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MECHANICAL CHARACTERIZATION OF AL 6063/B_4C PARTICULATE COMPOSITES

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ABSTRACT:
In the present work, the mechanical characterization of Al6063/B_4C particulate composites to be discussed. The Metal matrix composites are higher specific strength, good wear resistance, good surface finish, high corrosion resistance than ceramic materials. The Al6063/B_4C particulate composites to be manufactured by using stir casting technique. It is one of the most economical method of producing the composites.The mechanical characteristics of Aluminium-Boron Carbide Al6063-B_4C particulate composites using a stir casting method is discussed. The non heat treated Al6063 with varying percentage of B_4C (2-6%) were fabricated and conducted the mechanical tests. The finally mechanical characteristics of Al-B_4C was discussed.

KEYWORDS
Al-B_4C, Stir casting method,

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INTRODUCTION

Composite materials are a result of the continuous attempts to develop new engineering materials with low weight to strength ratios and improved properties. Among modern composites materials, particulate reinforced metal matrix composites (MMCs) are finding increased applications due to their favorable mechanical properties such as improved strength, stiffness and increased wear resistance over unreinforced alloys. In particular, composites show enhanced properties compared to unreinforced alloys. Aluminium metal matrix reinforced with Boron Carbide (B_4C) is a novel composite, which is used in automotive industries (ex. brake pads and brake rotor) due to high wear resistance, high strength to weight ratio, elevated temperature toughness and high stiffness.

Metal matrix composite (MMC) is a material which consists of metal alloys reinforced with continuous, discontinuous fibers, whiskers or particulates, the end properties of which are intermediate between the alloy and reinforcement. Aluminium metal matrix composites have become the necessary materials in various engineering applications like aerospace, marine and automobile products applications such as engine piston, cylinder liner, brake disc/drum etc. and also material is used for architectural applications, shop fittings, irrigation tubing, window frames, extrusions and doors. [1]

The work is made to develop the composite involving aluminium matrix reinforced with particulates of Boron carbide (produced by stir casting technique), the cast composites were tested for hardness tensile and impact properties.

2. EXPERIMENTAL MATERIAL

In this present work Al 6063 is used as matrix material, Table 1 and Table 2 shows Properties of Al6063 and Chemical Composition of Al 6063.lBoron carbide with particle size 90µm was used as reinforcement material. The properties of Boron carbide are shown in Table 3.

Table 1.Properties of Al6063

Density	2.7 g/cc
Hardness, Brinell	73
Ultimate Tensile Strength	241 Mpa
Tensile Yield Strength	214 MPa
Elongation at Break	12 %
Modulus of Elasticity	68.9 GPa
Fatigue Strength	68.9 MPa
Machinability	50 %

Table2.Chemical Composition of Al 6063l

Magnesium (Mg)	0.45 - 0.90
Silicon (Si)	0.20 - 0.60
Iron (Fe)	0.0 - 0.35
Others (Total)	0.0 - 0.15
Chromium (Cr)	0.0 - 0.10
Copper (Cu)	0.0 - 0.10
Titanium (Ti)	0.0 - 0.10
Manganese (Mn)	0.0 - 0.10
Zinc (Zn)	0.0 - 0.10
Other (Each)	0.0 - 0.05
Aluminium (Al)	97.5

Table3.Properties of B_4C

Density	2.51 g/cc
Melting Point	2,450° C
Hardness	3,000 Vickers
Compressive Strength	2800Mpa
Young's Modulus	450Gpa
Fracture Toughness	3.0K IC MPam $^{1/2}$
Thermal Conductivity	$35Wm^{-1}K^{-1}$
ThermalShock Resistance	Poor
Temperature of Application (in Air)	500° C Max

3. EXPERIMENTAL PROCEDURE

The details of the experiments carried out on Al6063 alloy subjected to refinement B_4C and with T6 heat treatment has been highlighted under the following.

- Preparation of Composites
- Melting and casting

3.1Preparation of Composites

3.1.1Matrix Material. The base matrix chosen in the work is the aluminium 6063. Alloy 6063 is an aluminum alloy containing copper, magnesium, manganese and some minor alloying elements. They have high strength to weight ratio, good formability, age harden ability and other appropriate properties.

3.1.2 Reinforcement Material. Boron carbide is taken as reinforcement material and its alloys. It Posses many of the mechanical and physical properties required of an effective reinforcement, in particular high stiffness properties and high hardness properties.

3.1.3Melting and casting

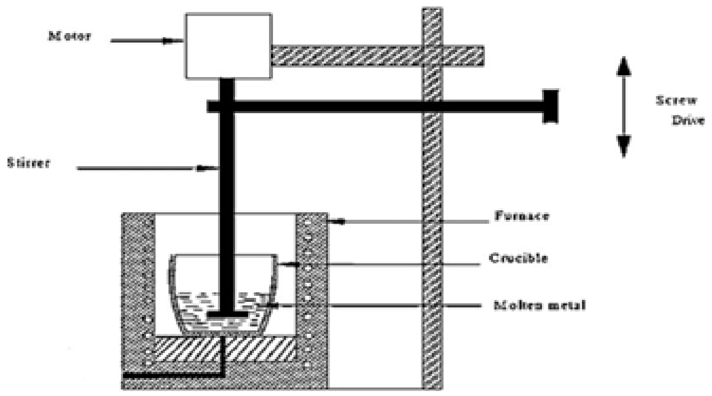


Fig1.Stir Casting Technique

1) Production of the metal matrix composite (MMC) through stir casting technique.
2) The Al6063 alloy melts at a temperature of 656˚C in a graphite crucible in melting furnace and degassing was carried out using degassing tablets.
3) The stirring device was a stainless steel rod, which was equipped with four stirring blades; the blades were mounted radial on the rotating rod and it will shows in Fig 1.
4) The addition of B_4C will be added on the percentage weight of the aluminium alloy.
5) The mixture starts from 2% by weight and will go on up to 6% by weight, with the increment of 2% per trial.
6) The molten alloy was stirred at 350 rpm for up to 1 min until a vortex is formed. Preheated B_4C particles at 2000˚C was added into the formed vortex slowly and steadily while continuing stirring for 3-5 min.
7) The molten metal will be poured into preheated mould die.

4. EXPERIMENTAL DETAILS

4.1 Hardness Test

Hardness is the property of a material that enables it to resist plastic deformation, usually by penetration. However, the term hardness may also refer to resistance to bending, scratching, abrasion or cutting. According to IS: 1500 – pt 1:2013 standard

The BHN is calculated according to the formula given below in eq-1

BHN=2P/ (ΠD (D-√(D2-d2)) --------------- (1)

Where,
P (Load Applied)
D (Dia of Ball Indenter)
d (Dia of Indentation)

From hardness data in Fig 2 it can clearly be seen that, with the exception of the ductility, the addition of B4C particles improves the mechanical properties of the resulting composite. It is shown the hardness of Al reinforced with 2-6% percentage level of B_4C. The results show that increasing the percentage level of B4C with Al, hardness of the composite also increased.

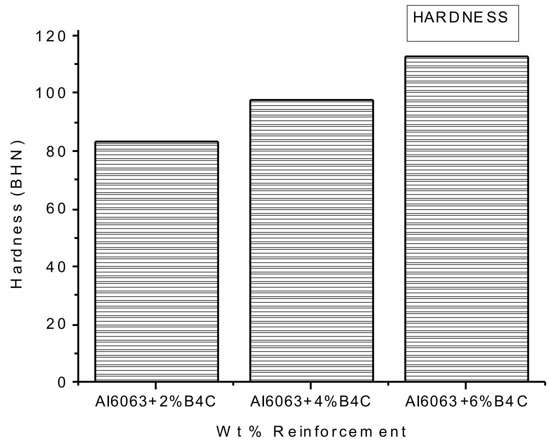


Fig.2: Hardness of Al in 2-6% of B_4C

4.2. Tensile test

The tensile specimens were prepared as per ASTM E8M-13a standard. The dimensions of the specimen are shown in Fig 3. The ultimate tensile strength was estimated using computerized uni-axial tensile testing machine The tensile strength of AMCs was found to be maximum for 6% (167.81MPa).

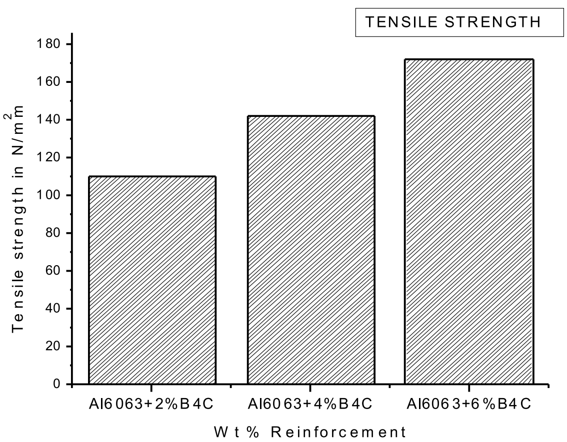


Fig 3.The Effect of Amount of B_4C Particulates on the Peak Stress of Stir Cast AMCs

4.3 Compressive Strength

According To ASTM E9 standard the test was carried out. The Fig 4 shows the effect of B_4C

content on the compressive strength of cast Al6063- B_4C composites. The Boran carbide content increases 2-6%, the compressive strength of the composite material increases some amounts.

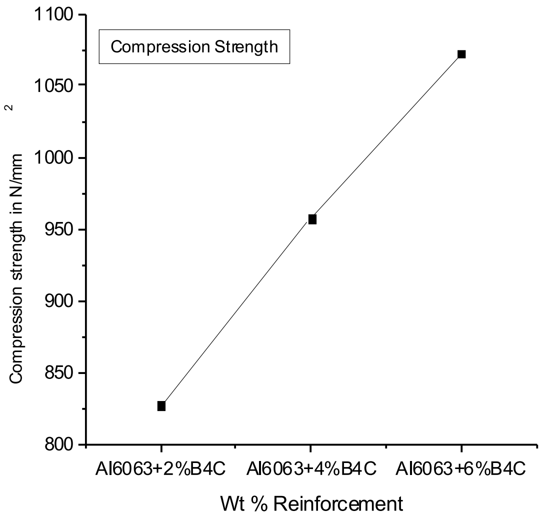
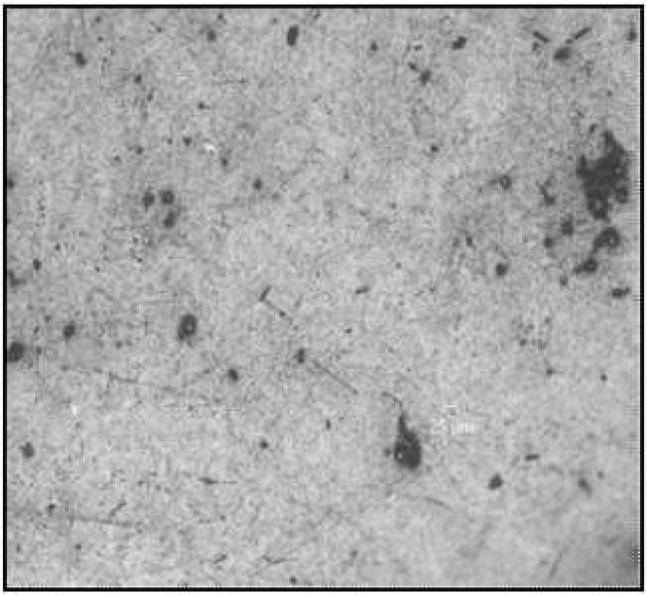


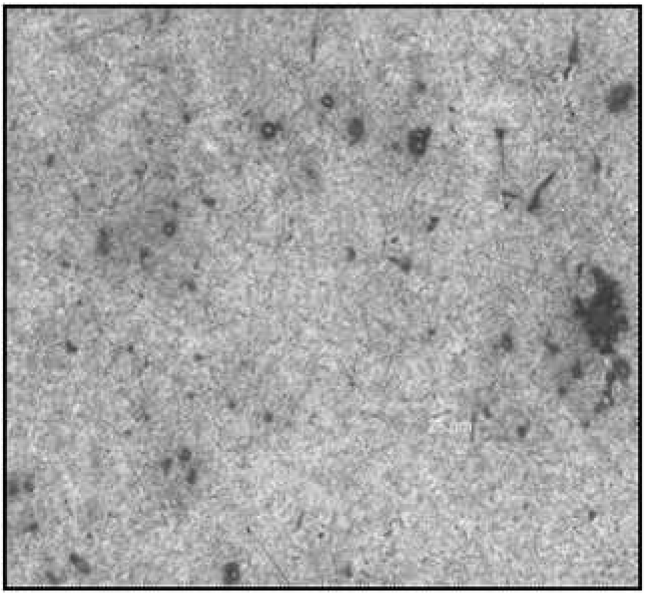
Fig 4 Effect of the B_4C content on compression strength

4.4. Microstructure

Fig 5(a) to 5(f) shows Microstructure of Al6063+2% to 6% Boron carbide in a step of 2, where Microstructure consists of fine grains of aluminium solid solution with fairly distribution of B_4C reinforcement particles throughout images.

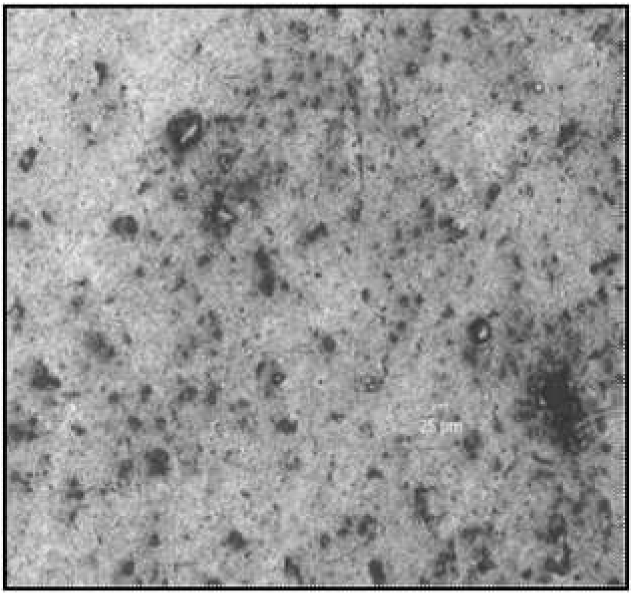


(a)

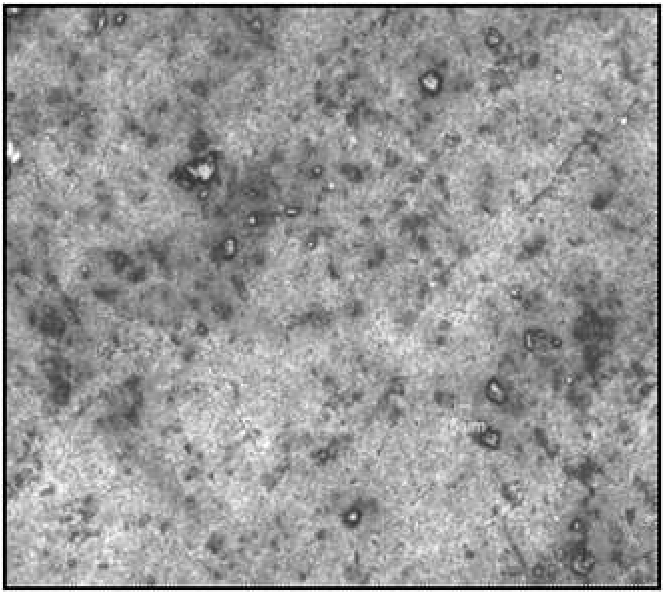


(b)

Fig 5(a) and 5(b): Microstructure of Al6063+2% B_4C Microstructure

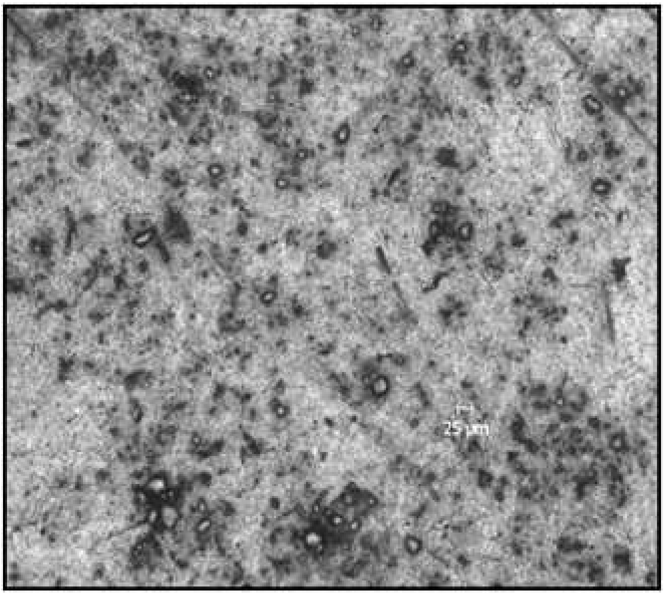


(c)

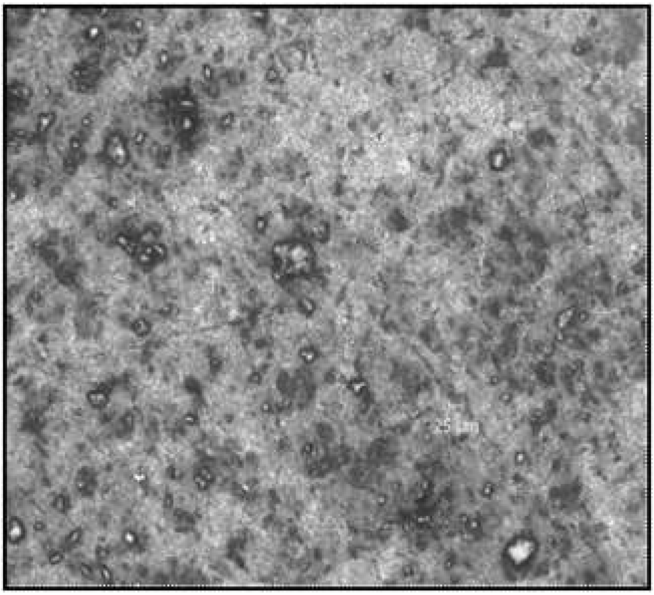


(d)

Fig 5(c) and 5(d): Microstructure of Al6063+4% B_4C Microstructure



(e)



(f)

Fig 5(e) and 5(f): Microstructure of Al6063+6% B_4C Microstructure

5. CONCLUSIONS

The non heat treated on Al- B_4C (2-6%) which shows results

- The hardness of the material is increased as reinforcement added with Aluminium.
- The tensile strength of the material is increases as reinforcement added with Aluminium
- The compression strength of the material is increased as reinforcement added with Aluminium
- Microstructure consists of fine grains of aluminium solid solution.

6. REFERENCES

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