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A Study on Tensile, Hardness and Impact Strength using Al 7075 as Matrix Material and by using different Reinforcement: A Review

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Abstract- *Composites are maximum positive materials used for recent works in the industry. Metal composites possess suggestively better-quality properties with high tensile strength, toughness, and hardness, low compared to alloys or any extra metal. There has been a swelling interest in composites comprising low density and low cost cavalries. Amongst various reinforced materials used, fly ash is one of the most low-cost and low density reinforcement available in large amounts as waste product during combustion of coal in current power plants as well as in the brick factory and rice mill. Hence, mixtures with fly ash with Al 7075 and aluminium 6061alloy as matrix metal and Silicon carbide with different proportions. as reinforcement are likely to over w helmed the cost barrier as well as the different physical and mechanical properties for widely used in the motorized and space craft claims.*

Keywords: **Aluminium Matrix Composites, Fly Ash, Stir Casting aluminium 6061alloy, silicon carbide, stir casting process, mechanical properties.**

1. Introduction

The various fabrication techniques available to Manufacture the MMC are compocasting (stir casting), liquid metal infiltration, squeeze casting and spray codeposition [1.2]. Vijaya Ramnath *et al.* [3] reviewed work done on aluminium metal matrix composites. Rajan *et al.* [4] made an attempt to compare the effect of the three different stir casting methods while making MMC with flyash as reinforcement with aluminium alloy and concluded that compo casting method is more effective. Abhishek Kumar *et al.* [5] used electromagnetic stir casting of A359/Al2O3 to produces MMC with smaller grain size with good particulate matrix interface bonding. Ding *et al.* [6] investigated the behaviour of the unreinforced 6061 aluminium alloy and short fiber reinforced 6061 Al alloy MMC and conclude that addition of high-strength alumina fibres in the Al6061 matrix will constrain the plastic deformation in the matrix which leads in reduction of fatigue ductility. Vijaya Ramnath *et al.* [7] investigated the mechanical properties of aluminium alloy aluminium oxide-Boron Carbide MMCs fabricated by stir casting and concluded that aluminium with 2% alumina- 3% boron carbide have better tensile strength in comparison with other compositions. Naher *et al.* [8] carried out a computational and experimental analysis to study the effect of viscosity on particulate distribution during Al-SiC MMC fabrication and concluded that stirring speed has effect on uniform distribution of reinforcement. Wang and Müller [9] conducted a study to predict the performance of array arrangement on ducted composite material marine current turbines (CMMCT) and also they suggested that the developed array can be used to optimize the existing CMMCT power generation. Mouritz *et al.* [10] reviewed the advanced composite structures for naval ships and submarines. Vijaya Ramnath *et al.* [11, 12] reviewed CNT based composites and found compression and chemical properties of aluminium CNT composites. Wear resistance is one of a important factor for various industrial applications. The friction and wear properties of several metallic alloys in un lubricated conditions are widely investigated [13]. Stiffness, hardness mand wear resistance of a MMC can be enhanced by adding titanium diboride to metal matrix composites. Also it is found that various works in this field have been directed at aluminium based materials [14]. In the present work, fly-ash which mainly consists of refractory oxides like silica, alumina, and iron oxides is used as reinforcing phase. Composite was produced with 10gm to40gm fly-ash as reinforcing phase. Commercially pure aluminium was also melted and casted. Then particle size and chemical composition analysis for fly-ash was done. Mechanical, physical and grain properties of the composite were evaluated and compared with the commercially pure aluminium. Mechanical properties of composites are affected by the size, shape and volume fraction of the reinforcement, composite material and reaction at the interface.

2. Literature Survey

In 2014 A. Baradeswaran et.al.[1] investigate," Experimental investigation on mechanical behaviour, modelling and optimization of wear parameters of B4C and graphite reinforced aluminium hybrid composites". Aluminium alloy (AA) 6061 and 7075 were reinforced with 10 wt.% of boron carbide (B4C) and 5 wt.% of graphite through liquid casting technique. The Scanning Electron Microscope (SEM) and Energy Dispersive Spectrum (EDS) were used for the characterization of composites. The wear experiment was carried out by using a pin-on-disc apparatus with various input parameters like applied load (10, 20, and 30 N), sliding speed (0.6, 0.8, and 1.0 m/s) and sliding distance (1000, 1500, and 2000 m). Response Surface Methodology (RSM) using MINITAB 14 software was used to analyse the wear rate of hybrid composites and aluminium alloys. The worn surfaces of hybrid composites and base alloys were studied through SEM and EDS systems. G. B. Veeresh Kumar1 et.al.Studied [2] in 2010,"Al7075-Al2O3 Metal Matrix Composites" .Particle reinforced composites have a better plastic forming capability than that of the whisker or fiber reinforced ones. The composites are prepared using the liquid metallurgy technique, in which Al2O3 reinforced 2 to 6 wt. % of size 20 μm particulates were dispersed in the base matrix in two steps. The particles were preheated before being introduced into the vortex and stirring of the molten composite were accomplished for 10 minutes at 400 rpm starrier speed. Pouring temperatures adopted were 720ºC. Muhammad Hayat Jokhioet.al.investigate [3] in 2012, "Manufacturing of Aluminum Composite Material Using Stir Casting Process". The 7xxx series aluminum matrix usually contains Cu-Zn-Mg. Aluminium matrix manufactured by varying Cu,Zn and Mg percentage.He investigate the effect of Al2O3reinforcement on aluminum 7xxx matrix on mechanical properties using simple foundry melting alloying and casting route. The required quantities of "Al2O3" particles were added in 2.5, 5, 10 and 15% weight percents.The age hardening treatments were also applied to study the aging response of the aluminum matrix on strength, ductility and hardness. The experimental results indicate that aluminum matrix cast composite can be manufactured via conventional foundry method giving very good responses to the strength and ductility up to 10% "Al2O3"particles reinforced in aluminum matrix. The high percentage of "Al2O3" upto 15% in alloy decreases the tensile strength. High "Al2O3" particles in matrix requires the study revealed that as the short basalt fiber content was increased, there were significant increases in the ultimate tensile strength, hardness, compressive strength and Young's modulus accompanied by a reduction in its ductility. The microstructure and facture studies using OM and SEM carried out were used to establish the relationships between the quality of the fiber/aluminium interface bond and the mechanical properties of composites.Fabrication, Surface Morphology and Corrosion investigation of Al7075/Al2O3 matrix composite in sea water and industrial environment was presented by VigneshShanbagh et.al. in [4]. Karthigeyan et.al. Al7075 [5] alloy composites containing different volume fraction of short basalt fiber are developed using the stir casting process. The experimental strength values of the composites are compared with the theoretical values in this paper. The results suggested that the experimental values best suited the theoretical values owing to the random distribution of basalt fibers in the Al7075 matrix the effects of load and sliding speed on the friction coefficient and wear properties of pin of Al7029-Fly Ash composite material on Pin on Disc apparatus was investigated in [4] by Deepak Singla and Mediratta. Their experiments indicated that composites with fly ash as reinforcement in Al7029 optimizes the different physical and mechanical properties of the composite.the mechanical properties of TiB2 reinforced Al7029 MMC material was studied in [6]. Sachin Malhotra et al. [7] observed that influence of varying weight percentage of zirconia (5% and 10 %) and fixed percentage fly ash (10%) reinforced Al6061 metal matrix composite by stir casting method. It was identified that hardness and ultimate tensile strength increase with increase weight fraction of reinforcement material. A better hardness 94HV and tensile strength 278 MPa for 10% zirconia and 10% fly ash reinforced composite material. Aluminium alloy 6061 had the determinate elongation of 21.66%, which was significantly reduced to a range of 85% to 90% due to the addition of reinforcement material. J. Jenix Rino et al. [8] investigated the mechanical behaviour of Al6063 alloy composite strengthened by zircon sand and alumina particle with an overall reinforcement in 8 Wt.% by stir casting method. It was observed that homogenous distribution of the reinforcement in Al6063 matrix material. Hardness and tensile strength of the composite having the higher value at the composite sample having the reinforcement mixture of 4wt.%ZrSiO4+4wt.% Al2O3. K. L. Meena et al. [9] observed that mechanical properties of the developed SiC reinforced Al6063 metal matrix composite material using the melt stirring technique. The experiment was performed by varying the reinforced particle size as 200 mesh, 300 mesh, 400 mesh and different weight percentage, 5%, 10%, 15%, and 20% of SiC particle reinforced composite material. The stirring process was conceded at 200 rpm using a graphite impeller on behalf of 15 min. A homogenous dispersion of SiC particle in the aluminium matrix was observed. Tensile strength, hardness and breaking strength improved with the enlargement in reinforced. Ehsan Ghasali et al.,[10] made an attempt to study on Investigation on microstructural and mechanical properties of B4C–aluminum matrix composites prepared by microwave sintering and concluded that having strong bonding strength. P.Pugalenthi et al., made an attempt to study on Evaluation Of Mechanical Properties Of Aluminium Alloy 7075 Reinforced With SiC And Al2O3 Hybrid Metal Matrix Composites and concluded that strength of the material increases by adding reinforcement. Deepak Singla Et Al [11] Made An Study On EVALUATION OF MECHANICAL PROPERTIES OF Al 7075-FLY ASH

COMPOSITE MATERIAL and results are tabulated. A. Venugopal et al [12] made an study on Evaluation Of Mechanical Properties Aluminium Metal Matrix Composite For Marine Applications and results are tabulated

3. Selection of Materials

Heat Treatment of Fly Ash

Before directly using the fly ash in the composite heat treatment is done on it to remove impurities and water content. For the surface treatment of ash it is heated in the furnace at a temp. of 600°C. During this temp range a ethanol solution is added at a temp. of 50°C and stir for some time. After it we also added cover11 to improve its surface

In this section, matrix material, reinforcement, experimental setup and details of compositions of composites are discussed **Matrix and reinforcement used** In this work wrought aluminum alloy is taken as matrix metal and aluminium Oxide is taken as reinforcement.

Table-1: Properties of Al and SiC. [12]

Properties	Aluminium (Al)	Silicon Carbide (SiC)
Density (gm/cm^3)	2.70	3.30
Tensile Strength (MPa)	185	588.0
Coefficient of thermal expansion ($10^{-6}/^{\circ}C$)	23	4.6
Modulus of Elasticity (GPa)	70	345

Composition of matrix and reinforcement [12]

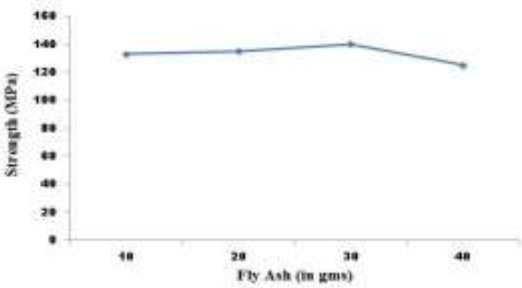
Samples Al in	% SiC in %
99.5	0.5
99	1.0
98.5	1.5
98	2
97.5	2.5

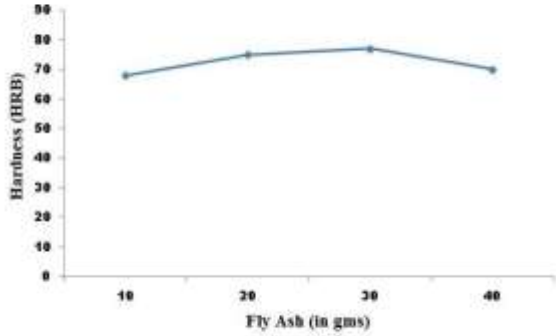
Composition Used For Metal Matrix Composite [11]

Sampl	Al(7075) (gm)	Mg(gm)	Fly Ash (gm)	weight(gm)
S1	500	10	40	550
S2	500	20	30	550
S3	500	30	20	550
S4	500	40	10	550

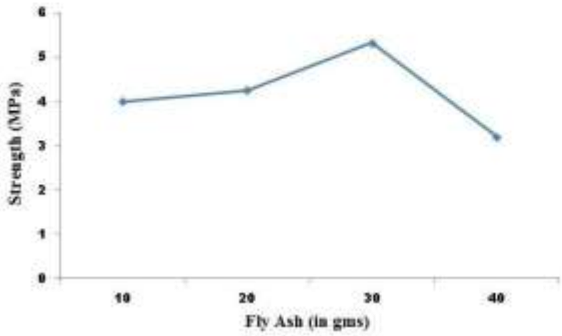
4.RESULTS AND DISCUSSIONS

4.1Tensile Strength

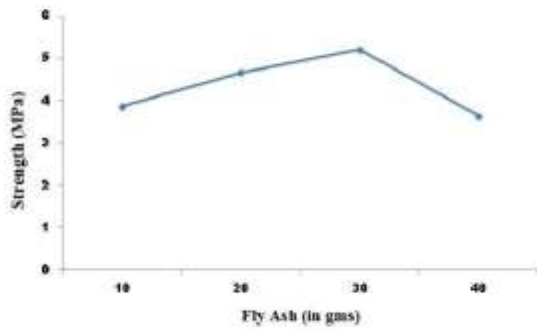


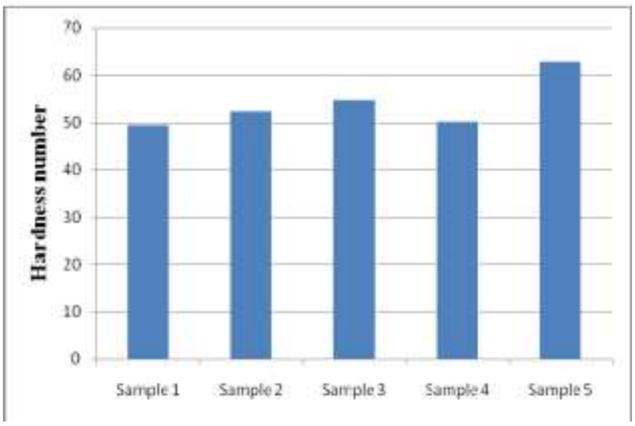


4.2 Impact Strength 4.2.1 Izod Results



4.2.2 Charpy Results





5. Conclusion

- The brinell hardness of sample 5 is greater than other samples because of the presence of silicon carbide.[12]
- Toughness of the composites was determined by using Izod and Charpy tests. As we increase the amount of ash the toughness value gradually increased up to some level i.e Sample2 but after this it diminishes.[11]
- Hardness and tensile strength of the composites also showed the same results as like of toughness. As we increased the amount of ash up to Sample2 it increases and after that goes down.[11]
- The density of the composites decreased with increasing ash content. Hence these light weight composites can be used where weight of an object maters as like in the aero and space industries.[11]
- From the above results we find the Sample2 having an good toughness, hardness, tensile strength and also having the low density comparatively alloys without reinforcement. So that these composites could be used in those [11]
- sectors where light weight and good mechanical properties are required as like in automobile and space industries [11]

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