A Study on Al 7075, Silicon Carbide And Graphite And Its Characterization

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Abstract- *Functional graded materials play a very important, role in engineering and other application such as aerospace, automobile and marine application. The fabrication of these functional graded materials also plays an impact on enhancing of characteristics of these material. One such fabrication method for these materials are stir-casting technique. The study represents an enhancing of properties of casted Aluminium and SiC alloy by adding graphite using stir-casting technique. In the present work, the effect of adding graphite to Al and SiC (6%) matrix with different composition varying from 1.5% to 4.5% and keeping constant stirring speed as 1500rpm at 850^o C and constant stirring time of 1minute 30 seconds. Henceforth, an attempt has been made to study the mechanical(tensile strength, compression, hardness), physical(microstructure, density) and tribological properties(wear) of Al MMCs. Reinforced composite material (MMC) has been examined under identical test conditions in order to examine the role played by the graphite on the characterization.*

Keywords- Hybrid composite, Stir casting, Sic, Graphite, characterization

I. INTRODUCTION

Several super alloys and heat resistant materials have been developed for various industrial applications such as aerospace, spacecraft, automotive and submarine structure. Engineering materials have lead to new generation materials particularly having low density, light weight, high strength, hardness and high stiffness. Metal matrix composite (MMC) materials one of the widely used composites because of their excellent properties such as high strength to weight ratio, hardness, stiffness, wear and corrosion resistant. MMCs are used for space shuttle, commercial airlines, electronic substrates, bicycle, automobiles, golf clubs and variety of other application. The biggest disadvantages of MMCs are their high costs of fabrication, which has placed limitation on their high costs of fabrication, which has placed limitations on their actual applications.

Casting processing such as stir casting employs mechanical stirring to produce aluminum metal matrix composites which are reinforced by sic and graphite particles. Stir casting helps in good distribution and dispersion of micro particles can be achieved by optimizing the process parameter of mechanical stirring. In order to achieve a dispersion and distribution of nano-particles in aluminum metal matrix composite is used. Silicon carbide and graphite are used non-metallic reinforcements combined with aluminum7075 to find the mechanical and physical properties of aluminum.

Applications

- Aerospace
- Automotive
- Medical
- Electrical field
- Sports
- Chemical Industry
- Other- Composites have long been used in the construction for industrial supports, buildings, long span roof structures, tanks, bridge components and complete bridge systems. With composites exhibiting excellent resistance to the marine environment. With the help of composite we make light weight doors, window, furniture, building, bridge etc. for domestic and construction purpose.[2]

Table .1- chemical composition of Al7075

Element (%)	Aluminium 7075
Zn	5.10-6.10
Mg	2.10-2.90
Cu	1.20-2.00
Cr	0.18-0.28
Fe	0.50(Max)
Si	0.40(Max)
Mn	0.30(Max)
Ti	0.20(Max)
Others	0.05-0.15(Max)
Remainder	Aluminium

II. LITERATURE SURVEY

Al7075- bagasse ash-Gr hybrid composite specimen are prepared using stir casting technique .hardness and tensile strength of composites is gradually increased with increasing

in the percentage of reinforcement i.e. at graphite(5%) and bagasse ash (6%) [1]

The fabrication and mechanical properties of Al 7075 alloy reinforced with constant amount of sic(5%) and tic(5%) hybrid metal matrix composite, The hardness of a cast Al7075-5%+tic-5%+sic-5% MMCs is increased by 39%with the base alloy ,the tensile strength is also increased with 32% when compared with Al7075 base alloy , it was concluded that ,composite containing 5wt% titanium carbide and 5wt% silicon carbide reinforcement exhibited superior mechanical properties[2].

The combination of a matrix material with reinforcement such as Sic and red mud particles, it improves mechanical properties like tensile strength, compressive strength, hardness and yield strength also microstructure i.e. at Red Mud(6%) and Sic(2%)[3].

Where here there are four cases i.e. pure Al7075,Al7075+3%Zircon,Al7075+6% Fly ash,Al7075+3%Zircon+6%Fly ash, the tensile strength and hardness increases when 3% Zircon and 6% Fly ash is added to Al7075, where wear rate decreases for the same[4].

Where graphite is constant of 3% and varied of silicon carbide (4%,8%,12%),the hardness and ultimate tensile strength increases with increases with percentage of silicon carbide and addition of reinforcements to Al7075 lead to decreases in percentage elongation[5].

In this study, it was observed that reinforced particles are uniformly distributed on matrix material by SEM analysis, hardness of composites was increases by increasing weight percentage of silicon carbide particle. It was also observed that the wear rate decreases as the weight percentage of silicon carbide increases[6].

In this present work, the tensile strength and hardness of al 7075 alloy reinforced with 0.5wt% of Sic and B_4C nano-particles were examined and compared with 0wt% of al Alloy. From the SEM micrograph the nano-particles are well dispersed in AL matrix and offers improved results than 0wt% AL alloy. Out of B_4C and SIC nano-composites. The dispersion of nano B_4C particles is better than SIC nano-particles because of their wet ability property [7].

III. SCAN OF LITERATURE REVIEW

Investigations have been carried out to find the mechanical and physical of hybrid metal matrix composite(Al 7075, SiC, Graphite) using stir casting technique.

- Fabrication of metal matrix composite according to required composition.
- Casting is obtained by the most affordable technique that is stir casting technique.
- To develop the specimen from the casting is machined to desired dimension for the test to be carried out.
- Material characterization of test specimen to determine it mechanical and physical properties using desired apparatus.

IV.OBJECTIVES

1. To develop a hybrid metal matrix composite by stir casting method.
2. A study on part characteristics of the hybrid metal matrix i.e. physical and mechanical characteristics.
3. Study of microstructure analysis.

V. MATERIAL CHARACTERIZATION

The following tests have been carried out:-

- TENSILE TEST

Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics. Uni-axial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials. Some materials use biaxial tensile testing.

$S = F/A$ ---------- (1)

Where,

S=Breaking strength
F=Force that caused the failure
A=Least cross section area of the material

- COMPRESSION TEST

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed

together), whereas tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently.

- WEAR TEST

Several standard test methods exist for different types of wear to determine the amount of material removal during a specified time period under well-defined conditions. ASTM International Committee G-2 standardizes wear testing for specific applications, which are periodically updated. The Society for Tribology and Lubrication Engineers (STLE) has documented a large number of frictional, wear and lubrication tests. Standardized wear tests are used to create comparative material rankings for a specific set of test parameter as stipulated in the test description.

- HARDNESS TEST

Hardness is a measure of the resistance to localized plastic deformation induced by either mechanical indentation or abrasion. Some materials (e.g. metals) are harder than others (e.g. plastics). Macroscopic hardness is generally characterized by strong intermolecular bonds but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: scratch hardness, indentation hardness, and rebound hardness.

- DENSITY TEST

The **density**, or more precisely, the **volumetric mass density**, of a substance is its mass per unit volume. The symbol most often used for density is ρ (the lower case Greek letter rho), although the Latin letter D can also be used. Mathematically, density is defined as mass divided by volume where ρ is the density, m is the mass, and V is the volume. In some cases (for instance, in the United States oil and gas industry), density is loosely defined as its weight per unit volume although this is scientifically inaccurate – this quantity is more specifically called specific weight.

$$\rho = m/V \qquad \text{---------- (2)}$$

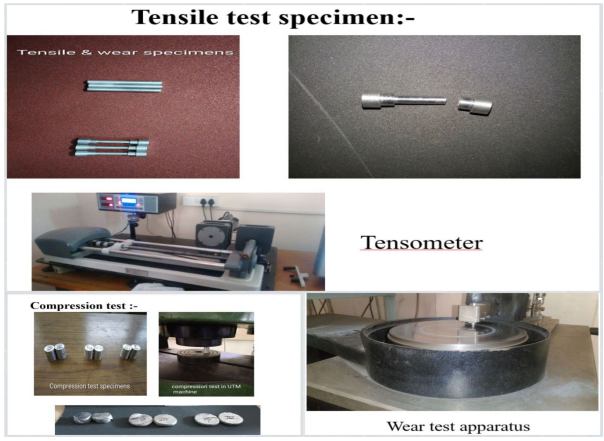
- MICROSTRUCTURE

Compared to many other metals and alloys and many other materials, such as carbides, ceramics and sintered carbides, aluminium and its alloys are low in strength and hardness. Aluminium is a soft, silvery metal with a face-centered cubic crystal structure, a hallmark of ductile metals. Its softness makes it somewhat difficult to prepare but the alloy is not sensitive to problems that plague preparation of magnesium and titanium, that is, a sensitivity to mechanical deformation that generates mechanical twins.

VI. RULE OF MIXTURE

- Casting is categorized into 4 parts :-

i. Al7075
ii. Al7075+SiC (6%) + Graphite (1.5%)
iii. Al7075+SiC (6%) + Graphite (3%)
iv. Al7075+SiC (6%) + Graphite (4.5%)



VII. RAW MATERIALS USED

- **Silicon Carbide**

Silicon Carbide is a compound of Silicon and Carbon. Grains of Silicon Carbide are bonded together by sintering to obtain hard ceramics. They are widely used in applications requiring high endurance limit in Car brakes, clutches and ceramic plates in bulletproof vests. Its chemical formula is Sic Figure 4.4 shows preheated Silicon Carbide particles of size (220 grit size).Silicon carbide (Sic) has excellent high temperature strength, a very high oxidation ability and good chemical resistance. It thermal conductivity is four times that of steel and it has low thermal expansion coefficient, hence it is preferred for high temperature exchangers. The density of SiC is 3.21 g/cm^3.Hence it is chosen for the present study. The melting point is 2830^{o}C.

- **Aluminium 7075**

Aluminium 7075 has an excellent machinability property. It exhibits well resistant to corrosion under both ordinary atmosphere and marine conditions. [2] Aluminium 7075 (Al7075) is chosen as the matrix material since, it is low cost and has better properties like good thermal conductivity, high shear strength, abrasion resistance, high-temperature

operation, non-flammability, minimal attack by fuels and solvents, and the ability to be formed and treated on conventional equipment. It possesses excellent casting properties and reasonable strength. This alloy is best suited for mass production of lightweight metal castings. The density is 2.81 g/cm^3 and melting point of aluminium is 800^{o}C.

- **Graphite**

The acoustic and thermal properties of graphite are highly anisotropic, since phonons propagate quickly along the tightly-bound planes, but are slower to travel from one plane to another. Graphite's high thermal stability and electrical and thermal conductivity facilitate its widespread use as electrodes and refractories in high temperature material processing applications. The density of graphite is 2.26 g/cm^3 and melting point is 4300K.

VIII. RESULTS AND DISCUSSION

1.Hardness:-

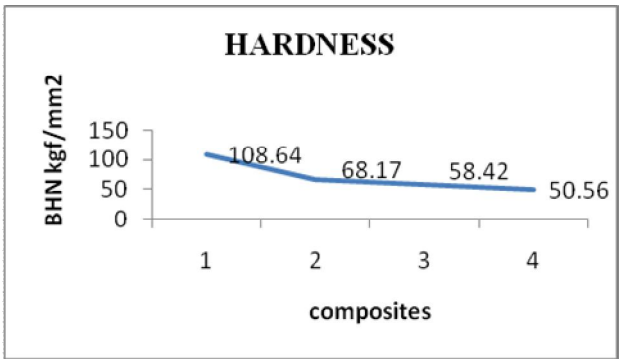


Fig.1. variation of hardness with variation of graphite in the composite material

Table.1.Hardness test

Varying weight of composition	BHN in Kgf/mm^2
Al7075	108.614
Al7075+Sic6%+graphite1.5%	68.17
Al7075+Sic6%+graphite3%	58.42
Al7075+Sic6%+graphite4.5%	50.42

2. Tensile test:-

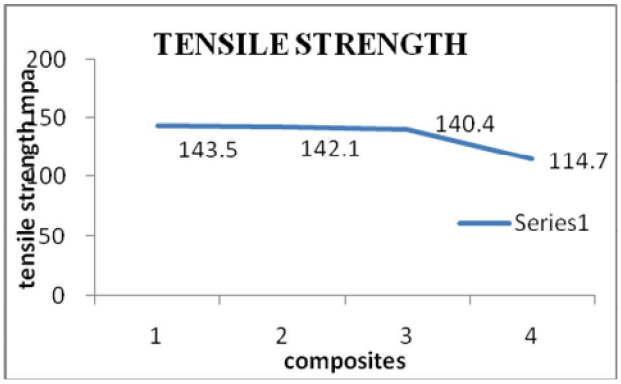


Fig.2.variation of tensile with variation of graphite in the composite material

Table.2.Tensile test

Varying weight of composition	Ultimate tensile strength in MPa
Al7075	143.5
Al7075+Sic6%+graphite1.5%	140.4
Al7075+Sic6%+graphite3%	114.7
Al7075+Sic6%+graphite4.5%	141.6

3. Density:-

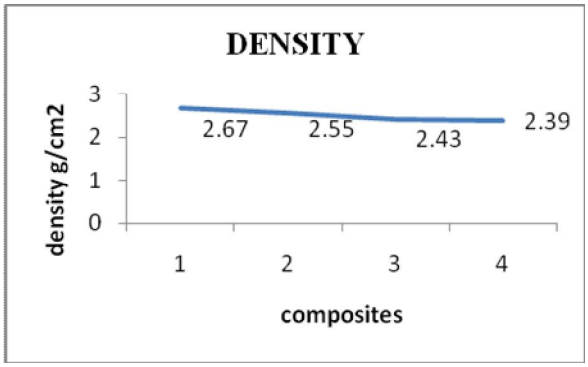


Fig.3.variation of density with variation of graphite in the composite material

Table.3. Density

Varying weight of composition	Density g/cm^3
Al7075	2.6707
Al7075+Sic6%+graphite1.5%	2.55
Al7075+Sic6%+graphite3%	2.433
Al7075+Sic6%+graphite4.5%	2.398

4.Wear test:-

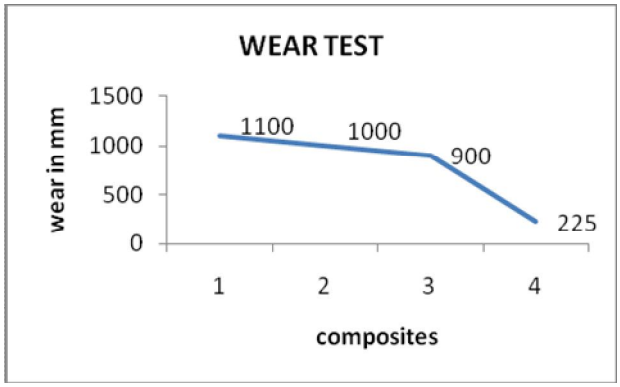


Fig.4.variation of wear with variation of graphite in the composite material

Table.4.Wear test

Varying weight of composition	Wear in microns
AL7075	1100
Al7075+Sic6%+graphite1.5%	1000
Al7075+Sic6%+graphite3%	900
Al7075+Sic6%+graphite4.5%	225

5.Compression test:-

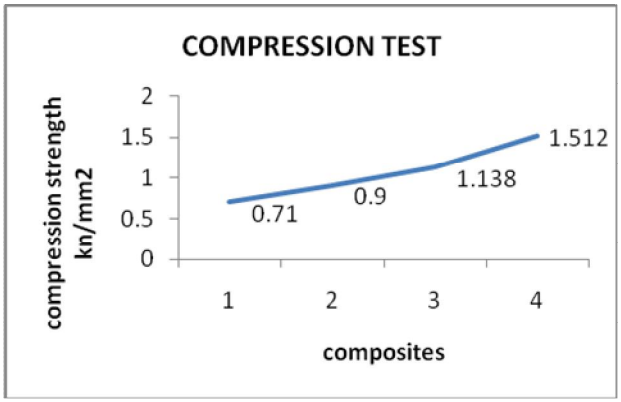


Fig.5.variation of compression with variation of graphite in the composite material

Table.5.compression test

Varying weight of composition	Compression strength in KN/mm^2
Al7075	0.71
Al7075+Sic6%+graphite1.5%	0.9
Al7075+Sic6%+graphite3%	1.138
Al7075+Sic6%+graphite4.5%	1.512

IX. MICROSTRUCTURE

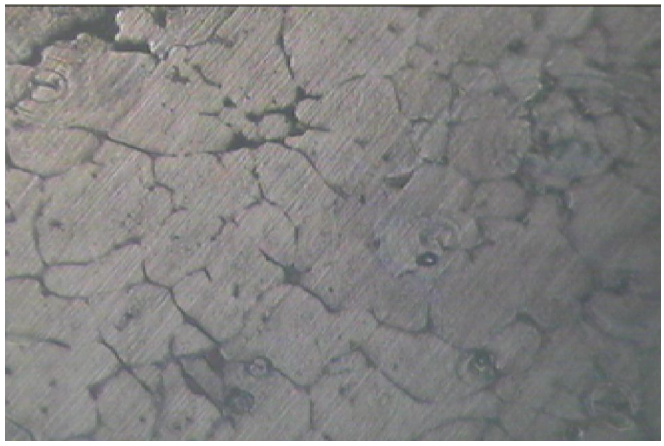


Fig.6.Microstructure of Aluminium

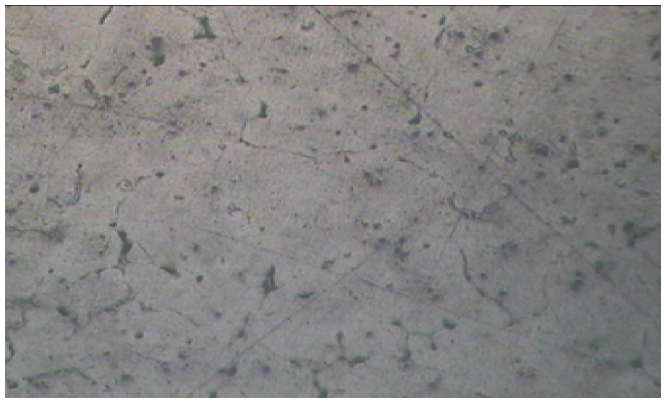


Fig.7.Microstructure of AL7075+6%SIC+1.5%Graphite

Fig.8.Microstructure of AL7075+6%SIC+3%Graphite

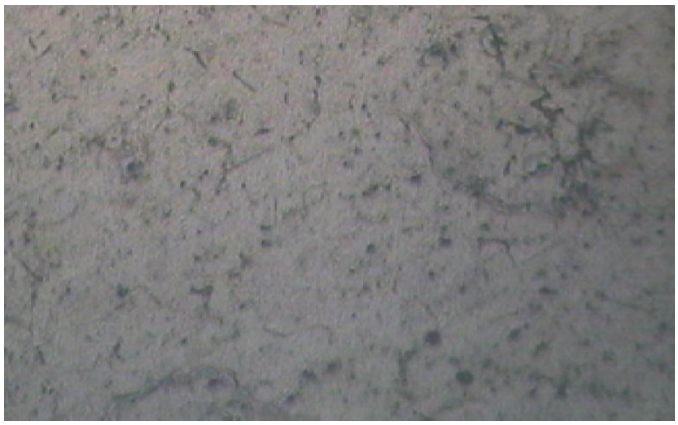


Fig.9.Microstructure of AL7075+6%SIC+4.5%Graphite

IX. CONCLUSION

The following concluding were drawn from the present investigation:

1. The compression strength of MMCs increases from 0.741kN/mm^2 to 1.512KN/ mm^2 with addition of graphite varying from 1.5% to 4.5%.
2. The tensile strength of MMCs increases from 143.5Mpa to141.6Mpa with subsequent addition of graphite varying from 1.5% to 4.5%.
3. Wear test revealed, with decreasing values of 1100 micrometers to 225micrometers with 1.5% to 4.5% variation of graphite.
4. Hardness decreases with the addition of graphite 1.5% to4.5%, the BHN is 108.614 Kgf/mm^2 to 50.56Kgf/mm^2.
5. Density also decreases with increased addition of graphite 2.67g/cm^3 to 2.398g/cm^3.

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