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Mechanical Synthesis and Characterization of MMC with Graphite and Silicon Carbide

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Abstract - *The present work deals with the preparation and mechanical characterization of aluminum 6063metal matrix reinforced with silicon carbide and graphite. Silicon carbide and graphite can be considered in different percentages like (1+2), (3+2), (5+2). By using these materials to prepare and investigate the mechanical characteristics like ultimate tensile strength, breaking strength, Rockwell hardness, Brinell hardness, compression strength and toughness. Aluminum metal composites have various properties which makes it to be applicable into various places like automobile, military industries, aerospace, building constructions and others due to light weight, thermal properties, stiffness, high mechanical strength, corrosion resistance. During the analysis of the composite matrix of aluminumthe properties / characteristic were investigated.*
Key words; *AMMC's, stir casting, mechanical properties aluminum 6063.*

I. Introduction.

Composite:-

The composites are defined as the combinations of two are more materials which include reinforcement and matrix material, this provides the addition of some other characteristics which were not present before. The combinations of two or more material improves the properties of new material and makes it unique.

Purpose of composites;

Material properties such as weight, tensile strength, corrosion resistance, performance, thermal and electrical properties and others have been the main driving force towards development of various composite materials. Due to technological advancement and modern ways of manufacturing various products aims at providing the most economical and affordable price products hence composites addresses this problem. The utilization of Aluminum material matrix composite in aerospace and automotive industries improves the performance and they are economic.

Classification composites and reinforcement;

There are three main classification of composite materials which are ceramic matrix, metal matrix and polymer matrix composites. Fibers, flakes, particulate and whisker comes under reinforcement as shown in figure 1..

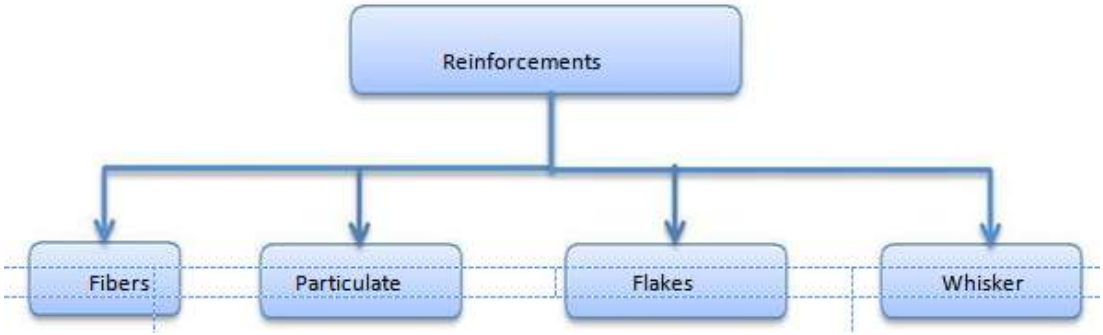


Figure 1.classification of reinforcements.

Applications:

Aluminum metal matrix composites (AMMCs) have considerable applications in automobile, military industries, aerospace, building constructions and others due to light weight, thermal properties, stiffness, high mechanical strength, corrosion resistance.

II. Literature Review

According to, **Rama Rao** analyzed and came up with results onaluminum alloy-boron carbide composites, these materials were fabricated byusing liquid metallurgy techniques and varying the percentage composition of new composites by fraction and percentage weight such as (2.5, 5 and 7.5%). Different state identification was carried out on boron carbide by x-ray diffraction, microstructure analysis. Various tests such as compression test, hardness test were conducted to check the new or unique characteristics of the composite material. The results shows that as boron carbide increases its densitydecreased whereas hardness increases. Also the increase in weight of boron carbide in the composite ked to increase in compressive strength.

According to **keshavamurthy**result the AL6061 as metal matrix and nickel coated Silicon nitride are reinforcement that material can be fabricated by liquid metallurgical technic. Finally he get microstructure and tribological properties of developed composite and its mechanical properties. by using pin and disc technic at the load of 20-100N .the wear and sliding friction are measured .sliding velocity is 0.31-1.57m/s. AL6061-Ni-p-Si3N4 composite lower wear and compare to coefficient of friction . The coefficient of friction changes at the load around 80N. . Further increase in the load, also increasing coefficient of friction and sliding velocity.

As per **Anil kumar** investigation the mechanical properties of fly ash with AL6061 fabricated by stir casting method these different of composite s with fly ash particle size is 75-100, 45-40 and 4-25mm are used finally he consider there types composite samples taken by the weight fraction like 10%, 15% and 20%.and find the different mechanical and thermal properties without fly ash. By this properties are decreased by changing of fly ash. If increase the weight of fly ash particle then the mechanical properties are decreased. The SEM analysis also done the final composite.

III. Materials Used In The Experiment; Aluminum 6063

The aluminum 6063 is very soft material which is structural, automobile body parts, Marine and military applications. The Al6063 is the combination of magnesium and silicon. It having good weldability and better mechanical thermal properties. The mechanical properties of al6063 are young's modules is 68.3GPa , tensile strength is around 145-186 MPa and thermal properties are the melting point 6150C, thermal conductivity is (K) is 201-218 W/M*K and specific heat capacity is 900 J/kgk. it allowed to formed a complex shapes.

Table 1. Composition of AL6063.

Material	Percentage of composition
Silicon	0.2% (max 0.6%)
Magnesium	0.45 %(max0.9%)
Iron	0.35%
Copper	0.10%
Other	0.05% - 0.15

Table 2. Aluminum composite characteristics, application and alloy numbers.

Alloy	Characteristics	Purpose	Alloy Number*
1000 (Pure aluminum)	Excellent corrosion resistance, machinability, electrical/thermal conductivity. Good surface treatability	Various containers, electrical appliances, reflector plates	1070 1100

2000 (AL-Cu Alloys)	Duralmin alloys, high strength, cuts well. Corrosion resistance and surface treatability is inferior.	Aircrafts, transfer equipment, machine parts	2017 2024
3000 (AL-Mn Alloys)	High strength with corrosion resistance. Press forms well, surface treats well	General objects, cans, Sconstruction material	3003 3004
4000 (AL-Si Alloys)	Low melting points. Naturally anodize coloring alloy	Brazing/welding fillers, construction material	4043
5000 (AL-Mg Alloys)	Wide alloy variety based on Mg content variations. High strength/corrosion resistance. Surface treats well.	Construction, structural, ship vessels, can lids, optical	5005 5052 5056 5083
6000 (AL-Mg-Si Alloys)	Good corrosion resistance, increase in strength by heat treating. Extrudes and surface treats well.	door framing, structural	6061 6063
7000 (AL-Zn-Mg Alloys)	Highest strength aluminum alloy. Good weldability.	Aircraft, sporting equipment, railway vehicles, welded.	7075 7N01

SILICON CARBIDE AS REINFORCEMENT:

Basically the silicon carbide as reinforcement in this experiment. This is also known as carborundam. The silicon and carbon as a very good semi-conductor. The silicon carbide powder has been mass production in 1893. The silicon carbide is widely used to high endurance and bullet proof vests .the properties of SiC are the molar mass is 40.096 g*mol-1 , density is 3.16 g*cm-3 , melting point is 28300 C , electron modality 900 cm2/ V.s (all poly types), magnetic susceptibility -12.8*10-6 and reflective index is 2.55

PROPERTIES OF SILICON CARBIDE:
The silicon carbide density is low, strength is high, thermal expansion is less, thermal conductivity is high, thermal shock resistance is excellent and superior chemical inertness

Figure 2.Silicon Carbides as reinforcement

GRAPHITE FIBRE;

The graphite as used in reinforcement in this experiment / the graphite is a crystalline form of carbon with its atoms are hexagonal structure and the color is iron block to steel gray. The specific gravity of the graphite is 1.9-2.3and density is 2.09- 2.23g/cm3 solid corban comes in different forms called as allotropes depends on type of chemical bond the two most common are graphite powder and diamond . The natural graphite is used for refractories batteries, brake lining and lubricants.

Figure 3.Graphite as reinforcement

Graphite properties:

The melting point is very high , density is low (28% of steel), less hardness, self- lubrication and less friction , good electrical conductivity the highest of non-metallic materials, thermal conductivity is high , thermal co efficient of expansion is less , and thermal resistance is high.

IV. Stir Casting Process.

This is the basic step of the experiment. in this stir casting process the AL6063 is placed in to the casting machine and material will be heated, when its comes from liquid state then the reaming graphite and silicon carbide poured into the inside the machine then the material will be stir by using mechanical stirrer and when material will be done complete stirring then the molten material will be taken into mold . The stir casting of the metal matrix composites was developed in 1968**.**

Figure 4 stir casting

MATERIAL COMPOSITION;

MATEIAL	AL6063 (%)	SIC (%)	GRAPHITE (%)
A1	97	1	2
A3	95	3	2
A5	93	5	2

Table 3.Material composition

V. Experimental Result And Discussion; Tensile Test

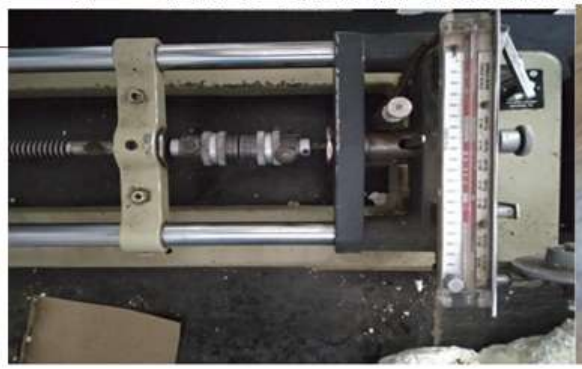


fig 5. Tensiometer

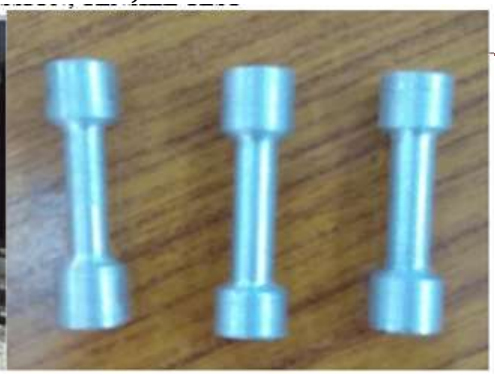


fig 6. Tensile test specimen

Ultimate tensile strength

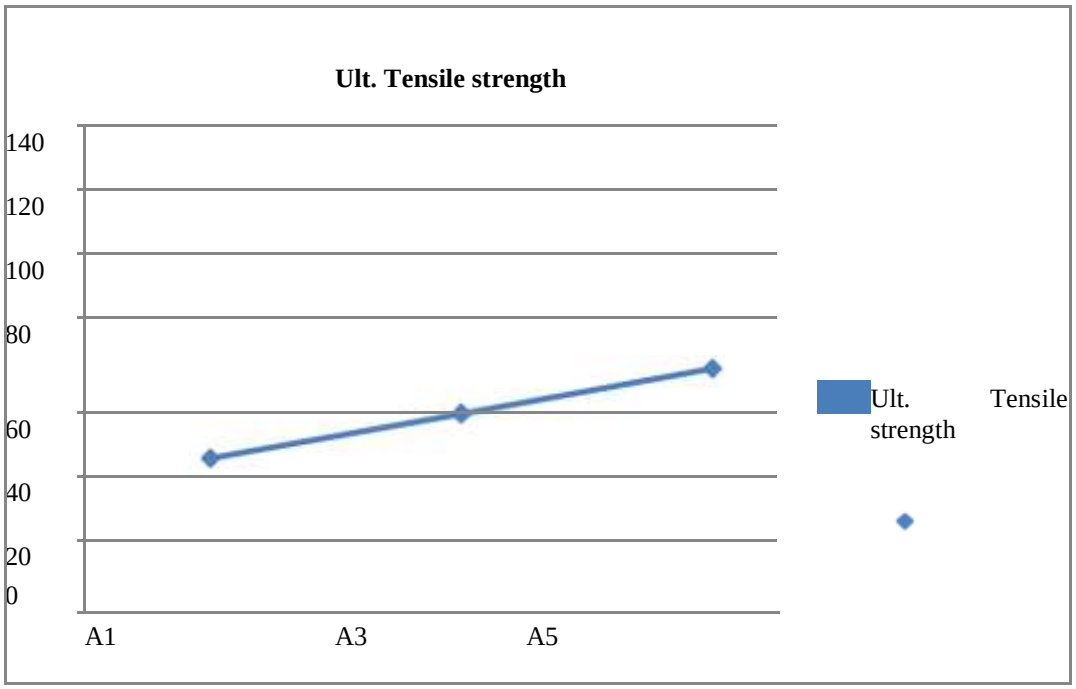
S.No	Material	Gauge length(mm)	Diameter2r (mm)	Ultimate load (kgf)	Ultimate strength
1	**A1**	24	5	180	**89.93**
2	**A3**	22	5	220	**109.91**
3	**A5**	23	5	260	**129.90**

Table 4.Ultimate tensile strength

Formula Used:

$$\sigma ut = \frac{\text{ultimate load}}{\text{cross sectional area}}$$

Cross sectional area of the specimen is $A = \pi r^2$ =πr^2 = $\pi * 2.5^2$ π*2.5^2= **19.6364 mm2.**
r = radius of the circular cross section =**2.5 mm**.



Graph1 specimen V/S ultimate tensile strength

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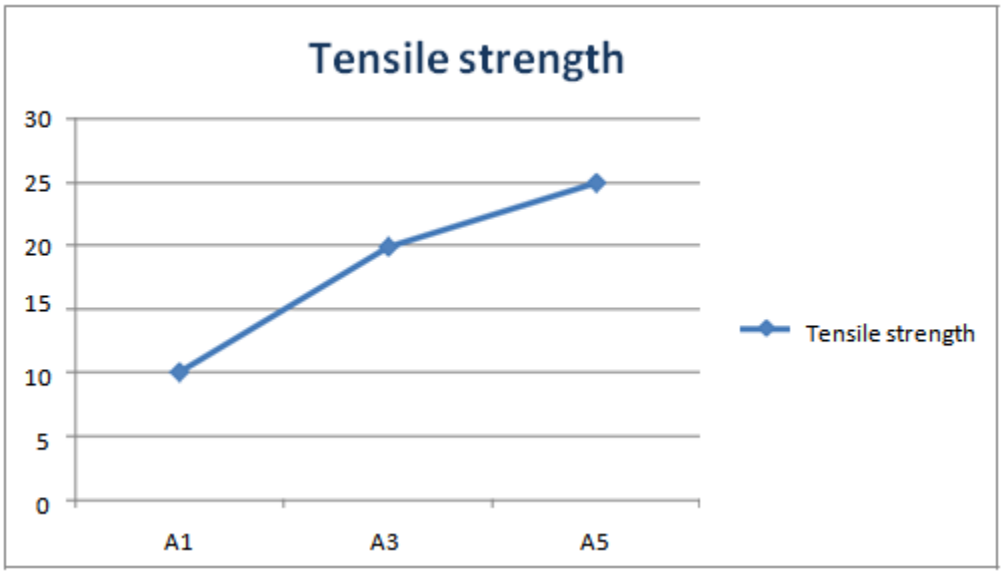
Tensile strength

S.No	Material	Gauge length(mm)	Diameter2 r (mm)	Breaking load (kgf)	breaking strength(MPa)
1	**A1**	24	5	20	**9.992**
2	**A3**	22	5	40	**19.984**
3	**A5**	23	5	50	**24.981**

Table 5. Tensile Strength



Graph2 specimen V/s tensile strength

ROCKWELL HARDNESS;

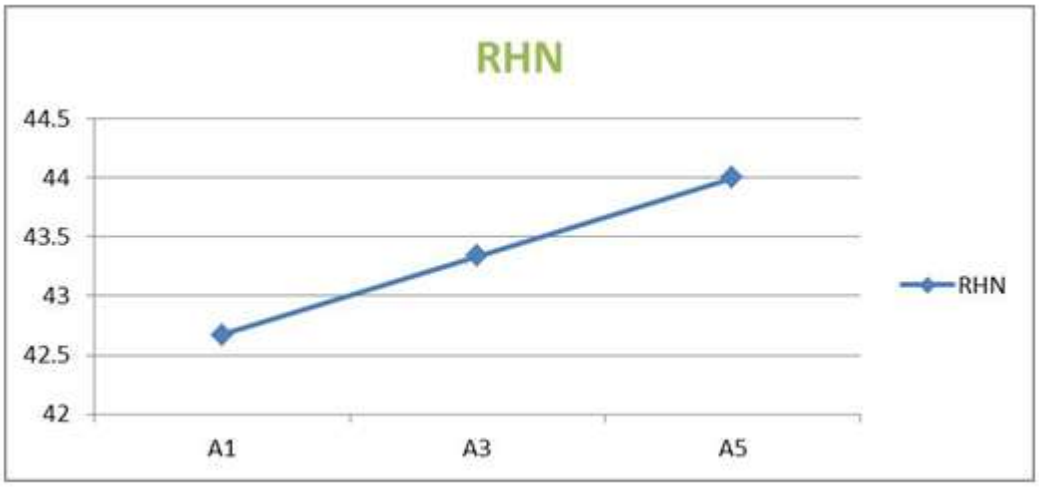
Fig 7: Rockwel hardness

fig 8 hardness test specimen

ROCKWELL HARDNESS

Material	Load Applied (100 kgf)	Reading on the Indicator scale			Average RHN
		Trial 1	Trial 2	Trial 3	
A2	100	42	43	45	**43.34**
A3	100	42	43	47	**44**

Table 6.Rockwell Hardness



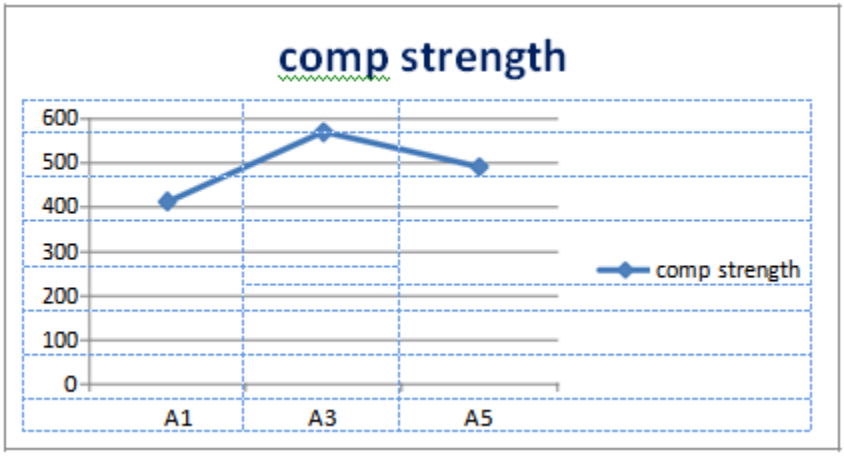
Graph 3 specimen V/s RHN

COMPRESSION TEST;

Fig9 compression testing machine

fig 10 compression test specimen

S.No	Diameter and length	Area A(mm2)	Load (P) KN	Compressive strength(N/mm2)
A1	18mm 40mm	254.469	105	**412.623**
	40mm			
A5	18mm 40mm	254.469	125	**491.22**



Graph4 specimen V/s comp stength

Brinell's Hardness Testing

Fig11 brinell's hardness. **Test specimen**

Modules S no	Indent dia Trail 1	Indent dia Trail 2	Indent dia Trail 3	Average
A5	4.89	4.58	4.47	**4.62**
A3	4.73	4.61	4.70	**4.68**
A1	4.78	4.80	5.2	**4.92**

Table 8. Brinell's Hardnes

Where, P is the applied load in Kgf = 500kgf

D = Diameter of the indenter = 10mm

=> BHN = $\frac{2P}{\pi D(D-\sqrt{D^2-d^2})}$

(BHN- Brinell hardens number)

IMPACT TEST;

Observations of impact testing machine;

One division on scale = 2J

Charpy scale range = 0-300J

Angle drop of pendulum = 1400

Effective weight of pendulum = 20.59 kg

Fig 12 Inpact testing machine **Test specimen**

S.No	material	Energy (j)
1	A1	**50**
2	A3	**40**
3	A5	**30**

Table 9.Impact Test

VI. Conclusion

The aluminum metal matrix composites reinforced with silicon carbide and graphite fabricated by the stir casting method successfully. According to results with the increase of reinforcement mechanical properties has been increased except compression strength. In compression test at the average value of reinforcement the compression strength has been increased

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