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Experimental Analysis Of Mechanical Properties Of Al6063 And SIC Composite

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Abstract: **Today's most of materials are available in market but without composite they have low mechanical properties. For good mechanical properties composite are very necessary. We know that increasing the use of aluminum alloy in aerospace, automobile and Infrastructure industries. But due to low properties aluminum alloy not directly use some material reinforce. The presents study results of experimental investigation on mechanical behavior of silicon carbide particle reinforced aluminum matrix. The influence of reinforced ratio of 5%, 7%, and 9% of silicon carbide particles on mechanical behavior was examined. The effect of different weight percentage of silicon carbide in composite on Tensile strength, Hardness, Microstructure was studied. It was observed that the Hardness & Tensile strength of the composites increased with increasing reinforcement element addition in it. The distribution of silicon carbide particles was uniform in aluminum.**

Keywords: **Silicon carbide (SiC), Metal matrix composite (MMC), Mechanical Properties, Casting.**

I. INTRODUCTION

The importance of composites as engineering materials was reflected by the fact that out of over 1600 engineering materials available in the market today more than 200 are composite [1]. Aluminium metal matrix composites (AMMCs) have considerable applications in aerospace, automotive and military industries due to their high strength to wear ratio, stiffness, light weight, good wear resistance and improved thermal and electrical properties. Ceramic particles such as Al_2O_3, SiC are the most widely used materials for reinforcement of aluminium [2, 3]. Metal matrix composites (MMCs) are one of the important innovations in the development of advanced materials. Among the various matrix materials available, aluminum and its alloys are widely used in the fabrication of MMCs and have reached the industrial production stage. The emphasis has been given on developing affordable Al-based MMCs with various hard and soft reinforcements (SiC, Al2O3, zircon, graphite, and mica) because of the likely possibilities of these combinations in forming highly desirable composites [4].

A. Aluminium 6063:

Aluminium 6063 is a medium strength alloy commonly referred to as an architectural alloy. It is normally used in intricate extrusions. It has a good surface finish; high corrosion resistance is readily suited to welding and can be easily anodized. Most commonly available as T6 temper, in the T4 condition it has good formability. The 6xxx-group alloys have a widespread application, especially in the building, aircraft, and automotive industry due to their excellent properties [5].

TABLE 1: CHEMICAL COMPOSITTION OF ALUMINIUM 6063 ALLOY

Si	**Fe**	**Cu**	**Mn**	**Mg**
0.43%	0.102%	0.0073%	0.029%	0.50%
Cr	**Zn**	**Ti**	**Ni**	**Al**
0.0026%	0.0049%	0.013%	0.0036%	Balance

B. Silicon Carbide:

Silicon Carbide is the only chemical compound of carbon and silicon. It is originally produces by a high temperature electro-chemical reaction of sand and carbon. Today the material has been developed into a high quality technical grade ceramic with very good mechanical properties [6]. Today, SiC is still produced via a solid state reaction between sand (silicon dioxide) and petroleum coke (carbon) at very high temperatures in an electric arc furnace.

II. EXPERIMENTAL PROCEDURE

A. Stir Casting Process:

1. Aluminium liquid
2. Electric motor
3. Sic particles
4. Insulated board
5. Blades
6. Crucible

The metal matrix composites were prepared by stir casting process in Hariom precision casting pvt.Ltd.Alwar. Al–SiC composite with varying SiC percentage were prepared by melting commercially pure aluminium and commercially pure silicon in a 220 mesh particle in a high frequency induction furnace and the melt was held at 680 °C in order to attain homogeneous composition.

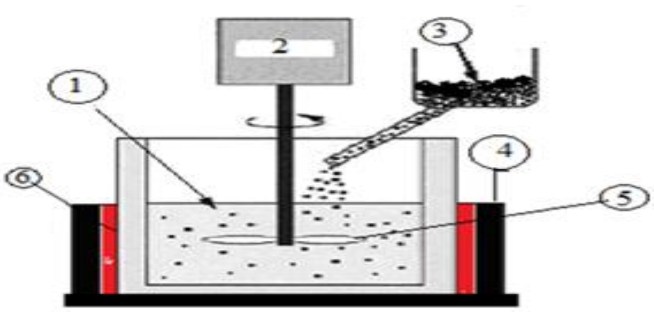

Fig. 1 Stir casting Setup

Fig. 2 Casted Component

B. Tensile Test Process:

In any design work, it is important to consider practically realizable values of strength of the materials used in design. The tension test is one of the basic tests to determine these practical values. The range of values obtained from the tests forms the basis for the size of the material in the products for the factor of safety. The tension test is conducted on a universal testing machine at room temperature [7].

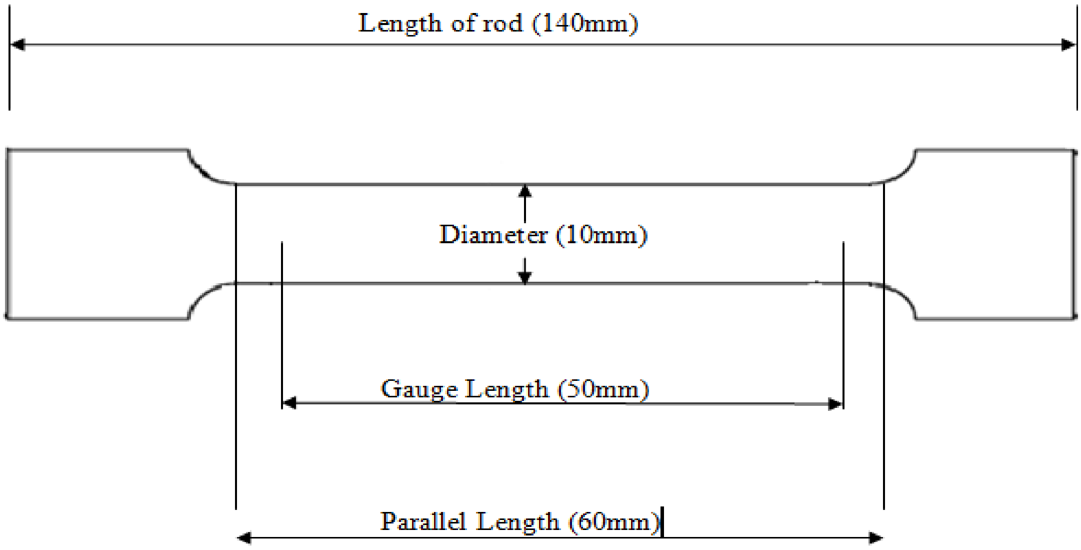

Fig. 3 Tensile Specimen

Figure 3 shows the standard tensile test specimen. Measure the original gauge diameter (d) and gauge length of the specimen by means of a verniercaliper & steel rule respectively. Mark gauge length by two tiny dots using a dot punch. Now test piece is Fix in Universal testing machine and tensile strength, yield strength were measured.

C. Hardness Test Process:

Hardness measurement were carried out on the base metal and composite sample by using Brinell hardness machine.The applied load was 500 kg and indenter was a steel ball 10 mm in dimeter. In this test a standard hardness steel ball of diameter D was pressed for about 10-15 seconds into the surface of the specimen by a gradually applied load P. The impression of the steel ball was measured to nearest 0.2 mm with the help of microscope. The Brinell hardness number was obtained by dividing the applied force by the spherical surface area of the indentation [8]. The diameter of the indentation was measured after the load and ball are removed.

D. Micro structure Test Process:

Microstructure studies were conducted in order to investigate the distribution of Sic partical retained in the metal matrix. Microstructure examination was generally performed using optical or scanning electron microscopes to magnify features of the material under analysis [9]. In order to identify and evaluate the microstructure of material, it is very important to prepare the test sample. Characterization was done in etched condition. Microstructures of the alloy samples were observed under inverted metallurgical microscope. The Al-SiC samples of different weight composition were mechanically polished using standard metallographic techniques before the examination.

III. TEST RESULT AND DISCUSSION

A. Tensile Test Result:

From the load and elongation values, obtained from the universal testing machine, corresponding engineering stress and engineering strain were calculated and plotted to get stress vs. strain curves for different samples of Al-5%SiC, Al-7%SiC and Al-9%SiC composition.

TABLE 2: TENSILE STRENGTH OF AL-SIC COMPOSITE

S. No.	Al-5%Sic	Al-7%Sic	Al-9%Sic
1.	OD=10.05mm^2	OD=10.05mm^2	OD=10.00 mm^2
2.	Load=440 kg	Load=560 kg	Load=680 kg
3.	Area= 79.32 mm^2	Area= 79.32mm^2	Area=78.53 mm^2
4.	Tensile Strength=54.35(N/mm^2)	Tensile Strength=69.17(N/mm^2)	Tensile Strength=84.94(N/mm^2)
5.	Elongation = 6%	Elongation = 4%	Elongation = 2%

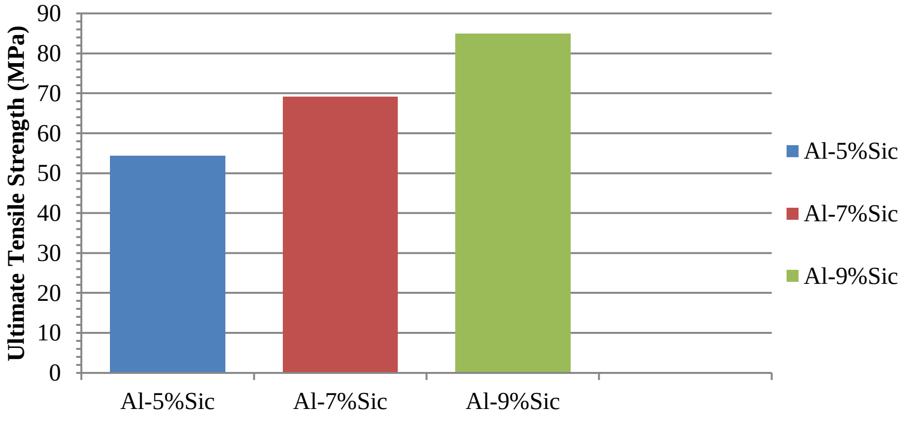

Fig. 4 Comparison of Tensile Strength in composite

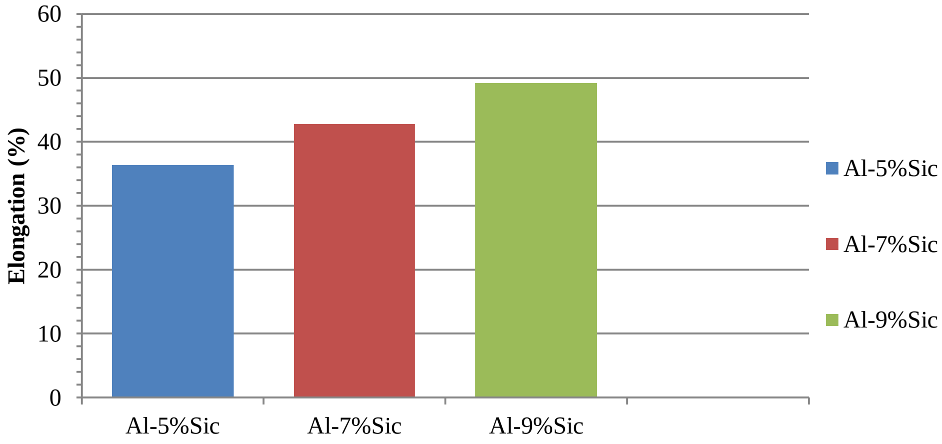

Fig. 5 Comparison of Yield Strength in composite

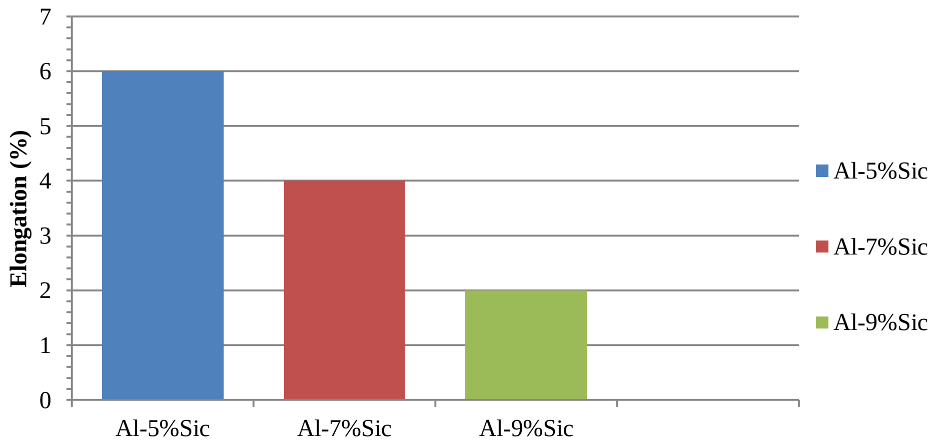

Fig. 6 Comparison of Elongation in composite

Discussion:

From Fig. 4 and Fig. 5 it is observed that ultimate tensile strength and yield strength increases with the increase of weight percentage of silicon carbide; while from Fig. 6 it is observed that total elongation decrease with the increase weight percentage of silicon carbide. The curves are continuous when transition from elastic to plastic region takes place. Therefore, the yield strengths of the alloys are computed by 0.2% offset method, according to ASTM standard.

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B. Hardness Test Result:

The result for specimens is shown in Table 3 the hardness value of cast composite increase as the weight percentage of SiC increases from 5%, 7%, and 9% in the composite. In this test load and ball diameter was constant for all specimens.

TABLE 3: BRINELL HARDNESS NUMBER

Composition	Indentation Diameter	BHN	Avg. BHN
Al+5% SiC	4.39	31.4	31.5
	4.38	31.5	
	4.37	31.7	
Al+7% SiC	4.11	36.4	36.2
	`4.10	36.2	
	4.09	36.0	
Al-9%SiC	3.99	38.3	38.1
	4.00	38.1	
	4.01	37.9	

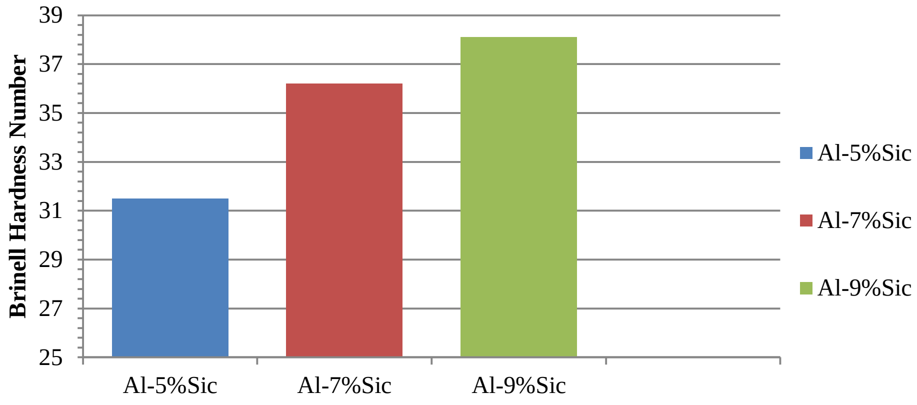

Fig. 7 Comparison of Brinell hardness number

Discussion:

From Fig. 7, it observed that the Brinell hardness numbers for Al-5% SiC, Al-7% SiC and Al-9% SiC are found to be 31.5, 36.2 and 38.1 respectively. This shows that hardness of the Al-SiC composition increases with the increase in the weight percentage of silicon carbide. This may be due to the increment of silicon carbide amount, which is harder.

C. Microstructure Test Result:

Microstructures obtained from inverted metallurgical microscope are shown in fig 8 to fig 10 for Al-5% SiC, Al-7% SiC and Al-9% SiC respectively.

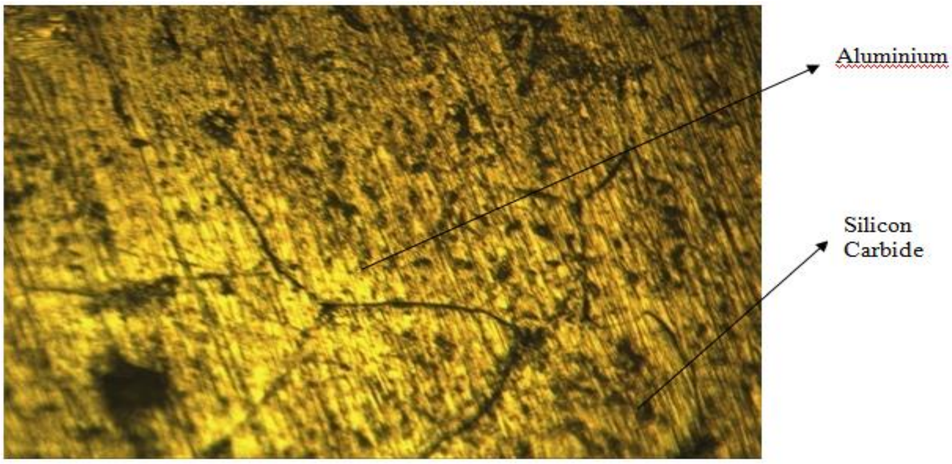

Fig. 8 Micrograph of Al 6063-5% of SiC

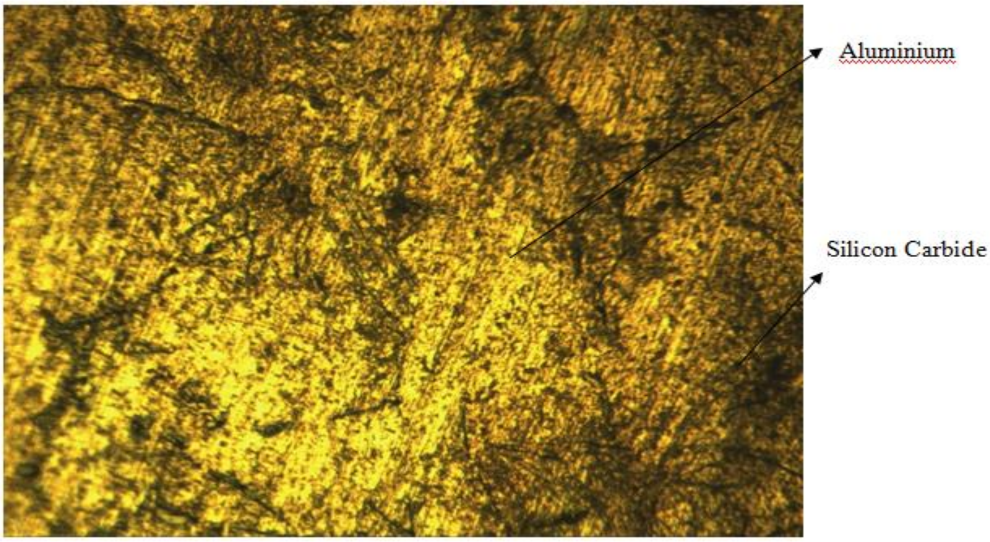

Fig. 9 Micrograph of Al 6063-7% of SiC

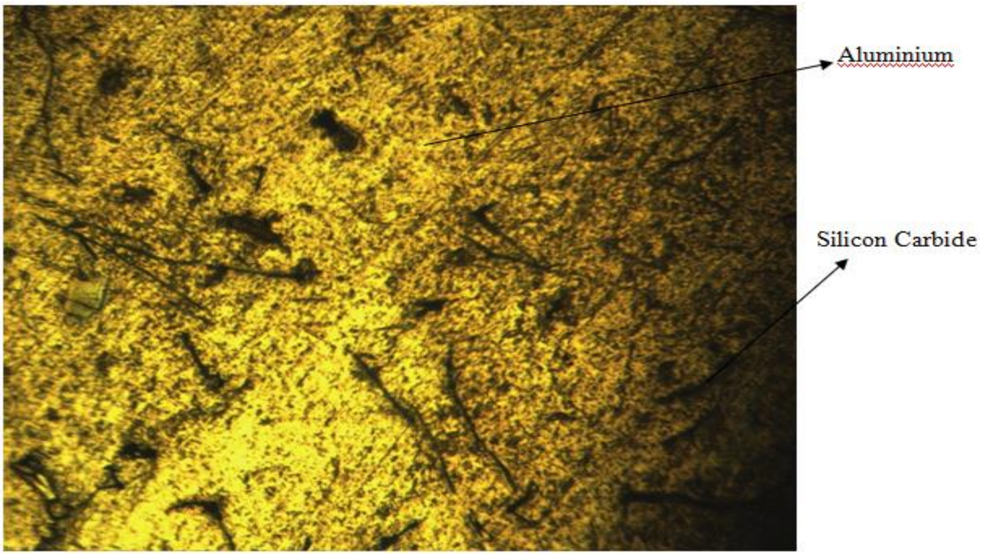

Fig. 10 Micrograph of Al 6063-9% of SiC

Discussion:

Fig. 8 shows an optical micrograph of Al-5% SiC composite and it may be seen that more-or-less rounded particles of aluminium and dark areas by silicon carbide. Here, silicon has networked structure. The micrograph of Al-7% SiC composite in Fig. 9 shows the refinement of the eutectic silicon particles. The silicon has long rod like structure. It may be seen in Fig. 10 the micrograph of Al-9%SiC composite that the degree of refinement of the eutectic silicon increased as the silicon content of the alloy increased beyond the eutectic composition. In addition, presence of primary silicon is also observed in the Al-5% SiC, Al-7% SiC and Al-9%SiC composites, although the size and volume fraction of the primary silicon Carbide is more in Al-9% SiC, as compared to Al-7% Sic composite and Al-7%SiC is more than compared to Al-5%SiC.

IV. CONCLUSIONS

- Yield strength and Ultimate tensile strength increases with the increase of weight percentage of silicon carbide.
- Total elongation decreases with the increase of weight percentage of silicon carbide.
- Hardness of the Al-SiC composite increases with the increase in amount of silicon carbide.
- In the microstructure studies revealed the uniform distribution of SiC composite in the matrix system.

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