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Effect of 2% Uncoated and Nickel Coated B_4C on dry sliding Wear of Aluminium Matrix Composite Material

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***ABSTRACT**: Nickel coated Boron Carbide is becoming a prominent in the field of Metal Matrix Composite materials. The coated B4C was prepared by electro less plating method and the required MMCs were synthesized by the liquid metallurgy technique successfully. The microstructure of coated Al-B4C composites was investigated by an optical microscope and scanning electron microscope. Wear properties at varying loads 0.5 Kg, 1 Kg and 1.5 Kg were applied and corresponding wear resistant properties were studied. It was found that upon the addition of 2wt % of coated B4C particles, the wear resistant properties increases considerably. It was also observed that coated B4C particulates AMC exhibits better wear resistant properties that of uncoated B4C particulate AMC.*

***KEYWORDS:** Liquid stir casting method, Coated B4C particulates, Microstructures, Pin-on-disk wear testing machine, Wear resistant property, SEM and Optical microscope.*

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I. INTRODUCTION

A composite material is a combination of two or more distinct materials bonded on macroscopic scale. Generally, composite materials consist of reinforcement like fibers, particles, flakes and fillers embedded in a matrix. Matrix may be of metals, polymer or ceramics. Now a day's metal matrix composites are playing prominent role in the field of automobile, aeronautical and marine industries. Aluminium composite material (AMC) exhibit high wear resistant properties at different loading conditions like 0.5 Kg,1 Kg and 1.5 Kg and at varying speeds like 200, 300, and 400 rpm [1-3].The experimentation is carried at ambient temperature without using lubricating oil.

Nickel coated particulate reinforced MMCs have recently found special interest because of their specific strength and specific stiffness at room or elevated temperatures. Sourav Debnath1 et al performed an experiment on nickel coated pure sintered aluminium metal by elecroless plating system. He observed that the wear properties of the metal matrix composite are strongly enhanced that of uncoated MMC [1].

Stir casting process is considered as a suitable process to fabricate coated B_4C particulates MMC as the process is economical and feasible and can get uniform homogeneous mixture at room and elevated temperature. P. S. Kori et al. synthesized a copper coated SiC composite material by electro less coating technique. Wear tests were carried out to study the effects of composition at normal pressure using pin-on-disc wear testing machine. They concluded that there was improvement in the wear properties upon the addition of coated B_4C particles [2]. Himanshu Kala et al. studied the wear behavior of aluminium matrix reinforced B_4C particles composite material. The Al-B_4C composite was successfully prepared by sintering process. It was observed that the synthesized composite provides better result in anti-wear field [3]. Suresh S. Bujari et al. conducted a study on sliding wear behavior of Aluminum alloy with B_4C and SiC reinforced metal matrix composites and he revealed that the B_4C particulate AMCs will exhibit better wear resistance properties than of SiC particulates AMCs [4]. A. Leon and R. A. L. Drew used electro less metal plating technique to study the preparation of nickel-coated ceramic particles as precursors for MMC fabrication. Al_2O_3 and SiC powders of three different sizes were used for coating. Preliminary results showed that the use of Ni-coated powders enhances the wettability between the matrix and ceramic phase [5-6].

It is well observed from the literature survey that the wear resistance properties is increased with increase in B_4C particulates. Further it was confirmed that the nickel coating B_4C particulate MMC provides better wear resistance properties that of uncoated B_4C particulate metal matrix composites [7-10]

1.1 Material Preparation

A two stage novel liquid metallurgical process is popularly used for synthesizing the required composites**.** Stir Casting is a liquid state method of composite materials fabrication in which dispersed short fibered B_4C particles are coated with Nickel particles by electro less plating system. Thus obtained Nickel coated B_4C particulates are then is mixed with a molten Al4.5%Cu alloy matrix by means of mechanical stirring at a stirring speed of 300 rpm. Solid hexa chloro ethane is added to remove absorbed gases during the process. About 300^0 C is mentioned throughout the experiment. The liquid composite material is then cast by conventional casting methods and may also be processed by conventional metal forming technologies. The casted specimens were cut by CNC machine to get required dimensions.

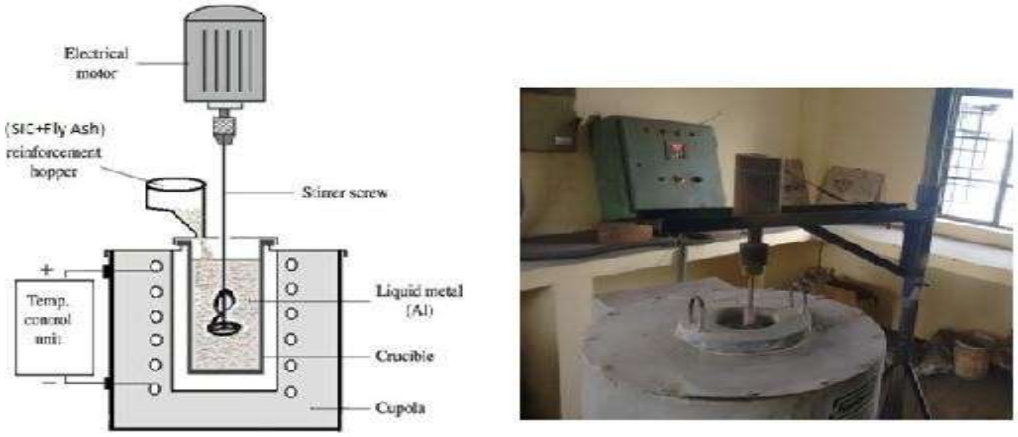

Fig 1: Stir Casting Setup

Table 1: Compostion of prepared MMCs

Designation	**MMC**
AMC 1	Uncoated Al-4.2% Cu+ B4C (2%)
AMC 2	Nickel coatedAl-4.5% Cu + B4C (4%)

1.2 Wear Properties

Wear is a process of material removal phenomenon. The prepared Al-4.5%Cu alloy with varying weight percentages of Nickel coated B_4C composites were subjected to wear test under dry sliding condition. The test was conducted on 8mm diameter and 30mm long cylindrical specimens against a rotating En-32 steel disc. The tangential friction force and wear were monitored with the help of electronic sensors. These two parameters were measured as a function of load and sliding velocity. For each type of material, tests were conducted at 50N nominal load at fixed sliding speed of 400rpm. Wear tests were carried out at room temperature without lubrication.

Fig 2: (a) Specimens before testing (b) Fig: Pin-on-disc wear testing Machine

1.3 Microstructure Study

Figure 3 shows microstructure of as cast Al-4.5%Cu alloy 2 wt% uncoated and Nickel coated B_4C particles. Further, the micrographs show that grain size of the reinforced composite is smaller than the alloy without nickel particles.B_4C particles added to melt also act as heterogeneous nucleating sites during solidification [7]. The microstructure study reveals the homogeneous mixture of B_4C particles and no void formation took place during synthesis.

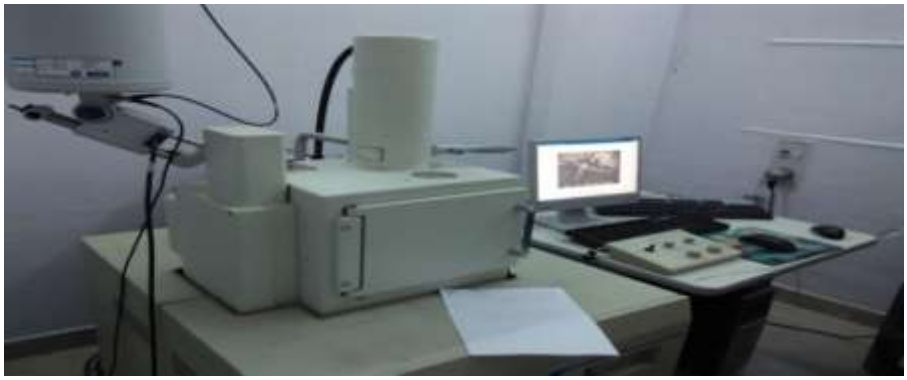

Figure 3: The Scanning Electron Microscope used for Microstructure study
B4C Particles

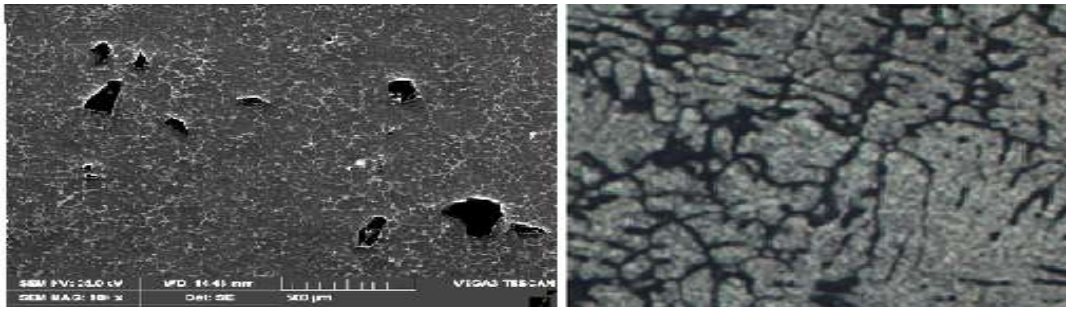

Figure 4: SEM of Al-4.5%Cu alloy (a) Uncoated (b) Nickel Coated 2 wt% Nickel coated B4C

II. RESULTS AND DISCUSSION

The wear testing was conducted on pin-on-disk wear testing machine which has track diameter 90 mm. Maximum sliding distance 4000 rpm is maintained through the experiment. Ambient temperature is maintained during the experimentation. No lubrication is provided during wear testing. The speed of the disk is kept constant at 300 rpm. Loads of 0.5 Kg, 1Kg and 1.5 Kg is applied on the disk. The experiment is conducted for both uncoated and nickel coated al4.5%Cu alloy- 2. Wt% pin materials. The wear readings in microns were taken and tabulated systematically. The results of uncoated and nickel coated Al4.5%Cu-2 wt.% B_4C are as shown in the following table.

2.1 Effect of load on Uncoated Al-4.5% Cu- 2 wt. % B_4C Composites

SL NO	MATERIAL	LOAD (Kg)	SPEED (rpm)	INITIAL WEIGHT (gm)	TIME (min)	SLIDING DISTANCE (m)	WEAR in Microns
1	Al-4.5%Cu-2% B_4C	0.5	300	4.111	12	1000	143
					24	2000	156
					36	3000	178
					48	4000	191
2	Al-4.5%Cu-2% B_4C	1	300	4.219	12	1000	189
					24	2000	206
					36	3000	234
					48	4000	251
3	Al-4.5%Cu-2% B_4C	1.5	300	4.190	12	1000	231
					24	2000	249
					36	3000	283
					48	4000	310

2.2 Effect of loads on Nickel coated Al-4.5% Cu- 2 wt.% B_4C

SL NO	MATERIAL	LOAD (Kg)	SPEED (rpm)	INITIAL WEIGHT (gm)	TIME (min)	SLIDING DISTANCE (m)	WEAR in Microns
1	Al-4.5%Cu-2% B_4C	0.5	300	4.111	12	1000	123
					24	2000	136
					36	3000	158
					48	4000	172
2	Al-4.5%Cu-2% B_4C	1	300	4.219	12	1000	149
					24	2000	166
					361	3000	194
					48	4000	217
3	Al-4.5%Cu-2% B_4C	1.5	300	4.190	12	1000	181
					24	2000	200
					36	3000	233
					48	4000	266

2.3 Comparison of uncoated and nickel coated

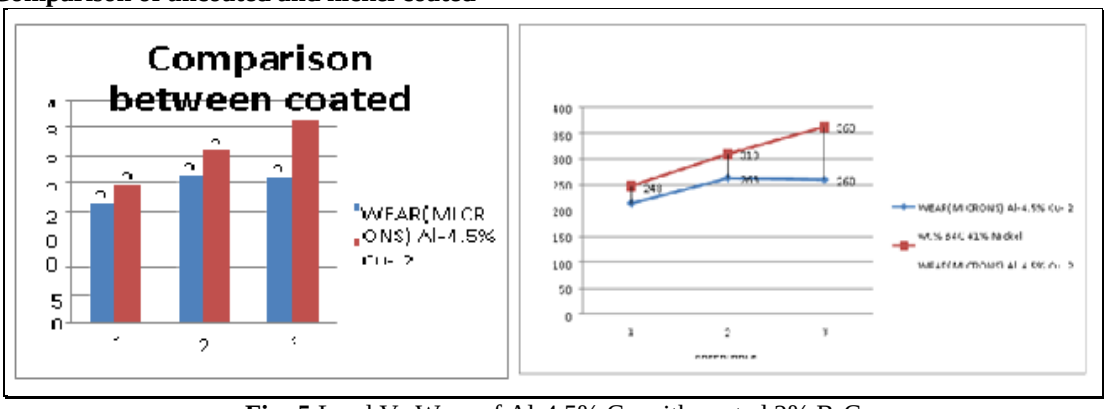

Fig: 5 Load Vs Wear of Al-4.5% Cu with coated 2% B_4C

III. CONCLUSION

- Al-4.5%Cu alloy reinforced with nickel coated B4C particles were successfully produced by liquid stir casting route..
- Al-4.5%Cu alloy reinforced with nickel coated B_4C composites have good wear results when compared with that of Al-4.5%Cu base alloy.
- There is decrease in wear rate with addition of 2 wt% Nickel coated B_4C particulates to as cast material.
- The results are much more nearer to literature survey done in this paper. The data after testing the

synthesized MMC shows that the wear resistant properties of B_4C reinforced has been enhanced considerably as compared to as cast material.

- Data are systematically tabulated and plotted with histograms and scatter diagrams. It was well observed that B_4C particles provide more wear resistant as compared to as cast.

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