EXPERIMENTAL STUDY OF MECHANICAL PROPERTIES ON AL 6063 COMPOSITE REINFORCED WITH SILICON CARBIDE

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***Abstract*: Composite materials have high performance than base metal like, high strength, high wear property and can withstand high temperature. The metal matrix composite (MMCs) materials has been developed using stir casting technique. Fabrication of Al 6063 alloys based metal matrix hybrid composite which is reinforced with 2%wt of Graphite and in varying composition of Sic by 9wt%, 12wt%,14wt% and 16wt%.This study has been done to find the variation in the mechanical properties such as hardness, tensile strength, impact energy of MMCs formed.**

***Keywords*: Metal matrix composites (MMCs), stir casting, Al6063, SiC, Graphite, Reinforcement, Hardness, Tensile strength, Impact energy.**

1. INTRODUCTION

Metal matrix composites are materials with a combination of two or more dissimilar materials to obtain enhanced properties. Nowadays most of the work is done to make some good composite with low cost.
Generally, the composite obtained after the fabrication has less weight and better strength and stiffness. In recent years, the composites has gained lot of popularity because of the low density and low cost reinforcements. Experiments were performed metal matrix composites to enhance the mechanical properties.

2. MATERIALS

2.1 ALUMINIUM 6063

AL6063 is an alloy of Aluminium, with magnesium and silicon as the alloying elements. The chemical composition is given in Table-2.1. The standard which controls its compositions are maintained by The Aluminium Association. It possess great mechanical properties and heat treatment can be performed easily and has greater weldability. 6063 finds its application mostly in aluminium extrusion. It can be moulded into difficult shapes with fine surface finish fit for anodizing and therefore it is popularly seen in architectural applications such as window frames, door frames, roofs, and sign frames.

Table 2.1: Chemical composition of AL6063

Si	Fe	Cu	Mn	Mg	Cr	Zn
0.3-0.7	0.6	0.1	0.3	0.4-0.9	0.1	0.2

2.2 Silicon Carbide

The material used for reinforcement in experimental investigation was Silicon carbide and it varies as 9%, 12%, 14% and 16% by weight, comprises of tetrahedral structure of carbon and silicon atoms with strong bonds between the atoms of the crystal lattice. Its thermal conductivity is high in addition to its low thermal coefficient of expansion and high strength which gives it remarkable thermal shock resistant properties. It is used as abrasives, refractories, ceramics, and several other high-performance applications.

2.3 Graphite

The other reinforcement material which was used in the study is Graphite which is kept constant to 2% by weight. It is a solid lubricant which improves the wear and anti-frictional properties of the formed metal matrix (MMC) composites. Due to increase in the SiC machinability reduces, to overcome this graphite is mixed. Graphite has high thermal and electrical conductivity and is thermally stable. Due to these properties it is as electrodes in refractories. Graphite and its powders are used in industrial applications because of their self and dry lubricating properties.

3. EXPERIMENTAL PROCEDURE

Stir casting method is used for the production of hybrid metal matrix composites. In this experiment Al 6063 bars are cut into small parts. The parts are then placed into a dish called crucible. Al 6063 was melted in a crucible by heating it in a furnace at 800°C for two to three hours .The silicon carbide particles, Graphite particles were preheated at 800°C and 700° respectively for one to two hours to make their surfaces oxidized. Then, the preheated Sic with variable composition and Graphite (2% by wt.) particles were added manually to the crucible. After complete addition of Particles into the melt the mixture is continuously stirred so as to achieve uniform mixing of particles in the matrix .After 10 minutes of stirring, mixture is poured into a mould and the required casting has been obtained. The hybrid composition is given in Table-3.1.

3.1 SPECIMEN PREPARATION

The test specimens were prepared by machining from the cylindrical bar and cuboid casting. The samples for tensile test, each specimen having 12.5mm gauge length dia x 100mm gauge length in size. The specimen for hardness test the sample for Brinell hardness test 65mm x 25mm x 10mm. The specimen for impact testing the samples for Charpy test 55mm x 10mm x 10mm length with 2mm V- notch at the centre.

Table 3.1: Composition of the product

SNo.	Hybrid Composition
1.	Al6063 + 2%Graphite + 9%SiC
2.	Al6063 + 2%Graphite + 12%SiC
3.	Al6063 + 2%Graphite + 14%SiC
4.	Al6063 + 2%Graphite + 16%SiC

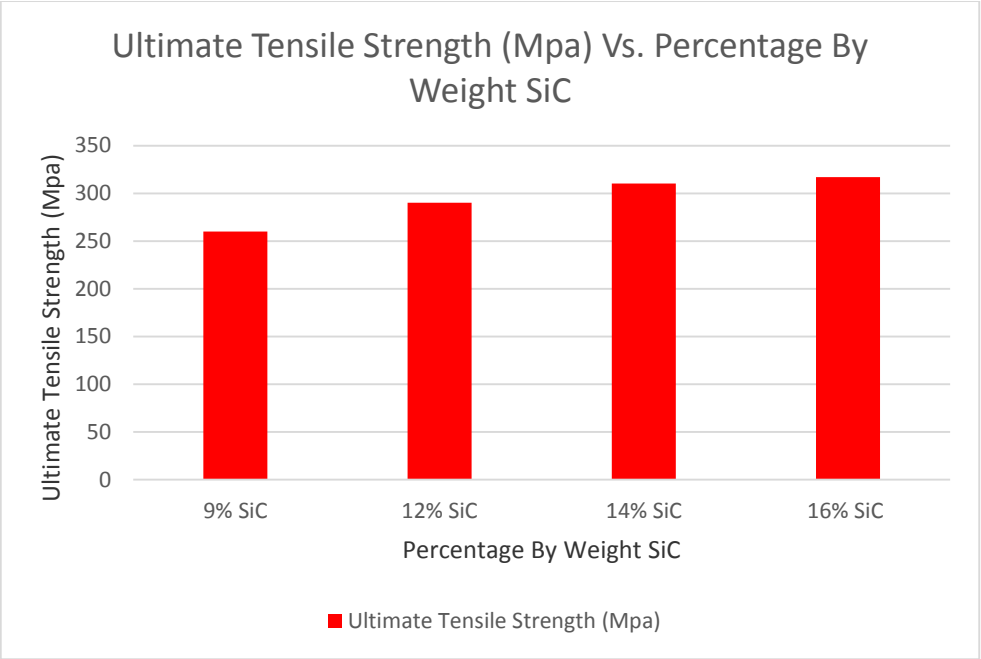
4. TESTING AND RESULT

4.1 TENSILE TEST

The tensile test was conducted on UTM at room temperature. The samples were prepared according to ASTM E8M. The tensile properties of the alloys were determined by performing the tension test on standard cylindrical tensile specimens. It was observed that the tensile strength increased with an increase in the weight percentage of SiC, This is due to the fact that Sic particles restricts the movement of dislocations while the load was applied on it. The improvement in tensile strength of the composite is mainly due to the fact that the filler Silicon Carbide provides higher strength by offering more resistance.

Table 4.1.1:

SNo.	Hybrid Composition	Tensile Strength (MPa)
1.	Al6063 + 2%Graphite + 9%SiC	260
2.	Al6063 + 2%Graphite + 12%SiC	290
3.	Al6063 + 2%Graphite + 14%SiC	310.2
4.	Al6063 + 2%Graphite + 16%SiC	317

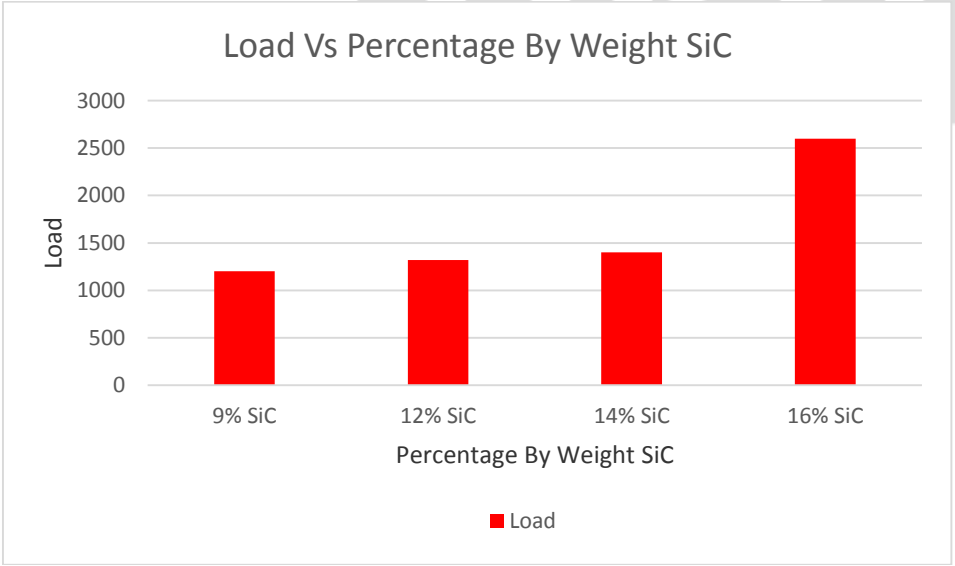


4.2 COMPRESSION TEST

The compression tests were conducted on CTM at room temperature. The data obtained with the variation in Sic by weight percentage in Al6063 shows that the compressive strength is increased with an increase in the weight percentage of SiC. The increase in SiC restricts the dislocation and thereby increases the compressive strength.

Table 4.2.1:

SNo.	Hybrid Composition	Compressive Load(KN)
1.	Al6063 + 2%Graphite + 9%SiC	1200
2.	Al6063 + 2%Graphite + 12%SiC	1320
3.	Al6063 + 2%Graphite + 14%SiC	1400
4.	Al6063 + 2%Graphite + 16%SiC	2610

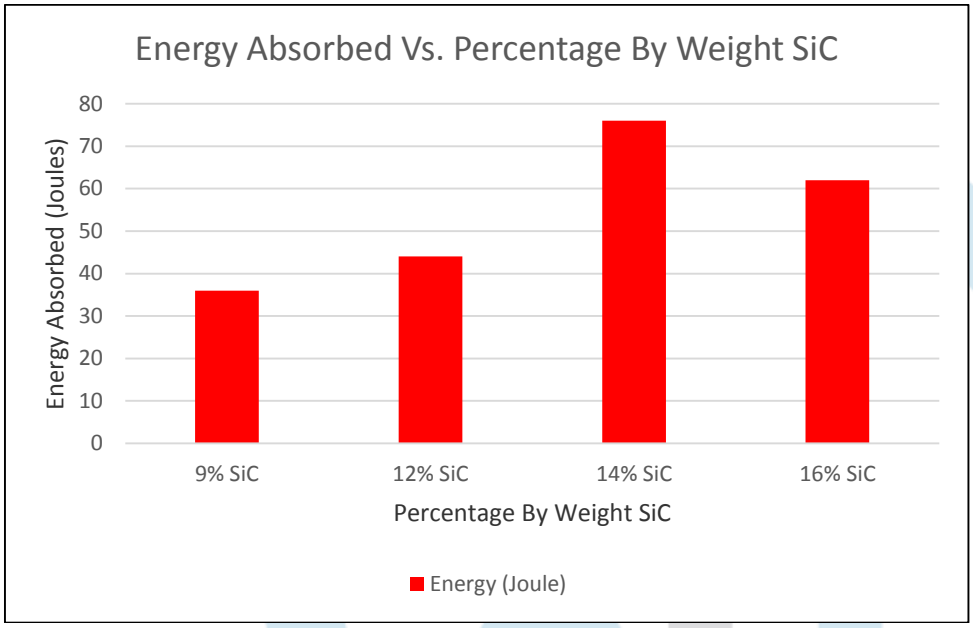


4.3 IMPACT TEST

The Charpy impact test (or Charpy V-notch test) is a standard test of high strain rate which is used to determine the amount of energy absorbed by material during fracture. This absorbed energy gives the value of toughness.

Table 4.3.1:

SNo.	Hybrid Composition	Energy Absorbed (Joules)
1.	Al6063 + 2%Graphite + 9%SiC	35
2.	Al6063 + 2%Graphite + 12%SiC	43
3.	Al6063 + 2%Graphite + 14%SiC	76
4..	Al6063 + 2%Graphite + 16%SiC	62

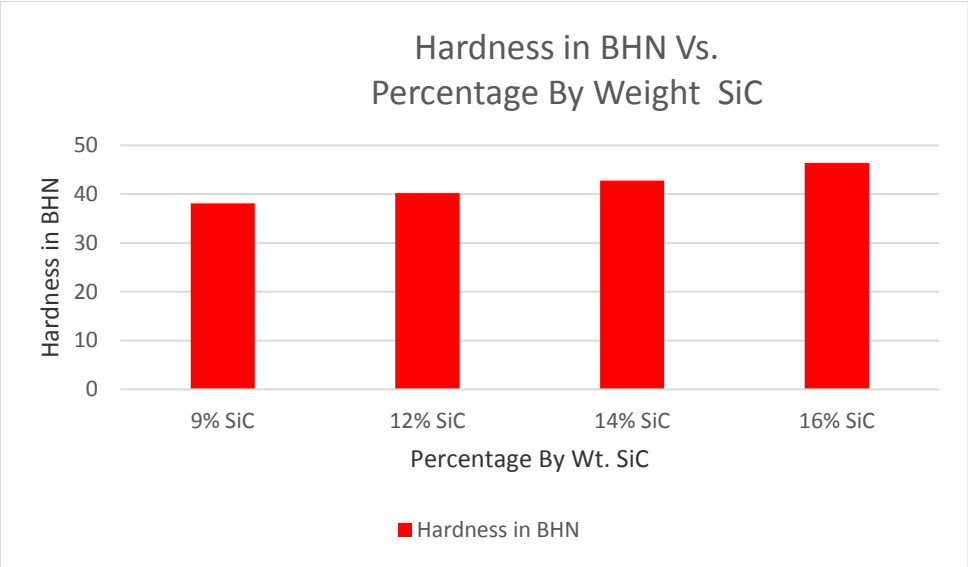


4.4 HARDNESS TEST

The Brinell hardness test was performed on the specimen of Al 6063 with varying reinforcement of SiC. The indenter used for the testing was a 5mm steel ball indenter and load of 300kgf was applied for 30 sec to evaluate the hardness of the sample. The result shows the increase in the hardness with the increase in the amount of SiC in the base metal.

Table 4.4.1:

SNo.	Hybrid Composition	BHN
1.	Al6063 + 2%Graphite + 9%SiC	38.1
2.	Al6063 + 2%Graphite + 12%SiC	40.2
3.	Al6063 + 2%Graphite + 14%SiC	42.8
4.	Al6063 + 2%Graphite + 16%SiC	46.4



4.5 OPTICAL EMISSION SPECTROSCOPY

The chemical composition of the different reinforcement materials after the testing of specimens is shown below.

Table 4.5.1: Al6063 + 2%Graphite + 9%SiC

Elements	Si	Fe	Cu	Mn	Mg	Cr	Zn
%range	6.7	0.323	0.053	0.019	0.276	0.012	0.005

Table 4.5.2: Al6063 + 2%Graphite + 12%SiC

Elements	Si	Fe	Cu	Mn	Mg	Cr	Zn
%range	8.4	0.329	0.055	0.019	0.132	0.012	0.005

Table 4.5.3: Al6063 + 2%Graphite +14%SiC

Elements	Si	Fe	Cu	Mn	Mg	Cr	Zn
%range	9.8	0.344	0.057	0.020	0.206	0.0123	0.005

Table 4.5.4: Al6063 + 2%Graphite +16%SiC

Elements	Si	Fe	Cu	Mn	Mg	Cr	Zn
%range	11.2	0.353	0.059	0.021	0.047	0.01250	0.005

From the above tables it is clear that the chemical composition of the SiC is increasing at uniform rate which is responsible for the increase in the tensile, impact energy and hardness of the materials.

5. CONCLUSION

Form the above experimental fabrication of Al 6063 with reinforcing of SiC in a varying percentage, aiming to increase the mechanical properties, we found the results and can conclude as:

- On increasing the amount of SiC in weight percentage in the base metal i.e., Al 6063, the tensile strength, compressive strength and hardness of the aluminium is increased gradually
- In the spectroscopy it was seen that the SiC composition is increased which resulted in the variation of properties.
- The energy absorbing capacity of the material is increased up to 14% SiC and then decrease for 16% SiC sample.

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