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# Development of Hybrid Aluminium Alloy Composite

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***Abstract:***

*Aluminium is a kind of metal which has variety of uses in advancing modern technology. MMC's are made by introducing a reinforcing material in the metal matrix. The reinforcement material here used is SiC and BC and Al-6061 is the matrix. Aluminium, SiC , Boron Carbide MMC are prepared by powder metallurgy and casting. According to most various literature it is understood that the SiC is used as major reinforcement material. In present investigation an MMC with Al-6061 as base matrix and SiC particulate reinforcement. It is also added 2% boron carbide to understand the influence on material properties.*

*In current study the sample of MMC with Al6061 as matrix and 2% Boron Carbide as reinforcements we have added varied fraction of SiC i.e.; 0%,4%,6%,8% by weight prepared by stir casting method. The samples are prepared as per ASTM standard to investigate the influence of reinforcement particle on mechanical properties such as tensile strength, impact strength, wear resistance, Brinell hardness. The properties are compared to understand the influence. Achieving homogeneity is the major challenge and it affects the properties of the composite directly. The Al alloy composite material has high strength, high stiffness, good thermal stability, good corrosion and wear resistance and good fatigue life. Aluminum is most attractive base metal for MMC due to its light weight. There are variety of applications for Al based MMC's in modern technological space.*

*Key Words: - Hybrid metal matrix composite, stir casting, Al-SiC BC composite, mechanical properties*

## 1. Introduction

In MMC's Aluminium is widely used as the matrix because of its mechanical properties, especially Aluminium is light weight. This makes the Aerospace and Automobile industries attracted towards Aluminium based MMC's [3][6]. Aluminium based composite material consists of high strength, high stiffness, more thermal stability, more corrosion and wear resistance and more fatigue life [6]. This makes aluminum composite a unique alternative for the existing materials and also can be designed to attain required properties. Aluminium composites have varieties of application in today's technology. MMC's based on Aluminium is mainly used in Aerospace and Automobile industries.

Here we are adding boron carbide into aluminium-SiC composite as it increases strength of composite materials, as per the journals that we had referred. We are using stir-casting method to manufacture the composite materials [9]. We choose stir-casting method by looking our economic constraints. As in the journal says MMC's that is fabricated using stir-casting has a disadvantage that the amount of reinforcement that can be added to the matrix phase is very less, that is up to 10% we can add above that we will not get uniformity [10]. So, we are producing composite on 0%,4%,6%,8% of Silicon-Carbide added to the matrix where the Boron-Carbide is kept constant (2%) in composition. The tests on these specimens have been conducted and the results is being comparatively with the aluminium specimen (0% SiC &Boron-Carbide).

## 2. Methodology

In this project we are preparing the AMC's using stir casting method. The metallic mould is pre-heated up to a temperature of 500$^{o}$C and weighed the desired quantity of Aluminium metal and Silicon Carbide powder as well as Boron Carbide. we pre heated Al 6061 , SiC and B4C up to 650$^{o}$C. The crucible was kept inside the furnace and pre- heated Al 6061, SiC and B4C was put in to the crucible and heated up to a average temperature of 800$^{0}$C, the stirrer was inserted and maximum stirrer speed of 600 rpm was to be maintained, as the material inside the crucible was completely in a molten state the molten AMC was poured in to the metal mould and allowed to cool in atmospheric temperature, and the metal mould was open to take out the casted specimen, the same procedure was conducted for all the compositions.

The casted specimen was machined to make the test specimen according to the ASTM standard in order to determine the mechanical properties of the specimen and to compare the results with different compositions of SiC. the sample where polished and the optical images are taken to understand the microstructure and the distribution of the particulates.

## 3. Results and Discussion

### 3.1 TENSILE TEST

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Loading Rate: 1KN/m

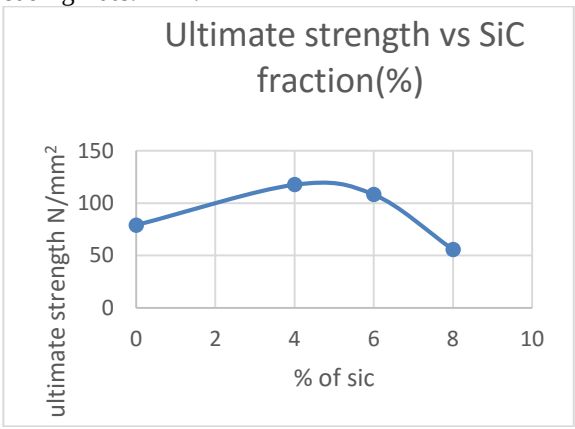


Fig: 3.1 Ultimate Strength vs % SiC

Figure 3.1 shows that tensile strength increases as the reinforcement fraction increases. The Al6061 with no reinforcement of SiC shows minimum tensile strength and 4% shows maximum tensile strength. However, for 6% and 8% the tensile strength decreases may be due to higher porosity, non-uniform distribution of particles.

### 3.2 BRINELL HARDNESS TEST

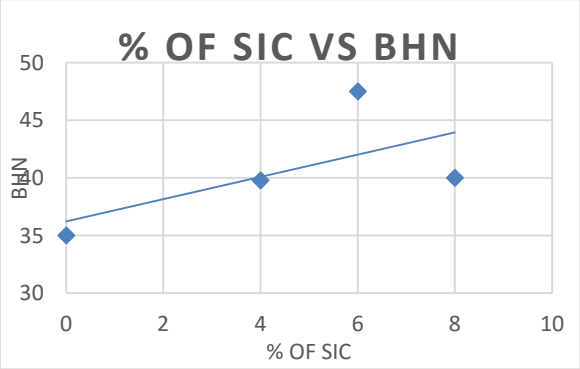


Fig 3.2 % of SiC vs BHN

The Figure 3.2 shows, the relation between % of SiC and Brinell Hardness Number(BHN). BHN values indicating Hardness of Al-SiC-$B_4C$ is much better than the aluminium metal. It is found from the trend that as the SiC fraction increases the hardness or BHN values found increasing the highest BHN value is obtained at 4% SiC and 2% $B_4C$ content.

### 3.3 WEAR TEST

Apparatus: Pin on Disc Wear testing machine

- Test Parameters
- Track Radius: 50 mm
- Disc speed=500rpm
- Time=15min

- Test result Comparison of wear rate of 4%,6%,8% SiC fraction AMC at various applied Load:

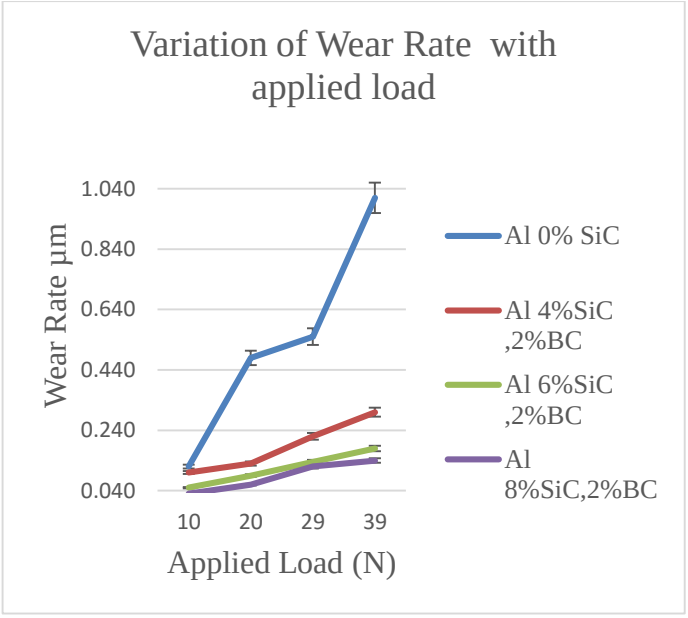


Fig 3.3 Comparison of wear Rate for AMC's with increase in Reinforcement of SiC

Figure 3.3 shows the variation of Wear rate with applied load. The trend shows that

- The wear rate increases with applied load. This trend is observed for all AMC hybrid composites with 4%,6%,8% SiC.
- It is also observed the wear rate decreases with increase in SiC reinforcement fraction at any given load.

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- Test result Comparison of Coefficient of friction (COF) of 4%,6%,8% SiC fraction AMC at various applied Load:

COF VS LOAD

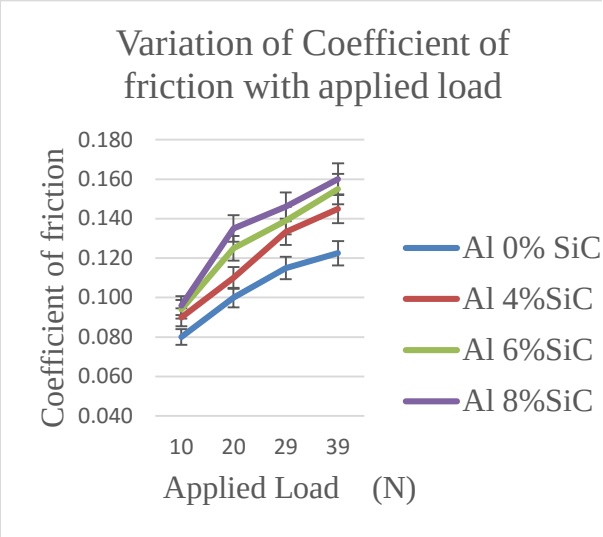


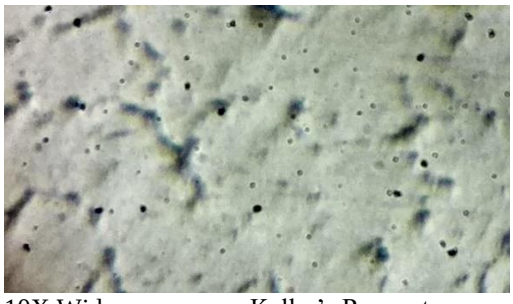

Fig 3.4

Figure 3.4 shows the variation of COF vs applied load. In this comparison of different composition of AMC is done and AMC with 8% SiC shows the highest variation and 0% shows the least variation. The trend shows that

**MICROSTRUCTURE STUDIES**

**Microstructure for Composition of Al6061 Alloy Reinforced with Silicon Carbide and Boron Carbide**

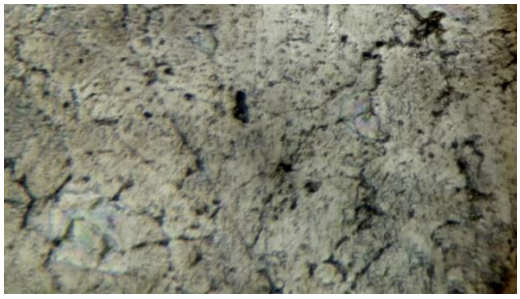
- AL6061 with 4% SiC and 2% $B_4C$



10X Wide Keller's Reagent

Fig 3.5

- AL6061 with 6% SiC and 2% $B_4C$



10X Wide Keller's Reagent

Fig 3.6

## 4. Conclusion

- The BHN values indicating Hardness of Hybrid AMC Al-SiC-B4C is much better than the aluminium metal. It is found that as the SiC fraction increases the hardness or BHN values found increasing the highest BHN value is obtained at 4% SiC and 2% B4C content.
- Tensile strength increases significantly with addition of the reinforcement particle SiC compared to the base material i.e Pure Al 6061.
- The tensile test result trend shows that Tensile strength values found increasing with increase in SiC fraction. The composites of Al6061 with 4% of SiC reinforcement shows higher UTS
- The Hybrid AMC Al-SiC-B4C with Al6061as matrix with 4% of SiC reinforcement can be used for making power transmitting elements such as gears, which are subjected to continuous loading.
- The wear rate increases with applied load. This trend is observed for all AMC hybrid composites with 4%,6%,8% SiC.
- It is also observed the wear rate decreases with increase in SiC reinforcement fraction at any given load.
- The coefficient of friction(COF) increases with applied load for all fractions of SiC in AMC.
- The COF decreases with increase in SiC fraction in AMC at given load.
- Microstructure for the composite shows that the reinforcement is thoroughly distributed in Al6061 at lower fraction of SiC up to 6% but at 8 % high porosity and cluster are observed, hence stir casting method can be adopted for manufacturing such composites
- More uniform distribution of SiC particles can be found if composite is prepared by powder metallurgy than stir casting; however, stir casting is more economical.
- To understand the distribution of reinforcement particles and porosity a micro graph study using SEM images certainly help to improve

the mechanical property of Hybrid AMC Al-SiC-B4C with Al6061as matrix.

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