EVALUATION OF HARDNESS AND TENSILE PROPERTIES OF Al 7075 BASED COMPOSITE

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ABSTRACT

Metal Matrix Composites (MMC's) consist of either pure metal or an alloy as the matrix material, while the reinforcement generally a ceramic material. Now a days these materials are widely used in space shuttle, commercial airlines, electronic substrates, bicycles, automobiles, etc., Among the MMC's aluminum composites are predominant in use due to their low weight and high strength. The key features of MMC's are specific strength and stiffness, excellent wear resistance, high electrical and thermal conductivity. Hence, it is proposed to form a new class of composite. Al 7075 alloy reinforced with E-glass and fly ash particulates to form MMC using graphite die for casting. The MMC is obtained for different composition of E-glass and flyash particulates (varying E-glass with constant fly ash and varying flyash with constant E-glasspercentage).

The test specimens are prepared as per ASTM standard size by turning and facing operations to conduct hardness and tensile tests. The specimens are tested for hardness as per ASTM standard E10 at different loads by using Brinell hardness testing machine and tensile strength as per ASTM standard E8 by using universal testing machine. Through the results, it is concluded that the MMC obtained has got better hardness and tensile strength properties when compared to Al 7075alone.

***Key Words** - Al 7075, fly ash, E-Glass, MMC*

INTRODUCTION

Traditional materials do not always provide the necessary properties under all service conditions. Metal matrix composites (MMC's) are advanced materials resulting from a combination of two or more materials (one of which is metal and the other a non-metal) in which tailored properties are realized.

In recent years there has been a considerable interest in the use of metal matrix composites (MMC's) due to their superior properties. Though many desirable mechanical properties are generally obtained with the fiber reinforcement, these composites exhibit an isotropic behavior and are not easily producible by conventional techniques. MMCs reinforced with E Glass and fly ash particulates tend to offer modest enhancement of properties. Among the MMCs the most metal used is aluminum reinforcedwithEGlassandflyash.Generallyaluminumislightweight,whichisforemost requirement application and is less expensive than other light metals such as titanium and magnesium. Moreover, when a reinforcement material is added to Aluminum matrix, the properties will further enhance, there by making it a prospective material for many light weight applications. Metal-matrix composites are either in use or prototyping for the space shuttle, commercial airliners, electronic substrates, bicycles, automobiles and a variety of other applications.

Aluminum matrix composites, a growing number of applications require the matrix properties of super alloys, titanium, copper, magnesium, or iron. Like all composites, aluminum-matrix composites is not a single material but a family of materials whose stiffness, strength, density, thermal and electrical properties can be tailored to the suitable requirement. The matrix alloy, reinforcement material, volume, shape of the reinforcement, the location of the reinforcement, and the fabrication method can all be varied to achieve required properties. Regardless of variations, however, aluminum composites offer the advantage of low cost over most other MMCs. In addition, they offer an excellent thermal conductivity, high shear strength, abrasion resistance, and high-temperature operation, no flammability, minimal attack by fuels and solvents, and the ability to be formed and treated on conventional equipment. In the present investigation, an Al 7075 alloy was used as the matrix material and E-Glass, Fly ash as additives. The composite was produced using conventional foundrytechniques.

2. EXPERIMENTALWORK

For the development of composite, 7075 aluminum alloy was used as the starting material; where as low melting additives namely E-glass and fly ash were added in pure element form. The chemical composition of the cast alloy is shown in table1.1.

Table 1.1: Composition of Al 7075

Element	Zinc	Magnesium	Copper	Chromium	Fe+ Zr+Ti	Si+ Mn	Al
% Composition	5.1 - 6.1	2.1 – 2.9	1.1 -2.0	0.18 - 0.28	<=0.75	<=0.40	Remainder

2.1 Fly ash:

It is a particulate waste material formed as a result of coal combustion in power plants. The fly ash particulates in reinforcement to form metal matrix composites is therefore very desirable from an environment standpoint. The composition of fly ash is shown in table 1.2

Table: 1.2 Composition of fly ash in weight percentages

Element	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	Loss on Ignition
% Composition	30.4	58.41	8.44	2.75	1.43

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2.2 E-Glass:

It is also known as electrical grade glass and was originally developed for insulation in electrical wiring. It was later found to have excellent fiber forming capabilities and is now used almost exclusively as the reinforcingphase.

It is a low alkali glass with the composition of SiO_2 54% wt, Al_2O_3 14% wt, CaO+MgO 22% wt, B_2O_3 10% wt and Na_2O+K_2O less than 2% wt.

2.3 Melting andCasting:

An electric resistance furnace was used for melting the alloy for casting purpose, 7075 aluminum was cut into small pieces and were put into the crucible which is preheated and then it was kept for melting in the furnace. Molten metal was super heated to 100^0C. Flux was sprinkled on the surface of the liquid metal; to prevent oxidation degassing was carried out by adding chloroethane to remove hydrogen from the moltenmetal.

In order to avoid void formation during solidification. The pre heated E-Glass and fly ash were then added into the crucible and by using a mechanical stirrer it was thoroughly mixed. The temperature of the molten metal was measured

(above 700^0C) and then poured into the die preheated to 250^0C.

2.4 Heat Treatment:

In order to develop the correct balance of mechanical properties, it was thought essential to subject the test casting to an optimized thermal treatment (viz. solution heat treatment and quenching). Test samples of suitable length were solutionized in a heat treatment furnace for a temperature of $480^0 \pm 5^0$C for duration of 2 hours. After solutionising the samples were immediately quenched in water kept at room temperature, stored in the tanks below the furnace. The quenching was done strictly within 15 seconds of opening the furnace door. The pouring process, cast specimen and machined specimen are shown below in Fig 4 (a), (b), (c) respectively.

2.5 Measurement ofHardness:

Hardness measurements were made on different sections of the as cast and heat treated material as per ASTM E10 standards and the results are plotted in Fig. 1

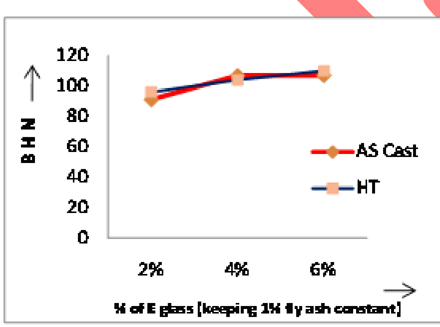

Fig.1 (a)

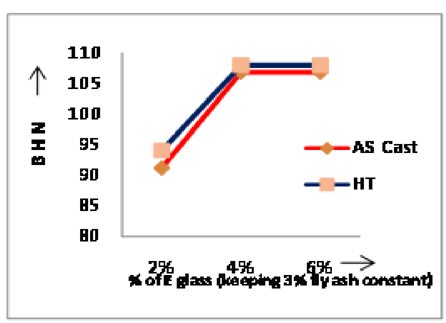

Fig. 1(b)

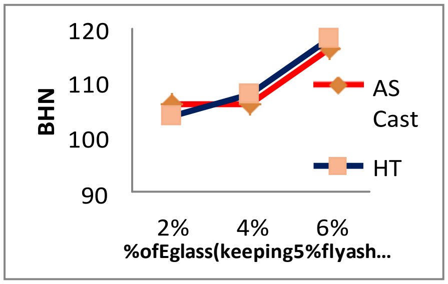

Fig. 1 (c)

2.6 Measurement of tensilestrength:

Tensile test was carried out as per ASTM E-8 standards for as cast and heat treated specimen and the results are plotted in Fig. 2.

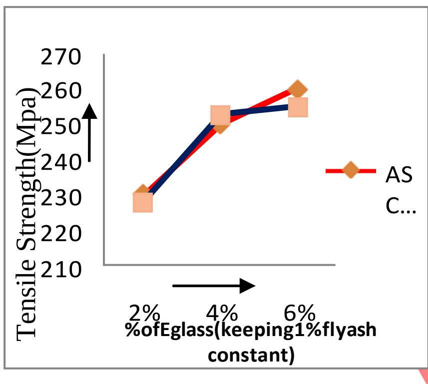

Fig. 2 (a)

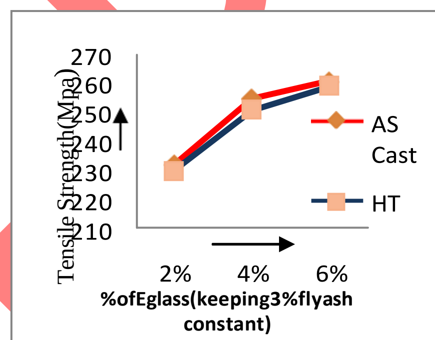

Fig. 2 (b)

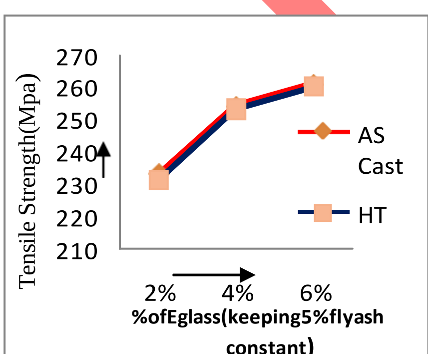

Fig. 2 (c)

3. RESULTS ANDDISCUSSIONS

Hardness: Hardness of the as-cast alloy produced in this work is lower at 2% of E-Glass when compared to 4% and6%. However, after thermal treatment the water quenched specimens exhibit higher hardness as shown in figs 1 (a), (b), (c) respectively.

From the graphs drawn it is evident that hardness number increases with increased percentage of E-glass.

Tensile Strength: In as cast condition ultimate tensile strength (UTS) of the new alloy produced is higher in 2% of E-Glass and lower in 4 and 6% E-Glass. However a slight improvement is observed in heat treatment condition as shown in figs 2 (a), (b), (c).

It can be observed that tensile strength increases with increase in percentage of E-glass.

4. CONCLUSION

1 The hardness increased as the % of E-glass and fly ash particulatesincreases.
2 Metal matrix composites of Al 7075 reinforced with E-glass and fly ash particulates is found to have improved tensile strength and hardness when compared to Al 7075 alloyalone.
3 The tensile strength (UTS) has increased in thermally treatedcondition.

The MMC formed is superior to Al 7075 alloy, with almost same density as that of the individual.

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Table: 1.2 Composition of fly ash in weight percentages

Element	Al_2O_3	SiO_2	Fe_2O_3	TiO_2	Loss on Ignition
% Composition	30.4	58.41	8.44	2.75	1.43

Table1.3: Brinell hardness number for as-cast specimen

SI. No.	% of Al (7075)	% of FlyAsh	% of E Glass	Indenter (mm)	Load in kgf	Diameter of indentation (mm)	Brinell hardness number (BHN)
1	97	1	2	2.5	60	0.9	91.15
2	95	1	4	2.5	60	0.833	106.86
3	93	1	6	2.5	60	0.833	106.85
4	95	3	2	2.5	60	0.9	91.85
5	93	3	4	2.5	60	0.833	106.86
6	91	3	6	2.5	60	0.833	106.86
7	93	5	2	2.5	60	0.833	106.86
8	91	5	4	2.5	60	0.833	106.86
9	89	5	6	2.5	60	0.8	116.2

Table 1.4: Brinell hardness number for heat treated (water quenched) specimen

SI. No	% of Al (7075)	% of FlyAsh	% of E Glass	Indenter (mm)	Load in kgf	Diameter of indentation (mm)	Brinell hardness number (BHN)
1	97	1	2	2.5	60	0.833	96
2	95	1	4	2.5	60	0.933	104
3	93	1	6	2.5	60	1	110
4	95	3	2	2.5	60	0.833	98
5	93	3	4	2.5	60	1	108
6	91	3	6	2.5	60	1	108
7	93	5	2	2.5	60	0.833	104
8	91	5	4	2.5	60	0.9	108
9	89	5	6	2.5	60	1.03	118

Table 1.5: Tensile strength of as-castspecimen

SI. No	% of Al (7075)	% of Fly Ash	% of E Glass	Tensile Strength(Mpa)
1	97	1	2	230
2	95	1	4	250
3	93	1	6	260
4	95	3	2	232
5	93	3	4	255
6	91	3	6	261
7	93	5	2	233
8	91	5	4	253
9	89	5	6	261

Table 1.6: Tensile strength of heat treated (water quenched)specimen

SI. No	% of Al (7075)	% of FlyAsh	% of E Glass	Tensile Strength(Mpa)

1	97	1	2	228
2	95	1	4	253
3	93	1	6	255
4	95	3	2	232
5	93	3	4	255
6	91	3	6	261
7	93	5	2	233
8	91	5	4	254
9	89	5	6	261