Evaluation of Tensile Properties of Al-Zn (7075) Based Hybrid Composite

Girisha H N Vamana R N D P Girish
Department of Mechanical Engineering
Government Engineering College
Ramanagar, INDIA

***Abstract*— In this present investigation efforts are made to study the tensile properties of as cast Mica particulates and Short E-glass fibers reinforced AA7075 Hybrid composites containing mica particulate of 200 microns and short E-Glass fibers of 2-3 mm length in different compositions. The vortex method of stir casting was employed, in which the reinforcements were introduced into the vortex created by the molten metal by means of mechanical stirrer. Castings were machined to the ASTM standards on a highly sophisticated lathe. The degree of improvement of tensile properties of MMCs is strongly dependent on the kind of reinforcement. An improved tensile property occurs on reinforced compared to Unreinforced MMCs alloys.**

Keywords—Hybrid Composites, Mechanical Properties, Aluminium 7075, Mica, E-Glass, Tensile.

I. INTRODUCTION

Aluminum-based Metal Matrix Composites (MMCs) have received increasing attention in recent decades as engineering materials. The introduction of a ceramic material into a metal matrix produces a composite material that results in an attractive combination of physical and mechanical properties, which cannot be obtained with monolithic alloys. This is an increasing need for knowledge about the processing techniques and mechanical behavior of particulate MMCs in view of their rising production volumes and their wider commercial applications [1]. Interest in particulate-reinforced MMCs is mainly due to easy availability of particles and economic processing technique, adopted for producing the particulate-reinforced MMCs.

A literature survey reveals that only a few materials namely SiC, Mica, Graphite and alumina are being used widely to reinforce metal alloys, while materials such as zircon, mica and E-Glass are being used sparingly[2,3]. Although significant research has been devoted to the development and application of new MMCs, there is still very little information about the basic mechanisms responsible for their properties. Much of the literature on the ageing of composite matrices is based on those that are powder metallurgy processed. Although precipitation in cast alloys is slower than power metallurgy processed materials[4,5]. Cast Mica Aluminum alloy-based particulate-reinforced composites have a large potential for a number of engineering applications, interest in reinforcing Al alloy matrices with ceramic particles is mainly due to the low density, low coefficient of thermal expansion and high strength of the resulting ceramics and also due to their wide availability[6-8]. Particulate-reinforced composites are more isotropic and modest improvements in properties are obtained and can be processed conventionally [9]. An accelerated ageing response in ceramic reinforced aluminum alloy composites has been acknowledged for several years. This mechanism can be due to increased dislocation density in the vicinity of the ceramic reinforcement. This is due to a difference in coefficient of thermal expansion between the ceramic particles and the matrix. The higher dislocation density can both and the diffusion of solute atom and serve as nucleation sites, thereby leading to a more rapid precipitation process [10, 11]. Excess vacancy concentration introduced by quenching from the solution temperature plays an important role in decomposition of supersaturated solid solution. The weight fraction of E-Glass fibers of 1, 3 &5 wt. % and Mica particulates 2, 4 and 6 wt % were used for making MMCs.

II. EXPERIMENTAL PROCEDURE

A. *Material selection*

A1 (7075) alloy, which excellent casting properties and reasonable strength was used as the basic alloy. This is a popular aluminum alloy with good strength and is suitable for the mass production of lightweight metal castings, the chemical composition of the Al (7075) alloy is given in Table - I. Mica particulate of 200 micron was selected as a particulate reinforcement. E-Glass fiber of 2-3 mm length also considered as a fiber reinforcing material. The chemical composition of the E-glass fiber and mica particulate is given in Table-II and Table-III.

B. *Preparation of the Composites*

The aluminium-7075 alloy with the chemical composition as given in the table-I was used as the base alloy. The mica particulate of size 200 micron and E-glass fibers with 2-3 mm length were used as the reinforcements. The vortex method (stir casting) was used to fabricate the hybrid composites. The composites with different compositions of reinforcements like 2% mica particulate with varied E-glass fiber 1-5 % in steps of 2% by weight, 4% mica particulate with varied E-glass fiber 1-5% in steps of 2% by weight and 6% mica particulate with varied E-glass fiber 1-5% in steps of 2% by weight were prepared with the following procedure.

The crucible in which the charge is melted is preheated to remove the moisture content from the crucible which otherwise leads to the cracking of the crucibles. Aluminium 7075 is cut into small bits, weighed according to the requirement and added into the preheated crucible. Once the crucible has been charged the furnace was switched on and the temperature was set to 720^0C-750^0C. The melt was degasified using hexa-chloro ethane pellets (0.2%) before the introduction of Mica particulates and E-Glass fibers are preheated to 500^0C. Preheated Mica particulates and E-Glass fibers are added into the vortex while the melt temperature is maintained at 720^0C and stirred at 50 rpm till the reinforcements are thoroughly mixed using a mechanical stirrer coated with alumina and the melt was degasified with N_2 gas.

Table-I**:** Chemical Composition of Al 7075 by Weight Percentage.

Composition	Zn	Mg	Cu	Cr
% Composition	5.6	2.5	1.6	0.23

Table-II**:** Chemical Composition of E-glass fiber by Weight Percentage

Composition	Silica	Aluminum oxide	Calcium oxide + magnesium oxide	Boron trioxide
% Composition	54	14	22	10

Table-III: Chemical Composition of mica particulate by Weight Percentage.

Composition	Silica	Alumina	K2o	Fe2o3	Na2o
% composition	45.57	33.10	9.87	2.48	0.62

C. Testing of Tensile Properties

As per the ASTM standard E8 tensile test was conducted using a computerized universal testing machine. The test uses specimens of 20 mm grip diameter, 30 mm grip length, 62.5 mm gauge length, 75 mm length of reduced cross section, inner diameter of 12.5 mm and total length 155 mm machined from the cast specimens of various compositions mentioned earlier.

III. RESULTS AND DISCUSSION

Figure-1: UTS of hybrid composites for different compositions of reinforcements. From this graph we observe that the UTS increase as the percentage of Mica is increased, but it is also observed that with the increase in the addition of E-glass also increases UTS.

Figure-2: Hardness of hybrid composites for different compositions of reinforcements. From this graph we observe that the Hardness increase as the percentage of Mica is increased, but it is also observed that with the increase in the addition of E-glass also increases Hardness.

Figure-3: Percentage elongation of hybrid composites for different compositions of reinforcements. From this graph we observe that the % of elongation decreases as the percentage of Mica is increased, but it is also observed that with the increase in the addition of E-glass also decreases % of elongation.

Figure-4: Yield strength of hybrid composites for different compositions of reinforcements. From this graph we observe that the yield strength increase as the percentage of Mica is increased, but it is also observed that with the increase in the addition of E-glass also increases yield strength.

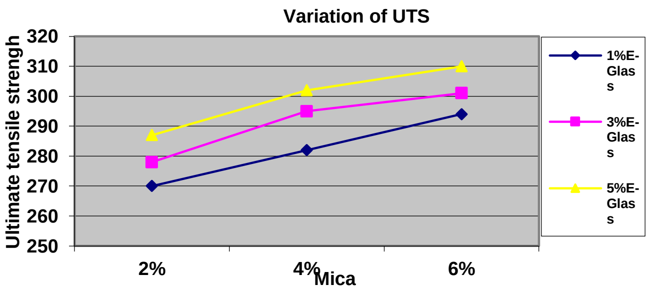

Fig –1: Variation of UTS in aluminium 7075 for different % of mica and E-glass.

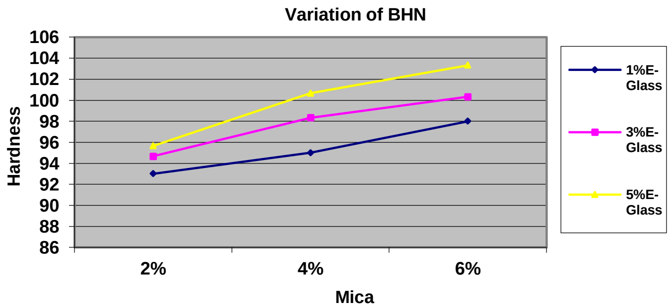

Fig -2: Variation of BHN in aluminium 7075 for different % of mica and E-glass.

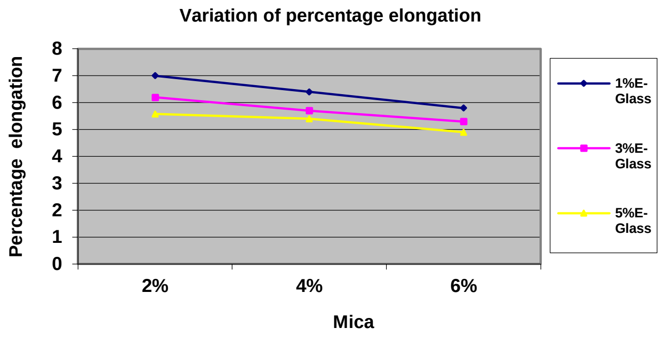

Fig -3: Variation of % of elongation in aluminium 7075 for different % of mica and E-glass.

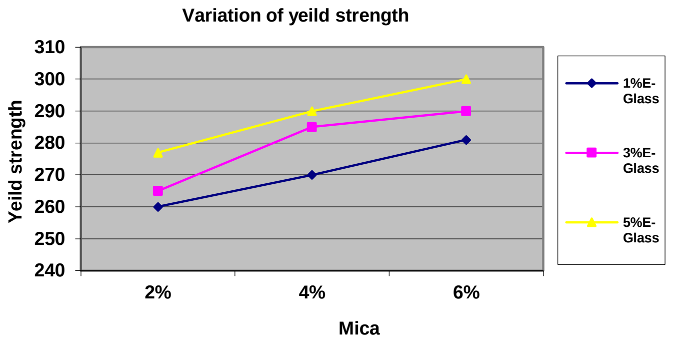

Fig -4: Variation of % of yield strength in aluminium 7075 for different % of mica and E-glass.

CONCLUSIONS

- The degree of improvement of mechanical properties of MMCs is strongly dependent on the kind of reinforcement as well as its volume fractions.
- As the addition of mica and E-glass reinforcement increases the UTS of aluminium 7075 alloy.
- As the addition of mica and E-glass reinforcement in aluminium 7075 alloy, there increase hardness, due to the presence of silica content in both reinforcement.
- There is a predominant decrease of ductility (% of elongation) of aluminium 7075 alloy, due to the addition of mica and E-glass reinforcement.

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