Tensile Property Evaluation of Aluminium Alloy (AA6061) Reinforced With Silicon Carbide

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Abstract- **The composite materials, offers a solution to the challenging problem of developing, materials with high performance capability. Due to the lightness of aluminium, its alloys find a wide range of applications. Silicon carbide (SiC) is known for its hardness and high degree of chemical inertness. In this experimentation, An Aluminium metal matrix composite (AMC) consisting of aluminium alloy (AA6061), reinforced with SiC is considered for evaluation. In the experimentation, AMC specimens were cast by Stir cast method, for different size and percentage of reinforcing material. Standard size tensile test specimens were prepared and tensile strength evaluated using Tensometer.**

Keywords: Challenging, High performance, Chemical inertness, AMC, Tensile strength.

I. INTRODUCTION

With the increasing demands for superior light weight materials, in areas such as aircrafts, space shuttles, deep sea submarines, hypersonic space planes etc, there is a need to develop materials with high performance capabilities. The composites approach offers a systems solution to this challenging problem. The recent advancement in the field of material sciences led to the development of species of materials known as composites [1]. Composites are materials made from two or more constituent materials with significantly different physical or chemical properties, that when combined, produce a material with characteristics different from the individual components. The composites created with metal or a metal alloy as the base, are known as metal matrix composites (MMCs) [2]. The aluminium alloy(AA6061) has proved its usefulness in various fields ranging from aircraft construction to common household equipments such as ladders and window frames. Silicon carbide (SiC) is a potential material for structural applications at high temperatures. Also, it has good hardness and high degree of chemical inertness [3,4]. This experimentation aims at materializing a MMC by reinforcing AA6061 alloy with silicon carbide and studying its tensile strength. The reinforcement is done using stir casting technique.

A.Methodology

An electric furnace with stirring mechanism, shown in Fig 1, is used for melting the base metal and uniformly distributing the reinforcement material [5]. An electric furnace is used to melt the base metal and the crucible with molten Al alloy is shown in Fig 2. After the addition of requisite SiC powder, stirring was done using motorized stirrer, as shown in Fig 3.

Pouring the molten metal in to Die is shown in Fig 4. Standard size tensile test specimens [6] were machined as shown in Fig 5. An "as cast" specimen was also obtained for strength comparison. Tensometer used is shown in Fig 6 and some of the specimens after fracture, are shown in Fig 7.


Fig 1-Stir casting set up

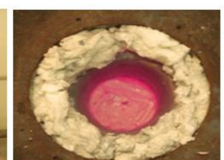
Fig 2-Molten aluminium alloy


Fig 3-Stirring by motorized stirrer


Fig 4 Pouring the molten AMC in to Die


Fig 5-Tensometer


Fig 6-Machined tensile specimen


Fig 7-Fractured tensile specimen

B.Experiment

Procedure followed in stir casting and subsequent evaluation of tensile strength is as follows[5,6].

- The AA6061 alloy is weighed for the required quantity and melted to $750^{\circ}C$, inside the electric furnace using ceramic crucible. The furnace was totally closed by ceramic wool in order to avoid escape of heat from the furnace.
- The reinforcement particles were weighed as per the experiment's requirement and preheated to 600ºC in a separate electric furnace.

- The permanent moulds were cleaned properly and coated with chalk powder and preheated to remove the moisture.
- Degassing tablet (hexachloroethane) was added. All the entrapped gases and inclusions, if any, form slag and floats at the top of the melt. This slag was removed carefully
- Matrix was kept in the furnace for around four hours and then the AA6061 alloy was ready for stir casting. The silica wool from the main furnace was removed and stirrer setup was brought into its position to stir the melt. 450 RPM was set as the stirrer speed using the speed regulator.
- The stirrer motor was powered on and as the stirrer rotated, the preheated reinforcement material was carefully added. Due to the stirring speed, vortex was formed and it allowed the reinforcement to mix properly throughout the melt. The melt was continuously stirred for 10 minutes and poured into the pre heated finger mould.
- The mould was kept for atmospheric cooling and the Aluminium metal matrix composite, cast specimens were removed from the moulds.
- Specimens were separated from the casting and machined as per the dimensions of standard tensile test specimen to be tested on tensometer.
- Casting is obtained and specimens were prepared for varying weight percentages (5%, 10%, and 15%) and particle size (200 mesh, 320 mesh and 400 mesh) of SiC. A specimen was also cast and machined, corresponding to basic metal without reinforcement and is called "as cast" specimen.
- Each specimen is mounted on the "Tensometer" and tensile properties like fracture stress, ultimate stress etc were recorded.

C. *Results and discussions*

Table 1, shows the true ultimate tensile stress (True UTS) value for each specimen. Also % improvement in strength as compared to "as cast" specimen is tabulated.

MATERIAL	% WT	TRUE UTS (MPa)	% Improvement
AS CAST	--	129.7	--
400 MESH	5	149.4	15.19%
	10	160.8	23.98%
	15	162.5	25.29%
320 MESH	5	140.8	8.56%
	10	166.6	28.45%
	15	152.4	17.5%
200 MESH	5	119.6	--
	10	131.3	1.23%
	15	138	6.4%

The improvement for 5% reinforcement of 200 mesh is negative and for 10% reinforcement of 320 mesh is very large. This may be attributed to the larger size of the particle and to the possibility of non-uniform distribution of reinforcement material accompanied by the presence of casting defects. The percentage of improvement is seen to steadily improve with the increasing reinforcement and is also maximum for 400 mesh.

Fig 1 gives the graph of, True UTS in MPa with respect to "as cast" and different weight percentage of reinforcement material.

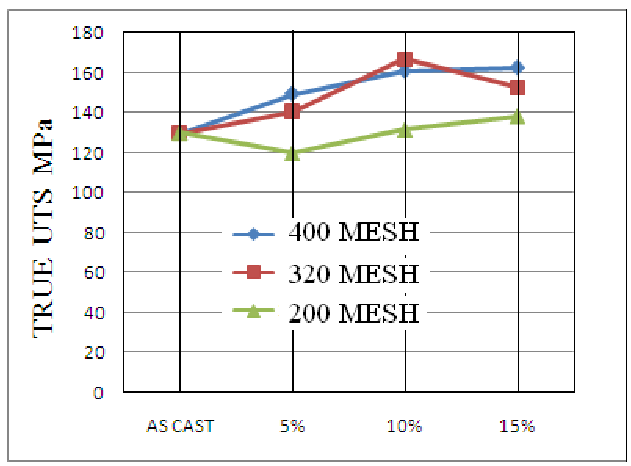

Fig 8-True UTS v/s % SiC

For 400 mesh, the tensile strength is seen to increase with the increase in the weight percentages of the SiC reinforcement. This may be attributed to the uniform distribution of the reinforcement particles into the metal alloy matrix at lesser particle size. However, A dip in true stress value, occurred for 320 mesh of 15% and for 200 mesh of 5 % reinforcement, which might be due to defects in the casting or thermal stressing which probably occurred during machining. Also improvement in tensile stress is more for 400 mesh compared to 320 and 200 mesh. This can be attributed to the larger particle size of the reinforcement and to the possibility of a non-uniform distribution of the reinforcement in the matrix.

II. CONCLUSIONS

The tensile strength of the materials shows a steady increase with the increasing weight percentage of reinforcements for a particular particle size of silicon carbide. The maximum improvement of true ultimate tensile strength (UTS) corresponds to mesh size of 400. Lesser particle size, gives uniform distribution of the reinforcement in the matrix.

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