Effect of varying reinforced particles percentage on aluminum based composite fabricated by stir casting.

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ABSTRACT

Stir casting is a vastly adopted method of fabricating different metal matrix composites. In the present work, an attempt has been made to synthesize aluminum base metal matrix composite using stir casting process. Different volume fraction of SiC particles according to weight fraction (7%,9% and 11%) were added to Al6061 aluminum alloy. Two step mixing method of stir casting techniques has been adopted. Mechanical properties like hardness and ultimate tensile strength of aluminum metal matrix composites at different composition of SiC was checked. The results indicated that SiC particles were distributed uniformly in the aluminum matrix without the formation of clusters. There was no interfacial reaction between the aluminum matrix and the SiC particle. Results shows that micro hardness and ultimate tensile strength increases with the increase in the percentage of SiC into the Al6061/SiC metal matrix composite.

Keywords: Stir Casting,Metal Matrix Composite,hardness,Ultimmate tensile strength

INTRODUCTION

Demand of product qualities and capabilities are continuously increasing with an exceptional rate but regular alloys are running short to meet these needs. Therefore, there is a worldwide interest to further develop and investigate such materials. Examples of matrices in such composites include aluminum, magnesium, and titanium. Metals are mainly reinforced to increase or decrease their properties to suit the needs of design. Aluminum alloys reinforced with various particulates, universally called as aluminum matrix composites (AMCs).Conventional monolithic aluminum alloys fail to meet the rising demand for highperformance in many applications. AMCs have the rightcombination of properties such as higher stiffness, superior strength, improved resistance to wear and low coefficient of thermal expansion, which promote them as a potential alternative material to replace aluminum alloys. A range of Silicon carbide, boride and nitride particles have been used as particulate reinforcements to produce AMCs. The introduction of SiC particles into the aluminum matrix significantly improves the high temperature properties. Stir casting is the most commonly used method for the production of AMCs compared with other methods. . Stir casting is an economical method to produce AMCs and suitable for mass production. It is also simple and

yields near net shape components. Products having many features and irregular contours can be made using stir casting

LITERATURE REVIEW

AkhilRȦ* et al (2014) [1] :- They studied on the metal matrix composites of analuminum silicon based alloy (LM6) with varying percentage (2.5%,5%,7.5% and 10%) of lead oxide glass particles. They found that the tensile strength and hardness of composite increased with increasing the percentage of reinforcement.

Raja T.1 et al (2014) [2]:- They studied for the evaluation of cold compaction behavior and hardness of Al-B4C composites for varying percentage of boron carbide which varied in the range of 5, 10, 15 & 20%. The particle reinforced composite was prepared by a powder metallurgy route with the particle size of Boron carbide as 150 μm. They found that the density of every sample decreases in small variation with increase in boron carbide % while hardness is increases gradually with the increasing boron carbide percentage.

Ramesh B.T (2014) [3]:- He fabricated Al based nano composite using powder metallurgy technique. Varity of nano materials such as carbon nanotube, graphene and nano-diamond as reinforcement for Al based material. He found that the density values of AL+CNT+GR composition are less compared to the density values of AL+CNT+GR+ND composition. The hardness values are high for AL+CNT+GR+ND composition than the AL+CNT+GR composition. The wear resistance increases with the amount of reinforcements. The value of compression strength was decreases with increasing % of reinforcements.

Suryanarayanan K.1 et al (2013)[4] -They studied on "Silicon Carbide Reinforced Aluminum Metal Matrix Composites. One of the main reasons for its consideration was the material**'s** low density and its good wear (and corrosion) resistance.

Alaneme a et al (2013) [5]:-They investigated a high performance Al matrixhybrid composites with the use of bamboo leaf ash (an agro waste ash) and silicon carbide as complementing reinforcements. Silicon carbide (SiC) particulates added with 0, 2, 3, and 4 wt% bamboo leaf ash (BLA) were utilized to prepare 10 wt% of the reinforcing phase with Al**-**Mg**-**Si alloy as matrix using two**-**step stir casting method. In their study they found that the hardness, ultimate tensile strength, and percent elongation of the hybrid composites decreased with increase in BLA content.

Madeva Nagaral1 et al. (2013) [6]:- They studied on mechanical behavior of aluminum 6061 alloy reinforced with al2o3 & graphite particulate hybrid metal matrix composites. They used stir method by three step addition of reinforcement combined withpreheating of particulates to fabricated metal matrix composites. They observed that tensile strength of prepared composites is higher in case of composites, when compared to cast Al6061. Addition of 6wt% Al2O3 increases the tensile strength considerably with respect to base matrix Al6061. Hardness of the prepared composites is higher than

the base AL6061 alloy. Addition of 6wt% Al2O3 increases hardness considerably, whereas the addition of Gr particulates decreases the hardness, but is higher than the Al6061 alloy.

Mahendra Boopathi et al. (2013) [7]:- They studied on evaluation of mechanical properties of aluminum alloy 2024 reinforced with silicon carbide and fly ash hybrid metal matrix composites developed by stir casting. They focused on the formation of aluminum-Sic-fly ash hybrid metal matrix composites. His study was aimed at evaluating the physical properties of Aluminium 2024 in the presence of silicon carbide, fly ash and its combinations. They observed that density of the composites decreased by increasing the content of the reinforcement. Hence, it was found that, instead of Al-SiC and Al-fly ash composites, Al-SiC-fly ash composites show better performance.

B. M. Viswanatha1, et al. (2013) [8]:- They studied microstructure and mechanical properties of Aluminum Matrix Composites (AMCs) reinforced with silicon carbide (SiCp) and graphite (Gr) particles. They used A356 alloy as the matrix material and SiC/Gr as reinforcement with varying percentage of SiC (0-9) weight percent and fixed quantity of 3 weight percent of graphite. They fabricated A356 hybrid composites by liquid metallurgy route with uniform dispersion of SiCp and Gr particles. They observed that the hardness of composites increased significantly with addition of SiCp, while maximum hardness was obtained for 9% of SiCp. The addition of low weight percentage of SiCp to A356 leads to increase in tensile strength and decrease in percentage elongation.

Jameel Habeeb Ghazi (2013) [9]:- He studied on production and properties of silicon carbide particles reinforced aluminium alloy composites. He fabricated the Al–Si / SiC composites containing three different volume fractions 7, 14 and 21 weight percentage of sic by stir casting technique. He observed the results from his research are given as Mg addition to matrix alloy before SiC addition improved wettability &facilitated homogeneous distribution. The hardness, ultimate tensile strength and yield strength of composite found increasing with increased reinforcements in the composites.

D. Sujan et al (2012)[10]:- They studied on the performance of stir cast Al2O3 SiCreinforced metal matrix composite materials. They found that the proposed composite materials exhibit coefficients of thermal expansion as low as 4.6 _10-6/°C. The composite materials achieve significant improvement in hardness and tensile strength compared to Al 356 alloy.

C.Neelima Devi et al (2012) [11]:- They studied on micro structural aspects ofaluminium silicon carbide metal matrix composite. It was found that micro structural variations of aluminium and silicon carbide grains are obtained due to density of sic particles decrease inspite of an increase in concentration. The micro structural behavior of aluminium with silicon carbide (grit size 60) has been studied by varying mass fractions of 5%, 10%, 15%, and 20%.

R. S. Rena et al (2012) [12]:- They studied on review of recent studies in Al matrixcomposite. Their review told the views, theoretical and experimental results obtained, these are they conducted

experiments on the Al6061-SiC and Al7075-Al2O3 to determine the density by weight to volume ratio and by rule of mixture. It was found that the density of the composites increases with the Addition of the hard ceramic reinforcement into the matrix material. The fracture toughness of the composite decreases with increase in the reinforcement content and size. Ductility is one of the important aspects in the mechanical properties of composites. The tensile elongation decreases rapidly with the addition of reinforcing particles and with increased aging time in the heat treatable alloys.

Rajesh Purohit et al (2012) [13]:- They studied on fabrication of Al-SiCp composites through powder metallurgy process and testing of properties. They found that the density, porosity, hardness, compressive strength and indirect tensile strength of Al-SiCp composites were found to increase with increase in the wt. % of SiCp from 5 to 30 weight percent. Mechanical alloying of powders result in improvement in hardness, compressive strength andindirect tensile strength of Al-SiCp composites with 5 to 30 weight percent of SiC particulates.

Siham Hussain Ibrahem Al-Bayati (2012) [14]:- He studied the effect of SiC additionas reinforcement to 6061,T6 alloy. Al 6061 T6 alloy SiC composites were prepared by melting the alloy in a vortex and adding 4 % and 10% weight fractions of SiC. It was found that the addition of silicon carbide as a reinforcement to the alloy contributed increasing in hardness for all addition percentage of SiC and improves the wear resistance. Increasing the SiC weight fraction has led to increasing the hardness and decreasing the wear rate.

T. Rostamzadeh1 et al (2010) [15]:- They studied on microstructure of al-5%sic nano composite powders. They performed X-ray diffraction (XRD), X-ray mapping, and scanning electron microscopy (SEM) analyses. They found that with increasing milling time, the lattice strain increases and the average size of the aluminum phase crystallites decreases. By using X-ray mapping and TEM analyses they found that the SiC nano particles are appropriately distributed in the metal matrix.

Neelima Devi. C et al (2011) [16]:- They studied on mechanical characterization of aluminium silicon carbide composite. They found that the weight to strength ratio for

Aluminum silicon carbide is about three times that of mild steel during tensile test. The maximum tensile strength has been obtained at 15% SiC ratio. This indicates that the Aluminium silicon carbide composite material is having less weight and more strength; it is very much useful in practical aerospace applications.

PROBLEM FORMULATION

Literature depicts that a considerable amount of work has been carried out by previous investigators to improve the mechanical properties of Al6063-SiC composite. The objective of developing metal matrix composite material is to combine the desirable properties of metal and ceramics. In the present study a modest attempt has been made to develop aluminum based silicon carbide

particulates MMCs with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material.

Objectives of the study

The main objectives to accomplishing of this project are:-

1) To make silicon carbide particle reinforced aluminum based metal matrix composite specimen using stir casting method.
2) To study the effect of weight percentages of silicon carbide (7%, 9% and 11%) on tensile strength of aluminum metal matrix composite.
3) To study hardness of aluminum metal matrix composites at different composition of SiC.

EXPERIMENTAL PROCEDURE:

Here stir casting was utilized for composite preparation. In order to achieve high level of mechanical properties in the composite, a good interfacial bonding (wetting) between the dispersed phase and the liquid matrix has to be obtained. The required amount of aluminium was put in the crucible so that it could be melted in the coal furnace. The aluminum alloy is melted completely in an electrical furnace attached with an impeller or a stirrer. The furnace is usually provided with an inert gas atmosphere to avoid contamination. The stirrer is switched on and the aluminum melt is stirred to form a vortex. The ceramic particles are fed at a constant rate at the periphery of the vortex. The ceramic particles mix with the molten aluminum to form an aluminum composite melt. After sufficient amount of stirring, the aluminum composite melt is poured into a mould for solidification. In the present investigation, Al-Si alloy was chosen as the base matrix since its properties can be tailored through heat treatment process. The reinforcement was SiC, average size of 350 to 400 microns, and there are sufficient literatures elucidating the improvement in wear properties through the addition of SiC.. In this casting process a metal pattern is made in the shape of the desired part such that cylindrical.The molten metal was then poured into apermanent mould of diameter 26 mm and length 300mm. the die was released after two minutes and the cast specimen were taken out.

After cleaning, grinding the specimen diameters up to a minimum limit of 10mm each per as the diameter of the pin holder of pin on disc apparatus. Therefore both of these castings are machined in CNC milling center as shown in fig1.

Fig.1: **Specimen on Lathe machine**

Sample preparation

Tensile specimens were prepared as per the ASTM specification. Tensile tests were carried with a **25kN,** electro mechanical controlled universal testing machine. Round

samples of **7cm** length were made as per ASTM standard and width of central portion was **6mm** where as the portion which was used for gapping is **7cm** width. Brinell hardness test is achieved by applying a known load to the surface of the tested material through a hardened steel ball of known diameter. The diameter of the resulting permanent impression in the tested metal is measured and the Brinell hardness number is calculated as

$$BHN = 2P / (\pi D (D - (D^2 - d^2)^{1/2}))$$

BHN = Brinell hardness number

P = load on the indenting tool (kg)

D = diameter of steel ball (mm)

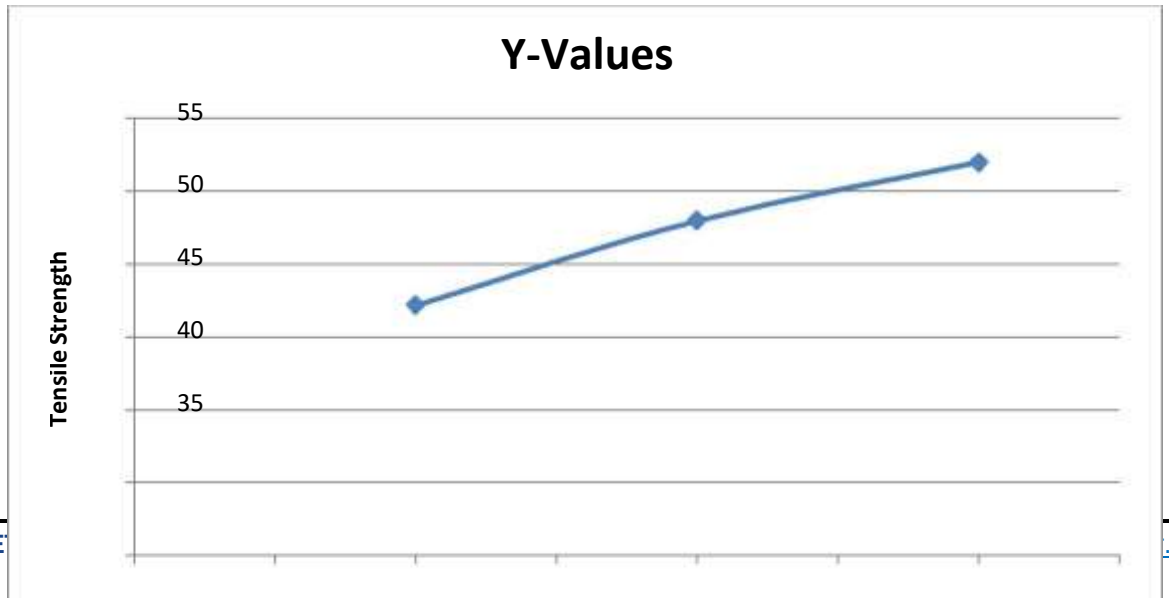
d = measure diameter at the rim of the impression (mm)

RESULTS AND DISCUSSION

Observations:-

Table 1 Observation table

S. No.	Material of test piece	Gauge diameter of test specimen	Cross sectional area(Mm	Ultimate load (N)	Ultimate Tensile Strength(MPa)	Hardness (BHN)
1	Al6061/Sic 7% SiC	10.22	81.99	3460	42.2	48
2	Al6061/SiC 9%	9.88	76.63	3680	48	51
3	Al6061/Sic 11% SiC	10.1	80.11	4165	52	60



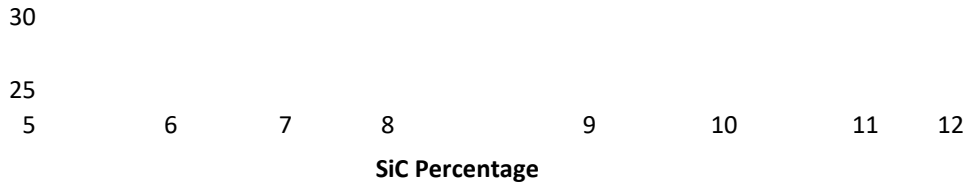


Fig:- Graph Shows ultimate tensile strength with silicon

From the graph we found that value of ultimate tensile strength increases with increase in SiC Percentage. All the values of ultimate tensile strength was observed minutely and it was observed that after more addition of nano particles value of UTS increases rapidly.

Results of hardness test

Table: - 5.2 Shows the value of Hardness with silicon percentage

S. no.	SiC percentage	Hardness
1	7	48
2	9	51
3	11	60

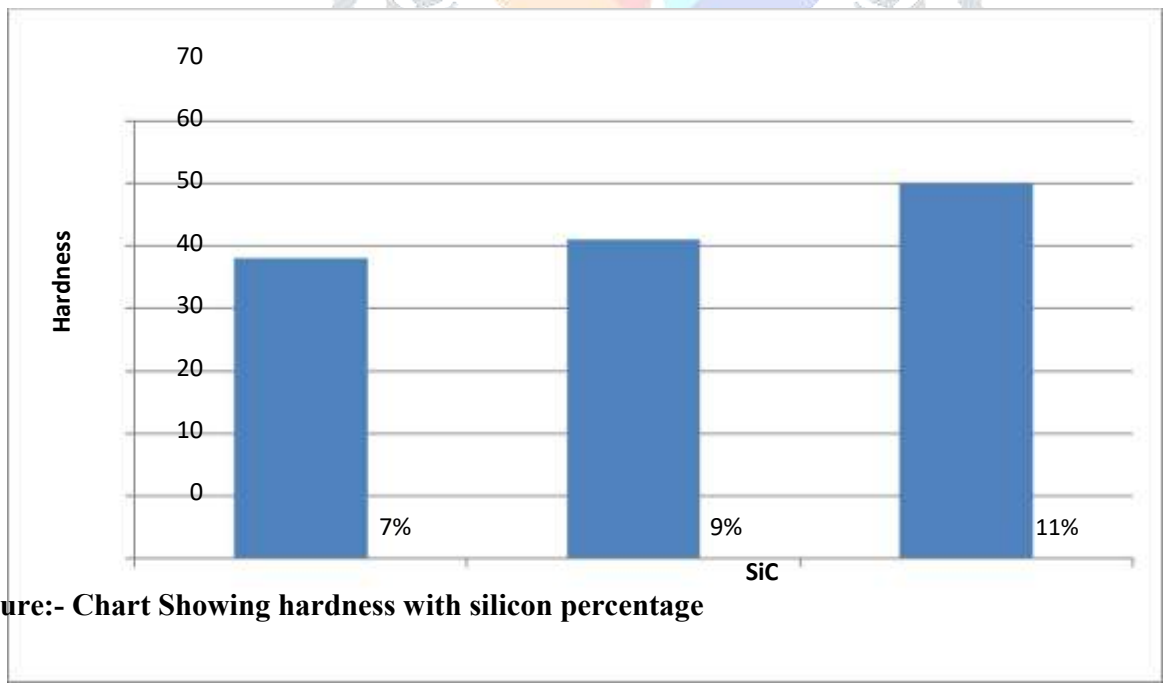


Figure:- Chart Showing hardness with silicon percentage

It has been observed that as the weight fraction of the reinforced particles increases hardness of the fabricated composite increase. Initially the hardness value increases slightly but after certain level it reaches to higher value as compared to previous pattern.

CONCLUSION

Important Conclusion

1. Casting of Al6061/SiC metal matrix composite can be done by stir casting.
2. Micro hardness increases with the increase in the percentage of SiC into the Al6061/SiC metal matrix composite.
3. Ultimate tensile strength increases with the increase in the percentage of SiC into the Al6061/SiC metal matrix composite.

The present work is the first attempt to find out mechanical properties of Al6061/SiC metal matrix composite casted by stir casting process. Based on the experience during the experimental work, the following suggestions are made to curry forward this research:

1. Stirrer design plays a crucial role in the vortex formation and overall soundness of casting, therefore different stirrer designs can be used for casting.
2. Few more concentration we must use in future which helps us in finding more accurate results.

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