

# Dry Sliding Wear Behaviour of A380/ B<sub>4</sub>C Composite

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**ABSTRACT:** The wear behaviour of A380 Al-alloy was investigated using a pin-on-disc wear machine under dry sliding conditions. The test was carried out on the A380 aluminium silicon alloy with varying percentage of B<sub>4</sub>C 3%, 5%, 7%, 9%. The wear tests were performed within a load range of 1 to 3Kg at a sliding velocity of 1, 1.5, 2 m/sec. The microstructure and compositional changes that took place during wear were characterized by optical microscope. Based on the metallographic observations the role of the primary silicon particles and B<sub>4</sub>C was suggested. In a low pressure region, primary silicon and B<sub>4</sub>C particles supported the applied load hence wear occurred mainly in the metal matrix. It is seen that as the percentage of B<sub>4</sub>C in A380 increased, the wear loss has decreased by increasing wear properties of alloy. In the high pressure region the fractures of primary silicon particles occurred and wear loss increased sharply.

**KEYWORDS:** A380/B<sub>4</sub>C composite, Stir casting, Wear.

## I. INTRODUCTION

Automotive and aerospace are few of the fast growing industries from past few decades. These industries are attracted to light metal materials (LMM's) due to their enriched properties like light weight, stability in dimension and ease of machine ability[1]. Even after having these properties LMM's are not able to fulfil the requirements in applications where the part manufactured out of these alloys have to sustain high thermal, mechanical stresses and severe condition of wear. When operating at high temperatures like more than 200<sup>0</sup>c these materials have shown decline in their properties which have been a major problem for above industries as the parts are subjected to elevated temperature. Due to this problem there is a need to improve the properties of LMM's so that they can find vast application in above industries[2]. LMM's when reinforced with reinforced particles like B<sub>4</sub>C, SiC, granite and fly-ash will results in composite materials. These materials are able to fulfil the objectives of many industries where the LLM's are failing[3].

## II. MATERIALS AND METHODS

A380 Al-alloy along with boron carbide (B<sub>4</sub>C) as reinforcement material is taken for the study. Boron carbide having mesh size of 40 μm is reinforced in A380 metal matrix to fabricate different wt % of 3%, 5%, 7%, 9%.

Table.1.Chemical composition of A380 Al-alloy.

Si	Fe	Cu	Mn	Mg	Ni	Sn	Zn	Others	Al
9.5	1.0	4.0	0.5	0.35	0.5	0.35	2.9	0.5	balance

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### A. Fabrication of A380/B<sub>4</sub>C composite



(a)

Fig (a) shows cast samples for wear test

The required quantity of A380 Al-alloy is placed in the graphite crucible and melted at temperature 800<sup>o</sup> c using the electric resistance furnace. The melt is added with hexachloroethane (C<sub>2</sub>Cl<sub>6</sub>) as a degasification agent which removes entrapped gases from the molten metal. The slag which comes on the surface is skimmed off. Before adding the B<sub>4</sub>C particles to the molten metal it is preheated to 150<sup>o</sup>c which removes the moisture content. The preheated B<sub>4</sub>C is mixed with potassium titanium hexafluoride (K<sub>2</sub>TiF<sub>6</sub>). The main aim of mixing K<sub>2</sub>TiF<sub>6</sub> is to increase the wettability of B<sub>4</sub>C. The addition of B<sub>4</sub>C + K<sub>2</sub>TiF<sub>6</sub> is added in two step method i.e. the total quantity of this mixture is divided into two parts, first part is added to molten metal and the string is done. The second half of mixture is added to molten with continues string action. The main aim of using two step method is it makes sure the B<sub>4</sub>C particles are homogenously dispersed in the A380 metal matrix. The molten metal is poured in to the mold of 10×125mm bar cross-section. The cast metal is machined to required dimensions of 8mm×30mm to be used for wear test.

### B. Preparation of wear test specimen



(b)

Fig (b) shows specimen for wear test

The as cast samples of dimension 10mm X 125mm are turned to 8mm on lathe. The specimen is cut to 32mm and both the surface of specimen is smooth turned. Next the machined specimen is ground to get even surface using polishing paper and the specimen length is maintained to 30mm.

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## C. Wear test



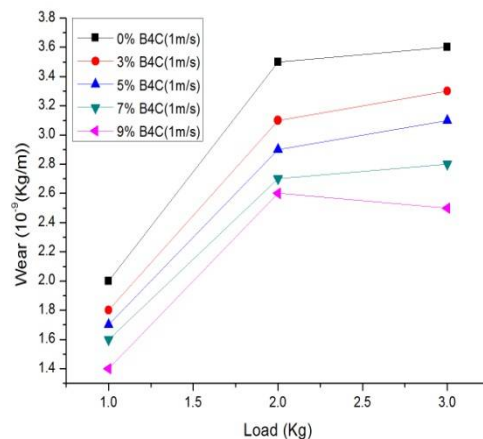
(c)

Fig (c) shows pin on disc machine.

The rotating disc of the machine is cleaned to make sure it is free from dust and worn out particles. The track diameter is set to 80mm. Weight of the pin is measured using weighing machine before placing the pin in pin holder. The prepared pins are fixed in the pin holder by using Allen key[4]. Speed, time and required load is set. The specimen is brought in contact with the disc and the machine is turned on. Different parameters like wear, friction force, speed and time are noted. Further the experiment is carried for varying speed and load. For every set of reading the weight of the pin is recorded which gives the amount of material lost. The same procedure is carried out for the each specimen. The images of the worn surface are recorded in optical microscope[5,6].

## III. EXPERIMENTAL DETAILS

From graph (a) it can be seen at constant velocity as the load increased the wear of the different sample has increased. It can also be observed from the graph that as the percentage of B<sub>4</sub>C increased the wear resistance improved i.e. for 0% reinforcement wear is high and at 9% reinforcement the wear has reduced. For 3%, 5% and 7% moderate wear was observed. This is due to presence of B<sub>4</sub>C particles in metal matrix which made the material to be harder. 9% specimen has shown a good wear resistance property compared to as cast A380 Al-alloy.

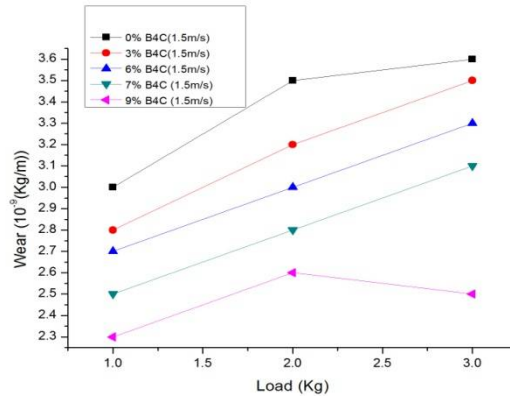


a) 1m/s velocity

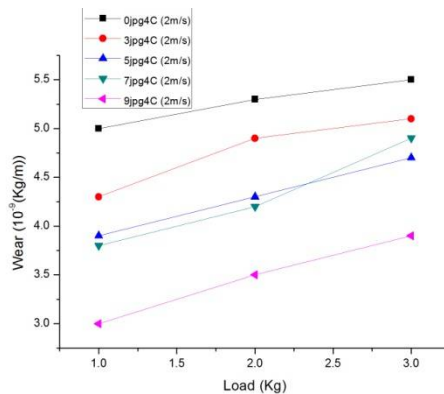
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b) 1.5m/s velocity



c) 2m/s velocity

Fig.1 Shows the graphs of Load verses Wear rate (a) 1m/s velocity (b) 1.5 m/s velocity (c) 3 m/s velocity

From fig.1 it can be seen at constant velocity as the load increased the wear of the different sample has increased. It can also be observed from the graph that as the percentage of B<sub>4</sub>C increased the wear resistance improved i.e. for 0% reinforcement wear is high and at 9% reinforcement the wear has reduced. For 3%, 5% and 7% moderate wear was observed. This is due to presence of B<sub>4</sub>C particles in metal matrix which made the material to be harder. 9% specimen has shown a good wear resistance property compared to as cast A380 Al-alloy.

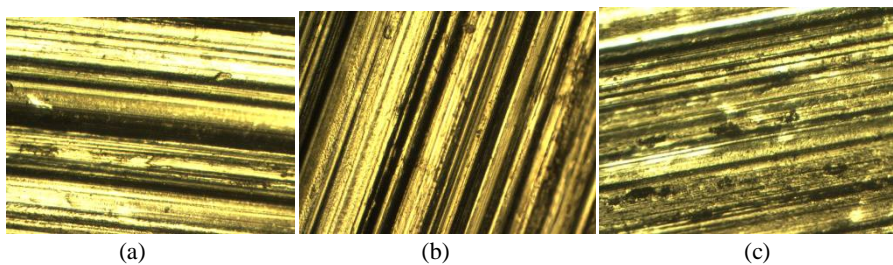


Fig.2 Optical microscopic image of wear surface of A380 base alloy (a) A380 base alloy (1Kg load) (b) A380 base alloy (2 kg load) (c) A380 base alloy (3 Kg load)

From the above fig.2 it can be observed nominal wear was found at low load and low speed.

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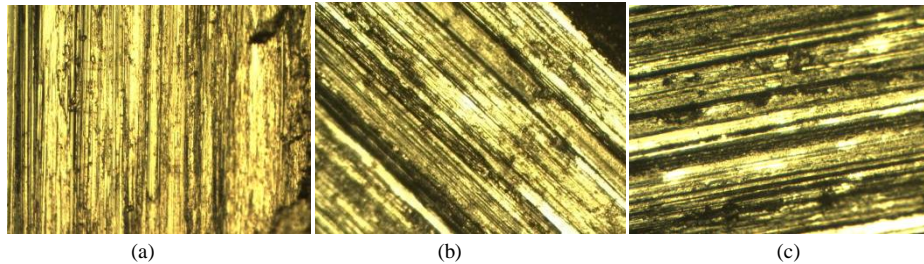


Fig.3. Optical microscopic image of wear surface of A380/B<sub>4</sub>C ( a) 5% B<sub>4</sub>C (1 Kg load) (b) 5% B<sub>4</sub>C (2 Kg load) (c) 5% B<sub>4</sub>C (3 Kg load)  
In the above fig.3 it can be seen the presence of B<sub>4</sub>C has helped in improving the wear condition of the base metal.

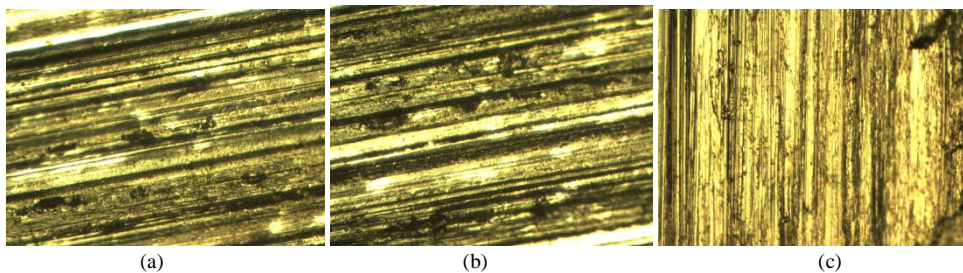


Fig.4. Optical microscopic image of wear surface of A380/B<sub>4</sub>C (a) 9% B<sub>4</sub>C (1Kg load) (b) 9% B<sub>4</sub>C (2 Kg load) (c) 9% B<sub>4</sub>C (3 Kg load)  
From fig.4 it is inferred that due to higher percentage of B<sub>4</sub>C the material has become harder which resulted in improving the wear resistance. But with higher hardness there is machining problem associated the specimen.

Wear resistance of A380/B<sub>4</sub>C composite increased compared to as cast A380 base alloy at different sliding speed and load condition. From the figure 8 it was observed that there was decrease in worn surface as compared to figure 7. This is due to the formation of a strong bond between B<sub>4</sub>C particles in A380 aluminium metal matrix. The un-reinforced A380 showed higher wear rate as compared to A380 B<sub>4</sub>C composite. The presence of higher percentage of silicon and B<sub>4</sub>C particles resulted in increase of hardness which enhanced its wear resistance. From the figure 7 at different loads it can be seen that as load and speed increased which leads to the formation of deeper grooves due to loss of material[7]. At lower loads wear was minimal. At higher load maximum wear was observed as a result of severe plastic deformation due to rise in temperature of contact surface between pin and the disc. From the figure 8 and 9 it is observed loss of material is minimum due to presence of reinforcement particles.

#### IV. CONCLUSION

From study it can be concluded that,

- A380/B<sub>4</sub>C composite wear successfully fabricated by two step stir casting process.
- Wear resistance of composite gradually increased as wt % of reinforcement particles increased in the base metal.
- From optical microscopic images of worn surface it can be concluded that as the wt % of B<sub>4</sub>C increases the worn surface gradually changes from distinct grooves to small scratches.

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## REFERENCES

- [1] Prashant Sharma, " Determination of Mechanical Properties of Aluminum Based Composites" International Journal on Emerging Technologies, vol. 3(1), pp.157-159, 2012.
- [2] Pai, T.P.D Ranjan, Pillai R M, "Aluminium matrix composite casting for automotive applications" Ind Foundry journal, vol.50,pp.30-39,2004
- [3] Pratheesh Krishnankutty, Allesu Kanjirathinkal, Ravi, Effect of Aging Time on Mechanical Properties and Wear Characteristics of Near Eutectic Al-Si-Cu-Mg-Ni Piston Alloy 13 June 2015.
- [4] Sanjay Kumar, Dr. S. S. Sen Selection of the Material on the Basis of Wear and Friction in Journal Bearing International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Issue 9, September 2014.
- [5] L. Blunt, P. Bills, X. Jiang, C. Hardaker, G. Chakrabarty The role of tribology and metrology in the latest development of bio-materials Wear 266 (2009) 424–431
- [6] X. F. Wu, G. A. Zhang, Effect of Sn addition on microstructure and dry sliding wear behaviors of hypereutectic aluminum–silicon alloy Jinzhou 121001 (2001).
- [7] B. K. PRASAD, K. VENKATESWARLU, O. P. MODI, A. K. JHA, S. DAS, R. DASGUPTA, A. H. YEGNESWARAN The effects of primary silicon particles on the sliding wear behavior of aluminium silicon alloys Journal of materials science letters 17 (1998) 1381-1383