

# CHARACTERISATION STUDY OF METAL MATRIX COMPOSITE OF ALUMINIUM + FLY ASH + SiC USING STIR CASTING METHOD

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**Abstract** - Now a day's aluminum has trending into engineer's friendly material. It used Metal Matrix Composite(MMC) possess significantly improved properties including high specific strength, specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. There has been to be increase the mechanical behavior of ordinary pure aluminum(Al) and addition materials is fly ash, silicon carbide, magnesium, are all mixed can be prepared by stir casting method. Samples (Al 90%,fly-ash 5%,SiC 3%,Mg 2%),( Al 90%,fly-ash 10%,SiC 3%,Mg 2%) and (Al 90%,fly-ash 15%,SiC 3%,Mg 2%).This project deals with the fabrication and mechanical investigation of aluminium alloy, fly-ash, silicon carbide and magnesium metal matrix composites. Aluminium is the matrix metal having properties like light Weight, high strength and ease of machinability. Silicon carbide which has better wear resistance, high strength, hardness, fly-ash which has excellent hardness and fracture toughness and magnesium which has improve fire resistance are added as reinforcements. Here, the fabrication is done by stir casting which involves mixing the required quantities of additives into stirred molten aluminium. After solidification, the samples are prepared and tested to find the various mechanical properties like tensile, flexural, impact and hardness.

**Key Words:** Composites, Aluminium, MMCs, Stir Casting and Testing

## 1. INTRODUCTION

Conventional monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. To overcome these shortcomings and to meet the ever increasing demand of modern day technology, composites are most promising materials of recent interest. Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersions used, fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for wide spread applications in automotive and small engine

applications. It is therefore expected that the incorporation of fly ash particles in aluminium alloy will promote yet another use of this low-cost waste by-product and, at the same time, has the potential for conserving energy intensive aluminium and thereby, reducing the cost of aluminium products.

Now a days the particulate reinforced aluminium matrix composite are gaining importance because of their low cost with advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components. Cast aluminium matrix particle reinforced composites have higher specific strength, specific modulus and good wear resistance as compared to unreinforced alloys [1]. While investigating the opportunity of using fly-ash as reinforcing element in the aluminium melt, that have high electrical resistivity, low thermal conductivity and low density of fly-ash may be helpful for making a light weight insulating composites [1].

Mechanical properties of composites are affected by the size, shape and volume fraction of the reinforcement, matrix material and reaction at the interface. These aspects have been discussed by many researchers. The increase in volume percentages of fly ash, hardness value increases in Al-fly ash (precipitator type) composites. He also reports that the tensile elastic modulus of the ash alloy increases with increase in volume percent (3–10) of fly ash [2]. Al<sub>2</sub>O<sub>3</sub> particle reinforced Al MMCs, with varying particulate volume percentages (25, 36, 46, 52 and 56) and report improvement in elastic modulus, tensile strength, and compressive strength and fracture properties with an increase in the reinforcement content [2]. The interface between the matrix and reinforcement plays a critical role in determining the properties of MMCs. Stiffening and strengthening rely on load transfer across the interface. Toughness is influenced by the crack deflection at the interface and ductility is affected by the relaxation of peak stress near the interface [2].

Extensive studies on the tribological characteristics of Al MMCs containing reinforcements such as SiC and Al<sub>2</sub>O<sub>3</sub> is available in the literatures. However, reports on friction and wear characteristics of fly ash reinforced AMCs are very limited. The addition of fly ash particles to the aluminium alloy significantly increases its abrasive wear resistance [3]. He attributed the improvement in wear resistance to the

hard alumina silicate constituent present in fly ash particles [2].

## 2. EXPERIMENTAL STUDY

A 400 gm of commercially pure aluminium was melted in a resistance heated muffle furnace and casted in a clay graphite crucible. For this the melt temperature was raised to 993K and it was degassed by purging hexachord ethane tablets. Then the aluminium-fly ash (5%, 10%, and 15%) composites were prepared by stir casting route. For this we took 400 gm of commercially pure aluminum and then (5, 10, 15,) wt% of fly ash were added to the Al melt for production of four different composites. The fly ash particles were preheated to 373K for two hours to remove the moisture. Commercially pure aluminium was melted by raising its temperature to 993K and it was degassed by purging hexachloro ethane tablets. Then the melt was stirred using a mild steel stirrer.



Fig 2.1 Stir casting furnace

Table 2.1 Sample Specimen

SPECIMEN-1	SPECIMEN-1	SPECIMEN-1
Al=90%	Al=85%	Al=80%
Fly-Ash=5%	Fly-Ash=10%	Fly-Ash=15%
Sic=3%	Sic=3%	Sic=3%
Mg=2%	Mg=2%	Mg=2%

Fly-ash particles were added to the melt at the time of formation of vortex in the melt due to stirring. The melt temperature was maintained at 953K- 993K during the addition of the particles. Then the melt was casted in a clay graphite crucible. The particle size analysis and chemical composition analysis was done for fly ash. The hardness testing and density measurement was carried out Al-(5, 10, and 15) wt. % fly ash composites. The hardness of the samples was determined by Brinell hardness testing machine with 250 kg load And 5 mm diameter steel ball

indenter. The detention time for the hardness measurement was 15 seconds.

The wear characteristics of Al-fly ash composites were evaluated using wear testing machine. For this, cylindrical specimens of 0.6 cm diameter and 60 cm length were prepared from the cast 3 Al- fly ash composites. Test was performed at under different loads and rpm for 5 minutes.



Fig 2.2 Fabrication for the samples

## 3. RESULTS AND DISCUSSION

### 3.1 Tensile test

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. During the test a uniaxial load is applied through both the ends of the specimen. The dimension of specimen is (150x10x5)mm. Typical points of interest when testing a material include: ultimate tensile strength (UTS) or peak stress; offset yield strength (OYS) which represents a point just beyond the onset of permanent deformation; and the rupture (R) or fracture point where the specimen separates into pieces. The tensile test is performed in the universal testing machine (UTM) and results are analyzed to calculate the tensile strength of composite samples.



Fig 3.1 tensile test specimens

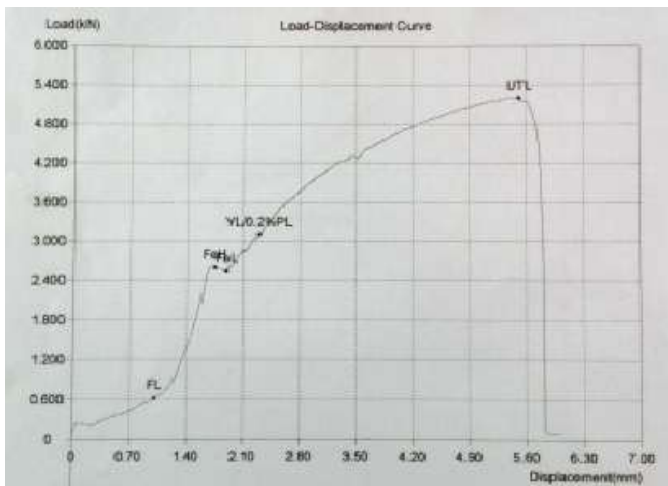


Chart 1 Tensile test Result for Sample (1)

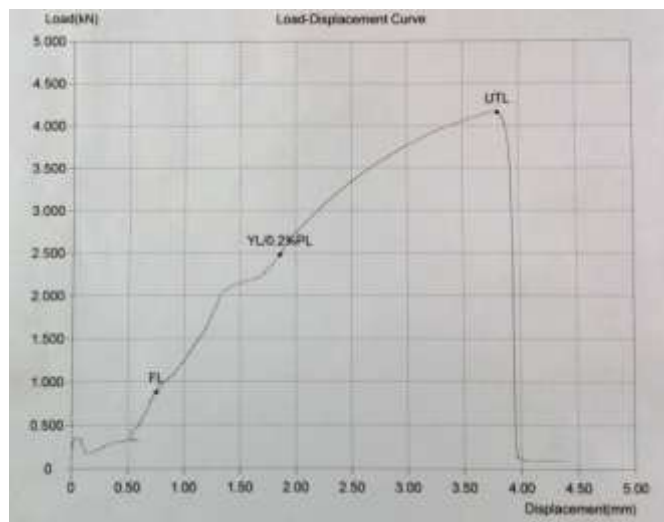


Chart 2 Tensile test Result for Sample (2)

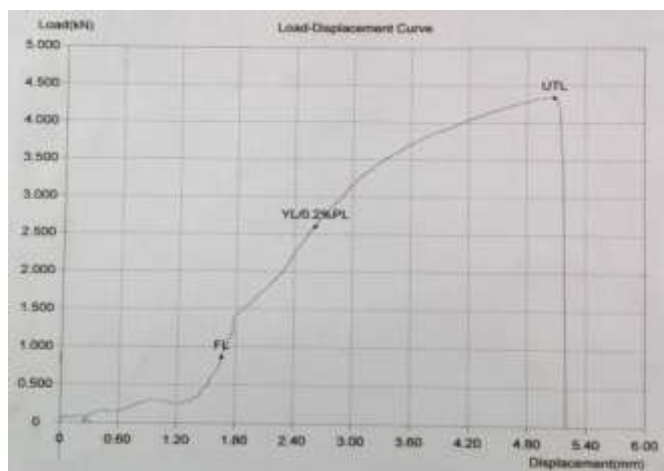


Chart 3 Tensile test Result for Sample (3)

### 3.2 Hardness Test

Hardness is the measure of how resistant solid matter is to various kinds of permanent shape change when a force is applied. Here Brinell hardness test was used to calculate the hardness of the three samples.

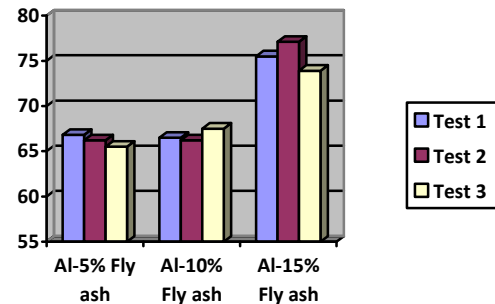


Chart 4 Hardness Performance Graph

### 3.3 Impact Test

Impact testing is of enormous importance. A collision between two objects can often result in damage to one or both of them. The damage might be a scratch, crack, fracture or break. Scientists need to know about how materials and products behave under impact and the magnitude of forces they can resist. Here charpy impact test is carried out for three samples. This result of three samples at same temperature the values of energy absorbed is same.

## 4. CONCLUSION

From the study it is concluded that we can use fly ash for the production of composites and can turn industrial waste into industrial wealth. This can also solve the problem of storage and disposal of fly ash. Fly ash up to 15% by weight can be successfully added to Al by stir casting route to produce composites. The hardness of Al-fly ash composites has increased with increase in addition of fly ash. Strengthening of composite is due to dispersion strengthening, particle reinforcement and solid solution strengthening.

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