International Journal of Enhanced Research in Management & Computer Applications
ISSN: 2319-7471, Vol. 6 Issue 10, October-2017, Impact Factor: 3.578

Study on Mechanical Properties of Al 6061 and SiC

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ABSTRACT

Present time is the era of cut throat compition in every field. This causes many new inventions and modifications in the present techniques. In these techniques there is an involvement of composite materials also. If we see the recent applications at a glance, then we will see that there is major place of aluminium alloy based composites. Pure aluminium alloy has the properties likely light in weight, easily extrudable good, tensile strength, corrosion resistance, etc. ; but if we want to make a such type of material which will be light in weight but good at strength,resistance to wear, and somewhere tough, then aluminium based composites will be the better option for it. There is an identifyable number of composite materials in the total materials available at present in the world. In this experiment based study there is shown that how the properties of aluminium alloy are changed with mixing of some reinforcement material. Aluminium 6061 alloy and silicon carbide are used for this study. 400 mesh silicon carbide powder with varying percentages (2, 4, 6, 8) is used as reinforcement material. The process used for making composite (Metal Matrix Composite) is stir casting method. Various testing are also employed to see the various changes in the base alloy properties after reinforcing of silicon carbide powder in it e.g. tensile testing, microstructure testing.

Keywords: Al6061, SiC, 400 mesh, AMCs, stir casting, muffle furnace, tensile strength,microstructure test.

I. INTRODUCTION

Composites have good mechanical properties such as strength, hardness, anti-abrasion, light weighted, anti-corrosion and other properties which are used to make various parts such as automobiles parts (i.e. piston, floor ,axle, casing, brake shoes and wheels.),aeroplane parts, parts used in marines, electricity polls and several components of the desired properties. The metal material matrix made by aluminium alloy base are widely used. In this study when we will discuss about matrix phase this should be refered to aluminium alloy 6061, whereas the reinforcement should be refered to 400 mesh silicon carbide powder. In present study there will be concentration on the proper mixing of silicon carbide in aluminium alloy. Different casting are made for different weight percentage of SiCpowder . However, the weight percentages of SiC powder are kept 2, 4, 6, and 8 for different MMCCs (Metal Matrix Composite Castings).SiC is preheated in a small graphite coated crucible and Al 6061 was heated upto its semi-solid state in another crucible(no.3).Specimens of different compositions ar made for tensile testing, and microstructure testing. Afterthat results and readings are used for a comparative analysis. In the last of this research paper future scopes are discussed.

II. PROCEDURE

In this section of paper experimental procedure is discussed. Such as how MMCs are prepared and about stir casting method. Experimental procedure is discussed below:

a) MMCs preparation

There are various methods of preparation of metal material matrix (MMCs) are in use but most common in trend is stir casting process. Before specimen making all the work carried out may be called as MMC making procedure.

b) AA 6061

AA 6061 in this study referred as matrix material . AA 6061 contains silicon (Si) and magnesium (Mg). It is from the aluminium alloy family with 6XXX designation. For extrusion purpose this alloy is used more.It has good mechanical properties. This is easily heat treatable and weldable. The various composition of this alloy are shown in the table 1 below.

Table 1:Compositions of AA 6061.

Al	96.0 %
Si	0.8 %
Mg	1.2 %
Fe	0.7 %
Cu	0.4 %
Mn	0.15 %
Cr	0.35 %
Ti	0.15 %
Zn	0.25 %

c) Reinforcement (SiC)

Silicon carbide is a compound made of carbon and silicon. This is obvious that carbon presence made it very hard and it has a melting temperature above then 2700°C. In this study it referred to reinforcing element. Properties of silicon carbide are shown in the table 2 below.

Table 2: Various properties of SiC.

Compressive Strength (MPa)	**3900**
Modulus of Elasticity (GPa)	**410**
Hardness (kgf/mm²)	**2800**
Density (gm/cc)	**3.1**

d) Stir Casting Process

Stir casting is from one of the mostly used techniques for making AMMCs. The function of the stirrer in this process is to mix the reinforcing phase (SiC) into the matrix phase (AA 6061). In this process, reinforcing phases (ceramic particles, short fibers) introduce by mean of mechanical stirring into molten metal. In this method of casting, first we heat the AA 6061 upto it become semi solid and preheat the SiC, then the preheated reinforcing material is mixed in the aluminium alloy by stirrer. Stirrer is rotated in the mixture for 5 minutes. Then this mixture is poured out in a casting mould. In the following figure 1 there are some photos of the some equipments. In the pic.1 there is astirrer setup mountedon the muffle furnaceand in pic.2 there is a mould in which casting is to be done.

Pic. 1 Stirrer setup on muffle furnace.

Pic. 2 Mould for casting.

Figure 1: Various equipments used in stir casting.

III. TESTING AND METHODOLOGY

Strips of AA 6061 are cut in small pieces and thereafter weighed according to SiC percentage. In one crucible AA 6061 is taken for heating upto its semi solid state and in another crucible SiC powder is taken for preheating purpose.Then in the muffle furnace crucibles are placed and when the temperature reaches at the temperature of semi solid state temperature of AA 6061.When the alloy material become mushy then the preheated reinforcing material is mixed in it with the stirrer driven by a electric motor with speed regulator. After 5 to 6 minutes the stirrer is rotates in the mixture. Then again the temperature of the muffle furnace isincreased uptomeltingtemperature of the aluminium alloy and in last the mixture is poured in the mould for casting.After solidification MMC is ready for further operations such as tensile and microstructure testing specimens making and testing on machines. After it various testings are carried out and the final results are taken.

a) Tensile testing

Tensile or tension tests are performed on a U.T.M manufactured by Fuel Instruments & Engineers Pvt. Ltd, Yadrav 416145, Maharashtra, India and model name is UNITEK 94100 with a maximum capacity of 100 KN.For the tensile or tension test specimens are made according to ASTM standards. The tensile specimen isshown in the following fig.2

Fig. 2 (a)Specimen for tension testing. **Fig. 2 (b) U.T.M for tensile test.**

b) Microstructure testing

For microstructure testing, specimens should be made such that there should be mirror like finishing. Finishing of specimens is obtained by rubbing emery papers of different gradingand velvet clothfitted on a rotating type polishing machine and then this surface is washed by an etching agent solution (1 gm NaOH in 100 ml of water).The microstructures of the specimens are captured and seen that the mixing is proper or not. The testing was done on the MICROSTRUCTURE TESTER with PCmanufactured by DEWINTER TECHNOLOGIES OF ITALY. Microstructure test specimen and machine are shown in the fig. 3 below.

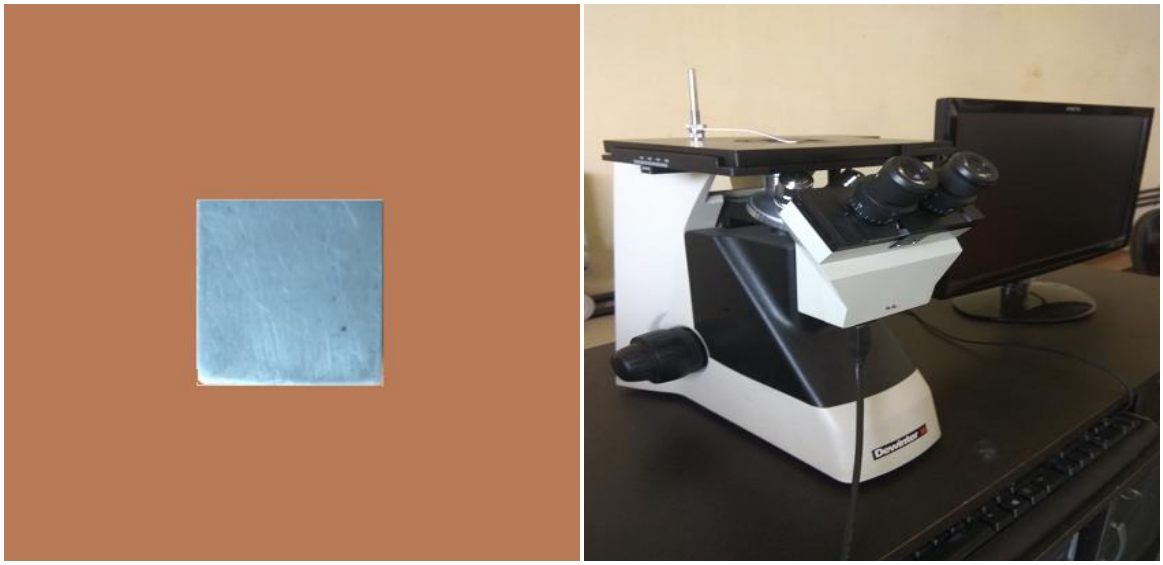

Fig. 3 (a) Microstructure specimen. **Fig. 3 (b) Microstructure testing machine.**

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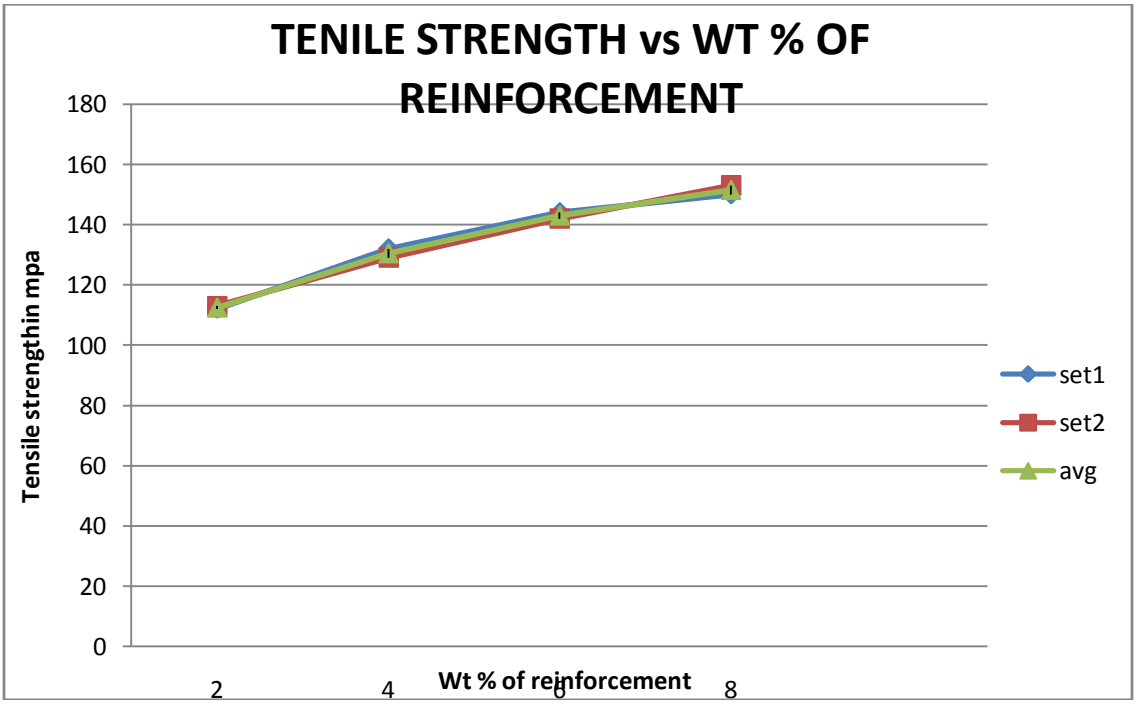
IV. RESULTS AND DISCUSSION

Results of various testing done on specimens having AA 6061 and SiC by Wt(%) are discussed below:



Graph: Tensile v/s reinforcement.

Table 4:Tesile strength v/s Wt percentage of reinforcements

S.NO.	Wt percentage	Tensile strength in MPa (Set1)	Tensile Strength in MPa (Set2)	Tensile strength in MPa (average)
1	2	112	113	112.5
2	4	132	129	130.5
3	6	144	142	143
4	8	150	153	151.5

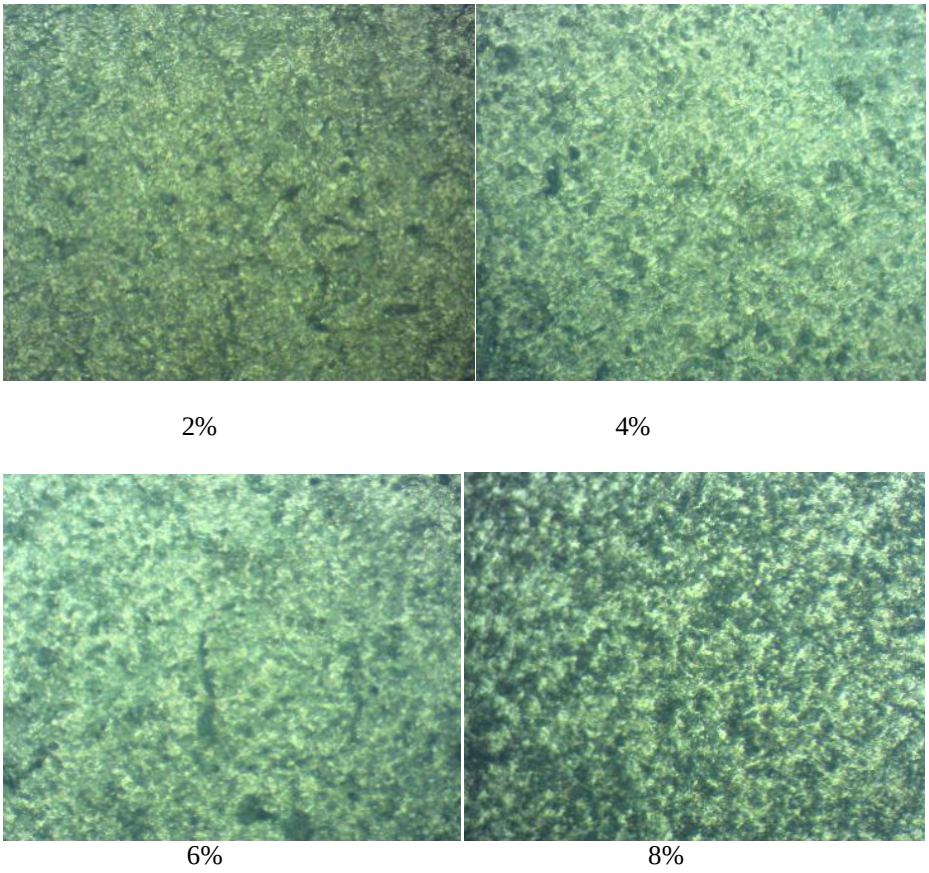


Fig.-4 Images of microstructure test of specimens.

CONCLUSIONS

The very main conclusions of the present study are as follows:

- The main focus was given on the proper mixing of the SiC into the matrix material AA 6061.
- Method choosed for making composite was moderate stir casting process.
- A good amount of time was given to modify the procedure in this study.
- The percentage of SiCaffects the tensile strength of the composite; because the increase in SiC will increase the tensile strength of the AMMCs.
- By increasing SiC in the AMMCs, the hardness of the AMMCs is also increased; however the grain size matters.
- However, elongation(%) resulting in the decreasing level with increasing the SiC particulates.

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