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Review on Fabrication of Aluminium 7075+ B_4C Composites and its Testing

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ABSTRACT

The new generation of metal matrix composites are Aluminium hybrid composites that have the potentials of satisfying the recent demands of advanced engineering applications, particularly in the automobile industries, due to low weight, density, coefficient of thermal expansion, and high strength, wear resistance[05,16]. Among the materials of tribological importance, Aluminium Matrix Composites have received extensive attention for practical as well as fundamental reasons.

In this paper, the influence of B4C on the mechanical and Tribological behavior of Al 7075 composites is reviewed. Al 7075 particle reinforced composites were produced through stir casting, K2TiF6
added as the flux, to overcome the wetting problem between B4C and liquid aluminium metal. The aluminium B4C composites thus produced were subsequently subjected to T6 heat treatment. The samples
of Al 7075 composites were tested for hardness, tensile, compression, flexural strengths and wear behavior.

Keywords: MMC, Composite Material

I INTRODUCTION

General engineering materials have limitations in achieving optimum levels of strength , toughness, density, wear resistance and stiffness. The composite materials give engineers the opportunity to tailor the properties of material according to their needs. Metal matrix composites have attracted by the researchers from a decade ago due to its unique properties like good strength to weight ratio, stiffness, hardness and ductility and wear resistance . Among all the type of MMC's aluminum is widely used because of its low density, good strength to weight ratio, easy fabricability, good corrosion resistance and also it has good engineering properties. Aluminum MMC's found in many applications in the contractions, aerospace, automobile, marine ,defense, consumer industries (sports goods). Aluminium matrix composite has resulted in a lighter, more abrasive and cheaper product . Amongst the various MMCs available, aluminum matrix composites (AMCs), particularly those based on the Al 7xxx-series alloys, offer benefits such as low density and high specific strength. It is well established that introducing a hard particle in an

Al-matrix can lead to significant improvements in wear and erosion resistance, stiffness, hardness and strength [01]. AMC's can be reinforced with silicon carbide(sic), Boron carbide(B4C), aluminum oxide(Al2O3), titanium carbide(tic), titanium dual Boron (Tib2),magnesium oxide(Mgo),titanium oxide(Tio2)[15]

The fabrication of MMCs can be achieved by the accumulation of reinforcement phase to the matrix. Certain suitable methods are powder metallurgy [06], spray atomization and co-deposition [07,08], plasma spraying [09,10], stir casting and squeeze casting [11]. In the engineering materials, the MMCs can be manufactured by a unique technique such as casting as it is inexpensive and proposes many other options for materials and processing conditions [12].

II EXPERIMENTAL PROCEDURE

In this experiment, a commercial grade aluminium alloy Al7075 was used as the matrix material, with B4C particles as the reinforcement. The aluminium composites were manufacturedwith 5, 10, 15 and 20 vol% B4C particles with particle size rangingfrom 16 lm to 20 lm were used as the reinforcement. The chemicalcomposition of Al 7075 wasanalyzed and shown in Table 1.The base metal weighing 1000 g of aluminium was melted in agraphite crucible. The temperature control of the molten meltwas taken care of, with thermocouples inserted into the melts to measure its temperature. The mixture of B4C particles and thesame amount K2TiF6 flux were added into the melt within 4 min at 850 _C with mechanical stirring at 500 rpm. The melt was finallypoured into the preheated molds at 850 _C casting temperature.The cast samples were heat treated to the T6 condition. The specimens were prepared for hardness, microstructure and wear.[05]

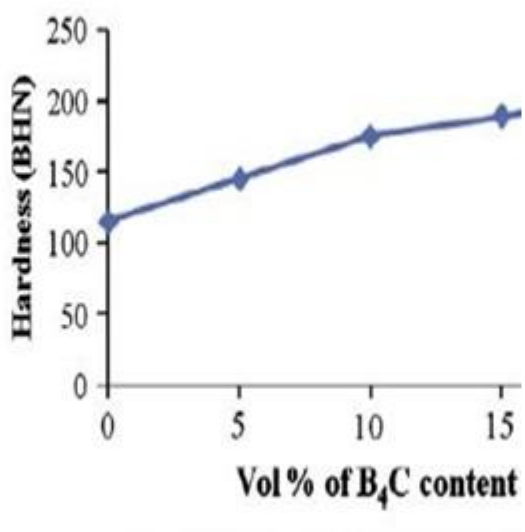
Chemical composition of Al7075 [Table 1]

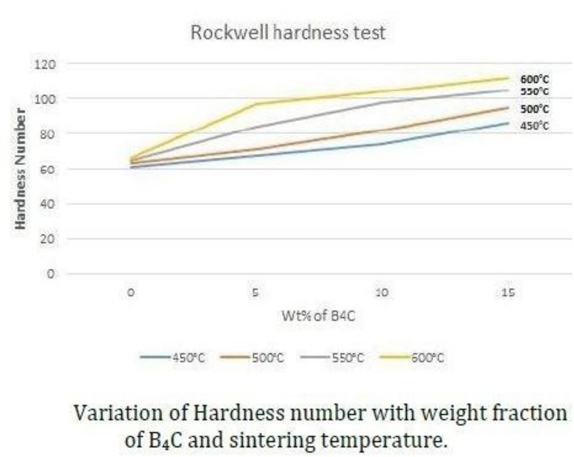
Elements	Zn	Cu	Mn	Mg	Fe	Cr	Ti	Si	Al
Weight%	5.4	1.42	0.12	2.42	0.42	0.21	0.11	0.13	Remaining

2.1 Hardness

The specimens were prepared for hardness, tensile, compression, flexural strengths and wear tests to study the mechanical properties and wear behavior of the composites.The hardness tests were carried out according to ASTM E10-00standards using Brinell hardness testing machine with a 10 mmball indenter and 500 kg load. The test was conducted at roomtemperature and the measurement of hardness was taken at different places on each sample to obtain an average value of hardness. Tensile tests were conducted as per ASTM E08-8 on the samples, with the computerised ultimate tensile testing machine(UTE40) at room temperature (30 _C). The compression strength was conducted as per ASTM E09-9 standard using the UTMmachine.

In this [13] study Rockwell, hardness scale is used for measuring hardness value. Each specimen is subjected to hardness test with 2.5 mm ball indenter, 100kgf load and 20 seconds of dwell time. The figure shows the variation in the hardness value of samples tested with respect to different percentage of reinforcement material and sintering temperature. It was, noticed that hardness value of the prepared composite goes on increasing with expansion in the content of B4C particles. The increased hardness can be because of presence of boron carbide reinforcement particles which are basically very hard. The uniform distribution of SiC in the formed composites is also responsible for increasing hardness of the Al7075- B4C composite. Another reason for increased hardness can be, attributed to sintering temperature. Because as the sintering temperature increases, the bonding between the matrix-reinforcement particles becomes stronger.





(a) **(b)**

Fig. 1.a,b Variation of hardness with B4C%[5]

Fig shows the wear rate of the composites for varying vol% of the B4C. The wear rate decreases with increasing vol% of B4C andtouches a minimum at 10 vol% B4C.The wear rate at 10 vol% B4C is only about 11% of the wear rate for aluminium alloy 7075 material.It is observed from the above that the wear behavior of the Al 7075/B4C composites is significantly improved with reinforcementof B4C particles, and the wear rate decreases with increasing vol% of B4C. Due to the increasing volume fraction of the B4C particlesthe matrix area in contact with the mating surface was reduced.The unreinforced aluminium alloy was softer than the B4C reinforced composites and due to this the base alloy undergoes heavy plastic deformation on the surface which causes the high wear rate of base alloy. The 10 volume fraction of the B4C reinforced composites showed the greatest wear resistance as compared to other volume fractions. The effect of applied load on the wear mass loss of the base alloy and composites had been shown in fig.

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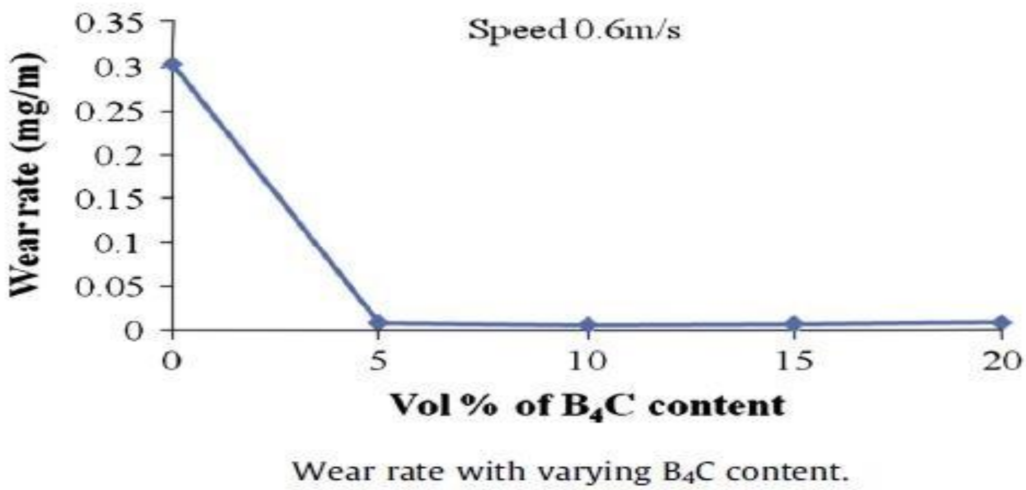
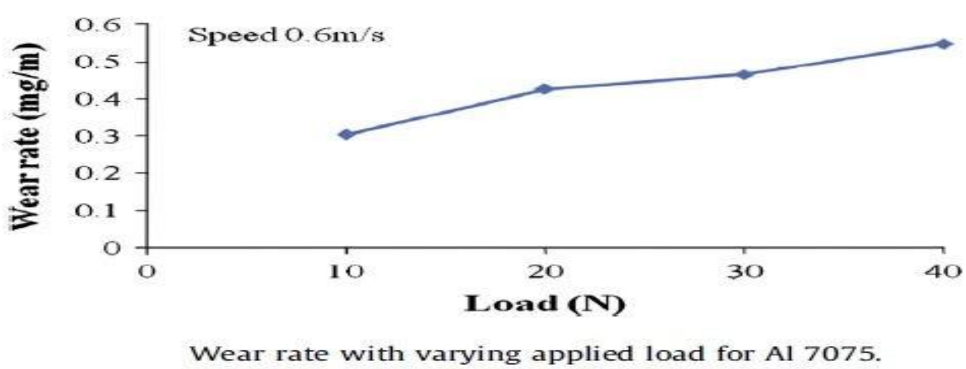
2.2 Wear

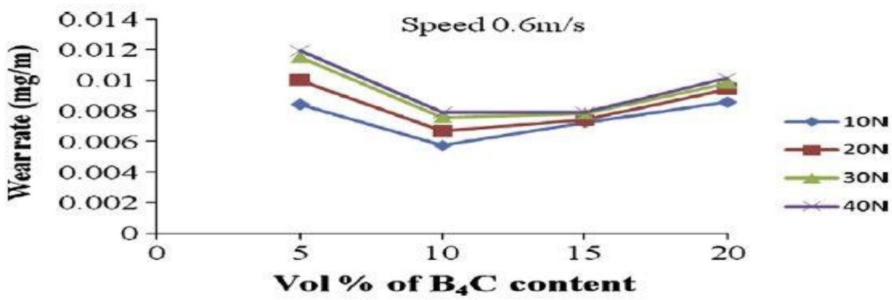
The high wear mass loss is observed in base alloy and minimum wear mass loss is noticed at 10 volume fraction of B4C composites. The wear rate increases with increasing applied load due to increasing temperature at higher loads and MML is no longer formed. At a larger load conditions produces large uncertainties which prevented theformation of a protective MML . The wear rate increases on increasing the applied load in all load conditions, and it was the minimum at 10 volume fraction of B4C.During abrasive wear, The B4C particles strengthen the aluminium matrix and also protect the softer matrix.



2(a)



2(b)



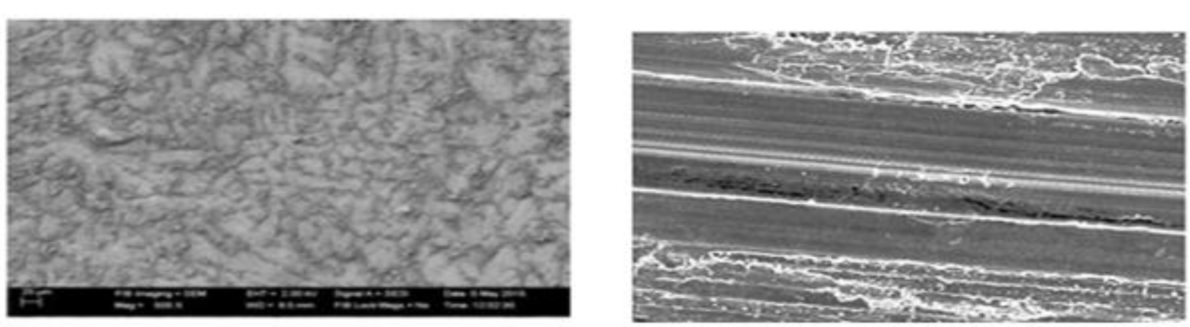
Wear rate with varying applied load for Al 7075–B_4C composites.

Fig. 2 a,b& c wear rate with B4C%

III MICROSTRUCTURE

Microstructure for different samples was studied using scanning electron microscope. Figure 1 (a)-(b) shows microstructure of as cast Al7025 and Al7025 with 6wt% B4C particulates where microstructure was viewed under scanning electron microscope. Figure 1(b) reveals the distribution of B4C particulates in specimens and it can be observed that there is fairly uniform distribution of particles. Excellent bonding between the matrix and the reinforcement is observed.

Scanning electron microscopy was done on base alloy Al7025 and Al7025+ 6 wt. % of B4C composite samples. Figure 6 indicates the surface morphology after wear testing on base alloy Al7025 and 6 wt. % of B4C composite specimen. The images support the argument that addition of hard B4C particles improved the wear resistance of composites. It is clear from the Fig. that the wear tracks and surface delamination are evident. Wear track is observed in case of Al7025, indicates the abrasive wear mechanism. Due to high temperate and friction, only oxide wear has taken place. The wear resistance is more in case of (Al7025+ B4C) composites alloy. The results revealed that thecomposites with B4C particulates have better wear resistance property compared to base alloy



3(a) 3(b)

Fig. 3 (a,b) Microstructure of particulate B4C

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