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Effect of Reinforcements SiC-Mg on Mechanical Properties of Al6063

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ABSTRACT

In the current study, SiC reinforced Al alloy matrixes are casted by employing a stir casting method of several used methods for casting of alloys. The tensile, hardness tests are executed to get the elongation, hardness of the cast and the Tensile strength of MMCs'. Micro structural properties of casted product have also been investigated by employing microscopic test. The result of experiment showed that the tensile strength and hardness of the casted composites made have been increased and these further increase with increase in weight percentage of SiC on the weight percentage basis.

Key Words: Stir casting, MMCs, SiC, UTS, Wt. %.

INTRODUCTION

A composite material may be defined as a material made by combination of two or more materials which have generally different properties which when combined produce a material with desired set of properties of forming material properties. For MMCs one material must be a metal. [1] The requirement for the engineering materials with the technical improvement has helped us to a very fast improvement in the field of composite materials. MMCs have an advantage over single material because of improved properties like increased strengths, stiffness, and more resistance to wear, and improved temp functioning with the improved creep and fatigue resistance.[2] In present study, the effect on three diff. ways on structure and property of fly ash reinforced with Al-7 % Si-0.35 % Mg among three method used the stir casting method resulted in good results.[3] Metal matrix composites have increased interest due to their properties in fields of aerospace and auto industries. So in this study experiments have been done with reinforcements (5, 10, 15, 20, 25 %) by wt fraction and best results i.e max hardness 45.5BHN and impact strength of 36N-m have achieved at 25 % reinforcements. These MMCs' are one of best developments that human have ever developed. [4] Among various materials used Al and alloys of Al are widely used in production of MMCs.

The importance has been given on development of various affordable Al-MMCs with various reinforcement like (Sic, Al203, Mica AND Mg) etc because of addition of these improve the properties of Al alloys.[5]From many processes for MMCs production stir casting is an important route for the commercial production of these. Its advantage depends on its simple way to operate and its flexibility. It is also attractive because of its way of operation of the process so minimizes cost of product. It is one of most economical way for MMC production of all methods and allows very large size component to be manufactured. The cost of producing MMCs using cast process is nearly 1/3 of other competitive methods that are used offer production and it may even fall to one tenth of total cost of. In a very simple way, the solidification manufacturing of MMCs involves production of a melt of related material followed by addition of reinforcement by stirring to obtain a suitable dispersion.[6] The interface plays an important role in determining property of MMCs. The metallic coating improved the wet ability of matrixes and hence help informing materials with improved properties.[8] The SiC reinforced LM6 alloy matrix composites are made by green sand moulding process by adding wt fraction base particulates. Tests were conducted and it was observed that the mechanical properties of cast objects by reinforcements are improved very much compared to pure alloy.[9] Various wt of SiC are reinforced with pure Al/The observation by SEM and other tests it is found that properties Al are improved a lot .

EXPERIMENTATION

The Aluminum alloy Al6063 composites are made by reinforcing it with SiC and keeping Mg reinforcement as fixed. The corresponding percentage of Sic by wt percentages are varying from 2 %, 4%, 5%, 7% up to 9% while keeping the values of Mg reinforcement as fix i.e 2% of total wt percentage of the mixture. The chemical composition and thermal physical characteristics of Sic-particulates and Al 6063 are given in table1 & table2. The amalgamated are produced by stir casting method where one metal is in liquid form. The melting process is accomplished by using a Muffle furnace in a range of 860 +- 220Celcius. Pic of that one is shown below in Figure 1.

Fig1: Electric resistance furnace with stirring system for melting of matrix metal i.e. Al6063.

The melt is agitated by the help of an impeller made of either HSS or any hard Carbide material and is driven by an electrical motor, the preheated Sic particles upto 1100c are added while stirring is going on. The metal and reinforcement mixture is allowed to mix up for some type by help of stirrer up to a temperature nearly 780. The melt is then poured into a mould of mild steel at a temperature somewhat less than the working temperature. In the end after making samples of the mould the tests are done on samples to find the properties of composites formed.

Table 1: Chemical constituents of Al6063

Element	Percent
Si	0.441
Cu	0.0043
Mg	0.5364
Fe	0.1645
Mn	0.0132
Ni	0.1
Zn	0.0011
Cr	0.0024
Sb	0.05
Ti	0.0079
Al	Base

Table 2: Thermal and physical properties of SiC, Mg and Al6063

Properties	Sic Particulates	Mg particles	Al 6063
Density(gm/cm3)	3.21	1.738	2.687
Average particle size (mesh)	400	------	----

Thermal conductivity(W/mK)	95-105	150-160	200-210
Specific Heat(J/KgK)	1250-1320	1046.7	930-960

RESULT WITH THE DISCUSSION

Tensile Strength

It is done by working with a universal testing machine (UTM) i.e (UNITEK 94100 manufactured by FIE FUEL INSTRUMENTS & ENGINEERS PVT. LTD, MAHARASTRA) to find out the properties of material like UTS and the elongation and its loading capacity. A rectangular tensile sample with the a guage width of 10 mm and thickness of 6 mm and guage length of 32 mm as per standards specified by A S T M are shown below in pic. 2 used for tensile tests done for the composites. The picture of the tensile tests sets after testing are viewed in picture 3.

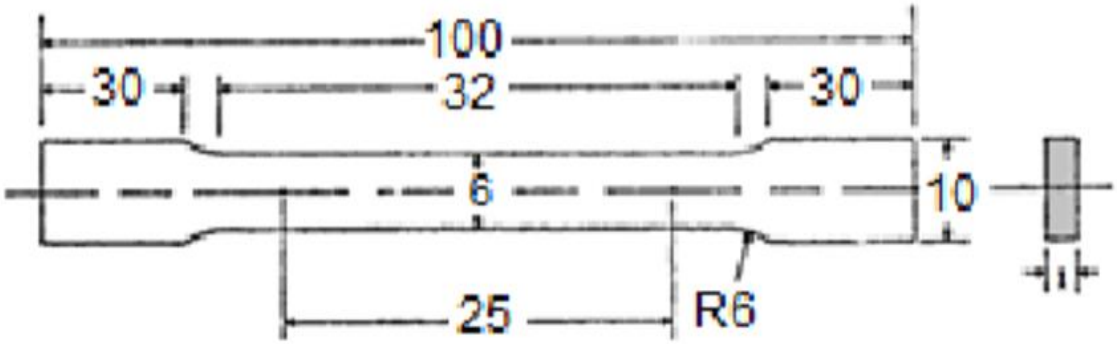


Figure2: Standard tensile test specimen as per ASTM standards.

Figure 3: Tensile test specimen after testing

For every wt portion added SiC particulates, five sets of samples with at each wt percentage were analyzed and all processes are revised for successive sample which have distinct wt portion of SiC particles in Al6063 alloy matrixes.

Figure 4 shows the plots between the avg. Tensile Strength and wt % of reinforcements. While Figure 5 shows the max displacement values versus max loading capacity for various wt fraction of SiC particulates added to Al6063 alloy shown below shows that the above properties improves with increase of wt parts of SiC particles reinforcements in matrixes materials.
Diffusion of stiff ceramics grains in soft ductile matrixes end into the betterment of strength, the enhancement in strength might result into close packing of reinforcements with fine Al matrixes as checked up may also result in hike in strength may also be end up into close packing of reinforcement with fine Al matrixes. Drenching ability is a main governing factor to make surety of better combination between reinforcement. A better bonding between reinforcements and aluminum matrix leads to a improvement of the UTS of the composites.

Table 3: Average tensile strength and Max. Displacement and Max Load value with different wt % of SiC particules

Weight fraction% of Sic	Average Tensile Strength (MPA)	Max Displacement values in mm	Max Load (KN)
2	109	3.270	6.520
4	129	5.720	7.755
5	138	6.680	8.3
7	149	8.250	8.920
9	159	8.810	9.250

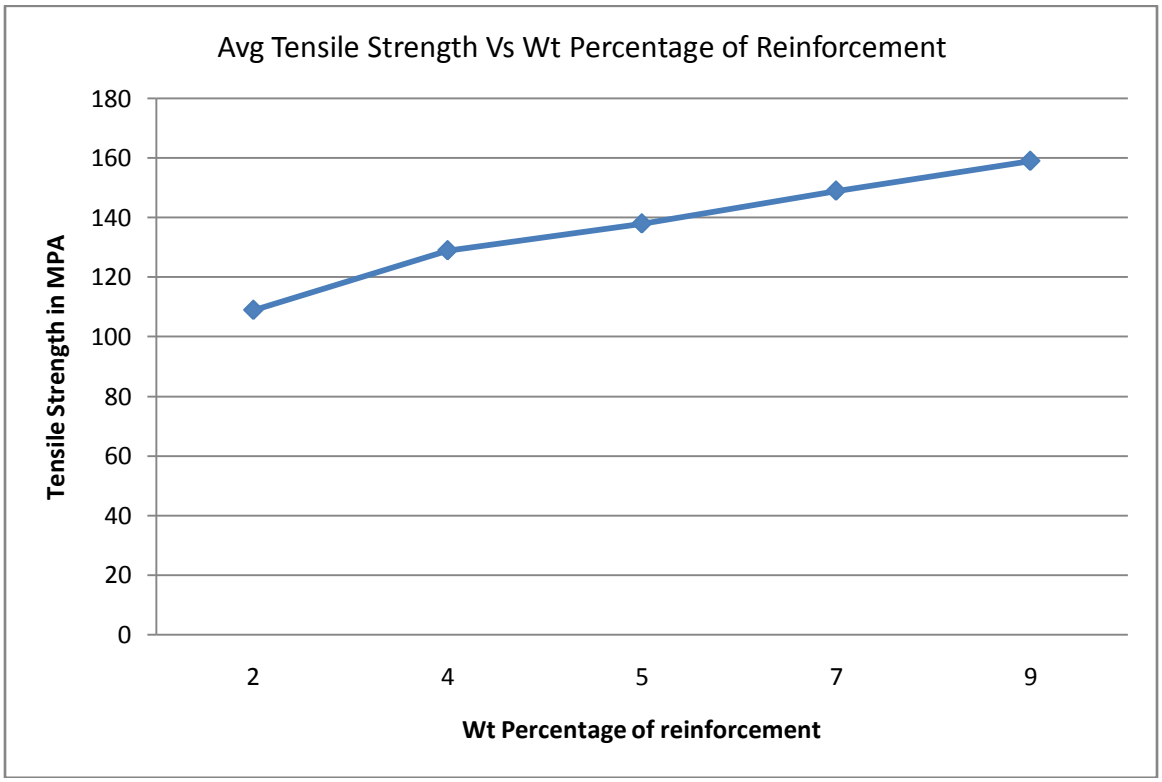


Figure 4: Avg Tensile Strength Vs Wt Percentage of Reinforcement

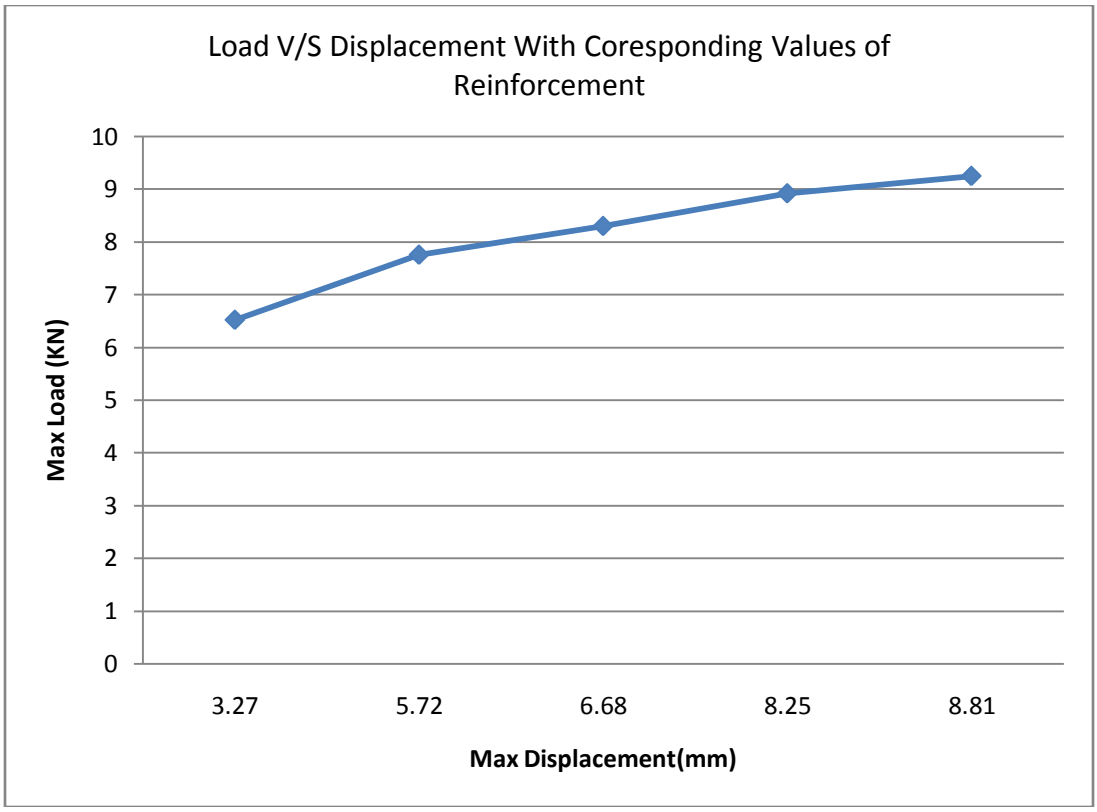


Fig 5: Max Displacement V/S Max Load

HARDNESS

Hardness test is done on each set of sample prepared for doing the hardness test with a load of 100 KN. The type of intender of the tester is of diamond type. Dimension of the effects of intender is measured in the Vickers Hardness tester made by FIE Pvt. Ltd., Maharastra.

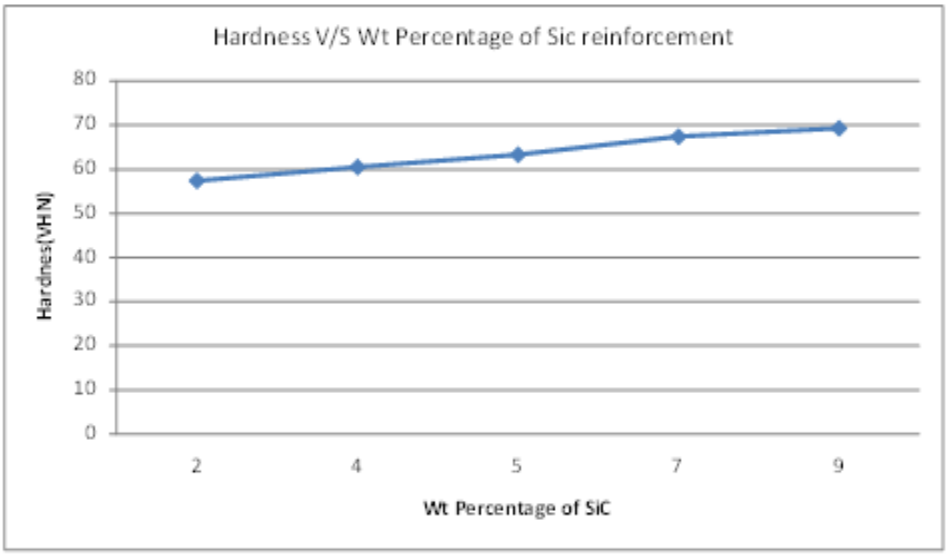


Fig. 6 Hardness V/S Wt fraction of SiC

The respective values of hardness are either given by vicker hardness machine directly or estimated by the formula. The Hardness results of the sets of the SiC particles reinforced with Al6063 formed composites with various wt % are put in Table 4.

Table 4: Hardness results of composites of Al6063-SiC-Mg

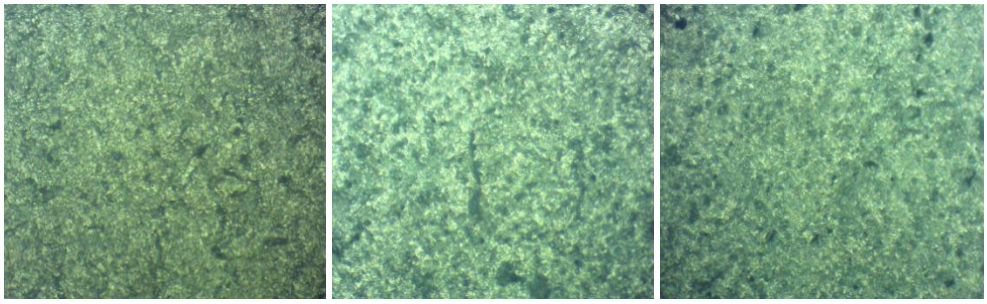
Material	Vickers Hardness
Al6063	53
Al6063 -2 % Wt	57.4
Al6063- 4 % Wt	60.5
AL6063- 5 % Wt	63.3
Al6063-7 %Wt	67.4
Al6063-9 %Wt	69.3

Depending on the hardness test completed above and the information get, we can find out the various hardness values with various wt % reinforcements of SiC- Mg in Al6063 alloys. It is obvious from the table , the values of hardness of reinforced casted samples of Al alloy will the increase with addition of SiC particles in alloy melted before.

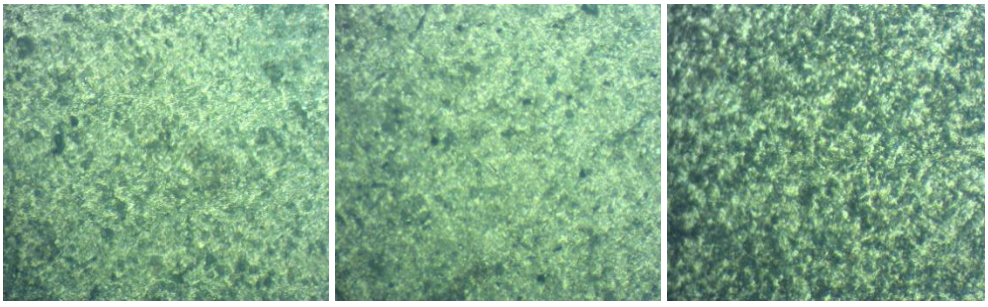
Microstructure Analysis

Sets of samples of microstructure are prepared by first cutting the size required for sample testing of the raw composite formed by using power hexa and hand grinder. Thus prepared samples are then further processed by polishing them with Emry papers of sizes varying from 200,400,600,1000,1200 and at last 1500 µm. Then specimens are etched by the help of an Etchant, Kellers' reagent having a composition of 2.5 ml HNO3, 1.5 ml hydrochloric acid, 1.0 ml hydrogen fluoride, 95.0 ml H20 of the total composition. After etching, the samples are dried by the help of a drier and then microstructure images are taken by the help of a microscope. The micro structure of made composites are below in Figure at various wt fraction of SiC.

Fig 6 tells about the micro structural behavior of cast composites which are structural form of dendrite. Sic-Mg are scattered in the Al6063 matrix in solid solution phase and these are diffused homogenously in matrix of Al as distinct dispersions. The compounds do not solidify at a single point temp but it solidified over a range of temp and its starting point is calles as liquidous and setting point is known as solidus temperature. The processes of dendrite structure generation might be result of the super cooling effect where some preferred areas come out as spokes in super-cooled areas and after beginning once, grow more swiftly then nearby locations. This occurred as the impelling force for solidifying was more for the super cooled areas and the spokes do not absorb the solute at its sides, thus interrupting the solidification on side locations. These straight spokes tries to form the side bays making a dendrite structure.



Specimen 1 Specimen 2 Specimen 3



Specimen 4 Specimen 5 Specimen 6

CONCLUSION

In this experimental study, inclusion of silicon carbide particulate with Mg as reinforcing material inAl6063alloy matrix and forming composites test samples after having the tensile, harness, micro structure testing works the following results are found and these are described as below:

- The end effects of investigation tells us that with addition of wt by portion of Sic particles an improvement in hardness are found out.
- The distinct tensile strength values improved steadily as the SiC amount in the composite increased from 2 percent to 9 percent by wt part in % of mixture.
- The micro structural study displayed that the SiC particles have been unvaryingly scattered through the MMC castings.

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