1/16" ball indenter of red dial B scale is used.The test results of Rockwell & Brinell hardness is shown in Table 3 & Table 4

Fig 4 A picture showing the Brinell and Rockwell Hardness Testing machine.

Components	**Weight %**
Copper	0.09
Magnesium	0.06
Silicon	11.5
Iron	0.20
Manganese	0.30
Zinc	0.07
Aluminium	Remainder

Table 1 Chemical composition of LM6.

Sr. No.	MATERIAL (Weight % of reinforcement)	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEAR VOLUME (mm^3)
1	LM6	11.615	11.595	9.22
2	SiC(3%)	9.81	9.770	7.38
3	SiC(5%)	18.205	18.195	3.69
4	SiC(7%)	17.96	17.935	1.47

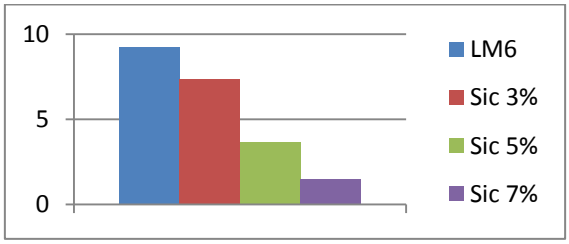
Table 2 shows the result of wear rate by keeping Load.5kg; Time 5min., & 500 rpm Disc Speed.

Sr. No.	MATERIAL (Weight % of reinforcment)	DIA OF IDENTATION IN 1st READING	2nd READING	3rd READING	BHN
1	LM6	1.5	1.5	1.5	95.49
2	SiC (3%)	1.5	1.4	1.4	111.35
3	SiC (5%)	1.4	1.5	1.4	111.35
4	SiC (7%)	1.5	1.5	1.5	115.5

Table 3 shows the result of Brinell hardness test results

Sr. No.	MATERIAL (Weight % of reinforcment)	1st DIAL READING	2nd DIAL READING	3rd DIAL READING	AVERAGE
1	LM6	42	43	45	43.33
2	SiC(3%)	42	47	45	44.66
3	SiC (5%)	44	45	43	44
4	SiC (7%)	40	43	40	46

Table 4 shows the result of Rockwell Hardness test results



Graph 1 shows the representation of Wear rate.

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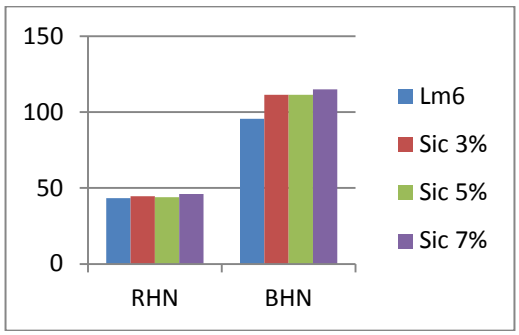

Graph 1 shows the representation of RHN & BHN.

V. CONCLUSION

The microstructure and mechanical behavior by reinforcement of aluminium with different weight fraction of SiC has been examined. The specimens were prepared by stir casting method with weight fractions of SiC as per the standard of as per ASTM G99 to find the mechanical behavior. Brinell hardness test was carried out to find out hardness and wear test was used to find the wear rate. From the test results It was observed that the hardness of the composite is increased gradually from 3 % to 7 %. From the wear test result analysis it has been observed that the percentage of Sic increases the wear rate decreases.

VI. REFERENCES

[1]. Basavaraju.S Arasukumar.K Dr.Chandrashekhar Bendigeri Dr.C.K.Umesh, Studies on Mechanical Properties and Tribological Characteristics of LM25- Graphite- Silicon Carbide and LM25-Flyash- Silicon Carbide - Hybrid MMC's, International Journal of Innovative Research in Science, Engineering and Technology Vol. 1, Issue 1, November 2012.

[2] Mahendra Boopathi, M., K.P. Arulshri and N. Iyandurai, Evaluation of Mechanical properties of Aluminium alloy 2024 reinforced with Silicon Carbide and Fly Ash hybrid metal matrix composites, American Journal of Applied Sciences, 10 (3): 219-229, 2013.

[3]. Mr. Amol D. Sable1, Dr. S. D. Deshmukh, Preparation of metal matrix composites by stir casting method, International Journal of Mechanical Engineering and Technology, Volume 3, Issue 3, September - December (2012), pp. 404-41.

[4] Er. Sandeep Kumar Ravesh , Dr. T. K. Garg, Preparation & Analysis for some mechanical property of Aluminium based metal matrix composite reinforced with SiC & Fly Ash, International Journal of Engineering Research and Applications, Vol. 2, Issue 6, November- December 2012, pp.727-731

[5] Shanmughasundara, R. Subramanian and G. Prabhu, Some Studies on Aluminium – Fly Ash Composites Fabricated by Two Step Stir Casting Method, European Journal of Scientific Research, ISSN 1450-216X Vol.63 No.2 (2011), pp.204-218.

[6]. H.C. Anilkumar , H.S. Hebbar and K.S. Ravishankar, Mechanical properties of Fly Ash reinforced Aluminium alloy(Al6061) composites, International Journal of Mechanical and Materials Engineering (IJMME), Vol.6 (2011), No.1, 41-45.