

XRD and SEM Analysis of A356/BA Composites Fabricated by Stir Casting Method

Sridhar H S¹, T.B Prasad², Chandraiah M T³, Uppur M Sumukha Kalkur⁴, Kiran Kumar B K⁵

Assistant Professor, Department of Mechanical Engineering, S.K.I.T Bangalore, Karnataka, India^{1,3}.

Professor, Department of Mechanical Engineering, S.S.I.T, Tumkur, Karnataka, India²

UG scholar, Sri Krishna Institute of Technology Bangalore, Karnataka, India^{4,5}

ABSTRACT: In the present investigation, A356/BA metal matrix composite with dissimilar weight percent of reinforcements (A1, A2, A3, A4, A5, A6) were made-up by stir casting process. Micro structural analysis, XRD, SEM tests was carried out in order to make out microstructure and mechanical properties of the composites. The outcomes of micro structural revise exposed uniform distribution. The mechanical results showed that the addition of BA particles led to the improvement in strength, toughness. It point out, type of fabrication process and percentage of reinforcement are the efficient factor influencing the mechanical properties and observed that when percentage of reinforcement increases in stir casting, best mechanical properties are obtained.. This paper describes the Chemical Composition of A356 alloy & bottom ash and also an economic alternative to the use of traditional materials the use of bottom ash shows a great influence input to waste minimization as well as resources Preservation.

KEYWORDS: Bottom ash, Heat treatment, Stir casting, economic choice.

I. INTRODUCTION

A356 based alloys have been developed with significant ductility, strength, elongation, hardness and toughness at room temperature in as-cast state. A356 alloys are ever more accepted in aircraft and automobile due to their lofty strength-to-weight relation and its thixotropic arrangement, its specific tensile strength and rigidity are superior to other Aluminum alloys. These qualities lead to less vehicle and aircraft weight and better fuel economy [5].

The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, bottom ash is one of the most inexpensive and low density reinforcement accessible in large quantities as solid waste by-product during combustion [2].

Casting and mold with their structures, as well as their heat treatment procedure which plays a very important role in improving the properties.

II. LITERATURE SURVEY

Anilkumar et.al. (2013) this paper studies about the mechanical and tribological behavior of reinforced AMC composite by varying Fly ash particle size. Three sets of composite with fly ash particle size 75-100µm, 45-50µm and 4-25 µm was prepared and comparison study was made with Aluminum. The result showed significance decrease in mechanical behaviour such as compressive strength, tensile strength and hardness with increase in particle size of fly ash in AMCs composite with uniform distribution of fly ash.

Ramachandra et al. (2007) Investigated the wear and friction characteristics of Al (12% sic) matrix Composite reinforced with fly ash particles. The authors observed that wear resistance of the composite increased with increase in weight percent of fly ash while it decreased with increase in normal load and sliding velocity. With increase in fly ash content the slurry erosive wear resistance of the composite increased and the corrosion resistance decreased.

ShashiPrakash Dwivedi et.al. (2014) In this report the author has studied about Electromagnetic stirring process of A356/SiC composites. In this investigation, A356/SiC metal matrix composite with different weight percent of reinforcements (5%, 10% and 15%) were made-up by electromagnetic stir casting and showed significant increase in its mechanical properties such as microstructure homogeneity, fatigue etc.,

Dinaharan et.al. (2016) The paper reveals about the various characteristic of AMC reinforced fly ash produced by friction stir casting process such as optical microscopy, scanning electron microscopy and electron backscattered diagram. Homogeneous of FA is observed in the AMC produced by friction stir casting. The result obtained from composite showed significant increase in micro hardness and wear resistance.

H. R.Ezatpour et.al.(2013) In this paper the research scientists studied about various mechanical properties like Hardness, Yield strength, Ultimate Tensile strength with mass fraction of Al₂O₃ in Aluminium. The Composite was manufactured by stir casting process. In this process the author also revealed about the various parameters like rpm, injection time, and speed etc., considered for stir casting process.

Grigorios Itskos et al (2011) In this report A356 Al-Fly ash composites were synthesized using pressure infiltration technique, by utilizing class C fly ash (FA) Metal Matrix Composites (MMCs) has excellent combination of physical, mechanical and tribological properties and their usage remains limited on account of their high production cost, The fly ashes were separated into their different size fractions by manual screening, by using the respective sieves. It was found that the finer the FA-particles, lower the friction coefficient. It was said finally that fine Fly Ash particles can strongly advantage the properties of composites and that grinding of fly ash facilitates MMCs-Manufacturing by pressure infiltration and it also advantages their wear properties.

III. MATERIALS & METHODOLOGY

3.1 A356 alloy

A356 alloy has been selected as the matrix material because of its good formability, outstanding mechanical properties and mechanized properties. wide variety of the applications in the industrial sectors. A356 based alloys have been urbanized with substantial ductility, strength, elongation, hardness and toughness at room temperature in as-cast state. A356 alloys are ever more accepted in aircraft and automobile due to their high strength-to-weight ratio. In general, stiffer and lighter designs can be achieved with A356 alloys than is possible with steels. Aluminum alloy A356 was selected as matrix material. because, it is readily castable & widely studied and used. To select a suitable reinforcement and matrix for the aluminum nano composite, important factors such as density, wet ability and chemical reactivity at high temperatures should be considered. Silicon carbide is selected as reinforcement material because of its good wet ability, nearly identical density and the big difference of the thermal expansion coefficients with aluminum alloys. Metal matrix composites (MMCs) exhibit attractive physical and mechanical properties such as high tensile, creep and fatigue strengths, superior wear resistance, and improved thermal stability.

Table 3.1.1 Chemical composition of A356 Aluminium alloy, wt. Percentage

Element	Cu	Mg	Si	Fe	Mn	Ni	Pb	Sn	Ti	Zn	Al
Percentage	0.051	0.730	7.761	0.500	0.116	0.030	0.024	0.015	0.027	0.042	REM

3.2 Bottom Ash

Bottom ash is one of the most inexpensive and low density reinforcement obtainable in large quantities as solid squander by-product during flaming of coal in thermal power plants. Hence, composites with bottom ash as reinforcement are likely to overcome the cost obstacle for wide spread applications in automotive & space craft, aircraft, military, marine Applications. Sand to gravel and superior carbon content than fly ash. Bottom ash is the innate Particulate reinforcement.

Table 2: Chemical composition of Bottom ash, wt. Percentage.

Element	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	MgO	CaO	MnO	ZnO	CuO	P ₂ O ₅	LOI
Percentage	65.50	16.21	4.90	1.20	0.75	2.80	0.12	0.020	0.040	0.080	REM

3.3 Mechanical Stir Casting Process Parameter

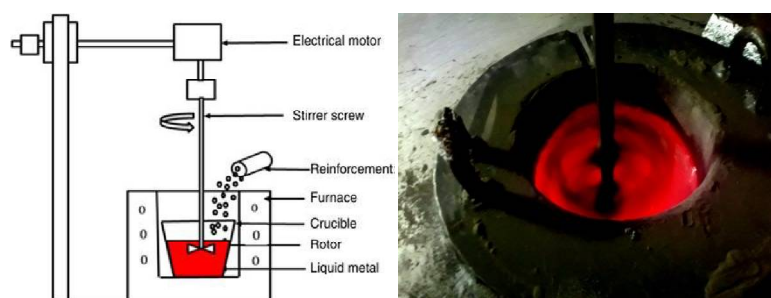
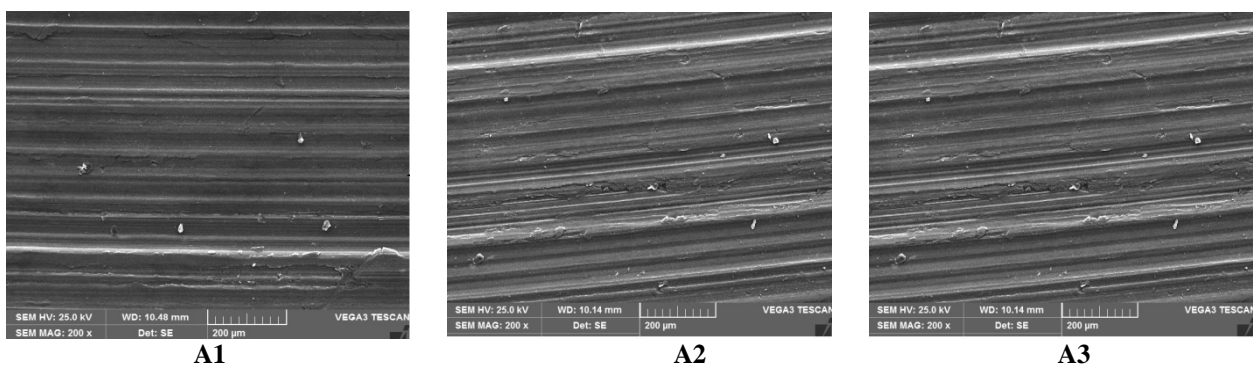


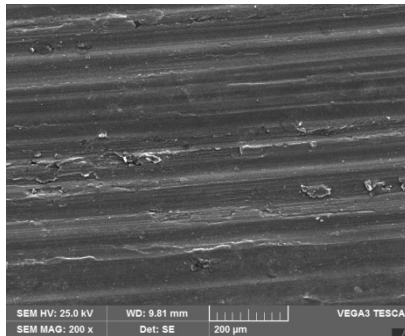
Figure 3.31: Schematic diagram of mechanical stir casting route

Clean the crucible which is made up of Graphite and Preheat the mould, Place the A356 metal pieces into the crucible, Maintain the furnace temperature around 750-800°C. Once A356 gains molten form add scum powder degassing tablet to it scum powder is used to remove slag, flux from the molten metal. degassing tablet [exo-chloro ethane] is used to remove unwanted gases from the molten metal, Preheat the reinforcements Pour this reinforcements into the molten metal with 2, 4, 6, 8, 10%wt each trail Using a Stirrer the reinforcements are stirred well in molten metal for about 10mins with approximate speed of 150-250rpm Then the molten mixture is poured into mould & left for cooling. Discontinuous reinforcement is stirred into molten metal, which is allowed to solidify. Stir casting is a liquid state method of composite materials fabrication, in which a dispersed phase (ceramic particles, short fibers) is mixed with a molten matrix metal by means of mechanical stirring. In stir casting, molten metal is stirred with the help of mechanical stirrer. This action disperses the reinforcing phase, which is added to the surface of the melt in the molten metal, and solidifies the composite. the crucial thing is to create good wetting between the particulate reinforcement and the liquid aluminium alloy melt

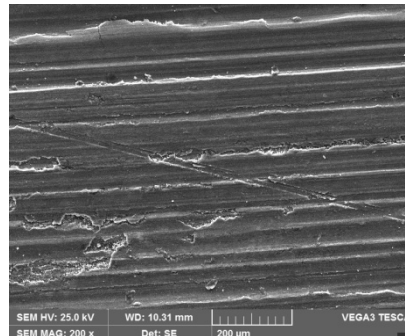
IV. EXPERIMENTAL RESULTS

4.1 Scanning electron microscope (SEM) Analysis

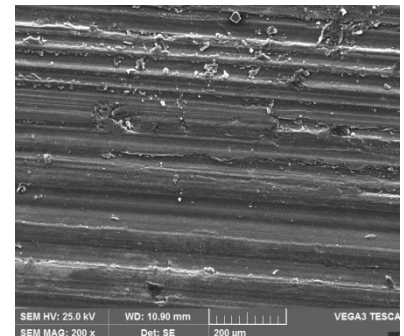




A4



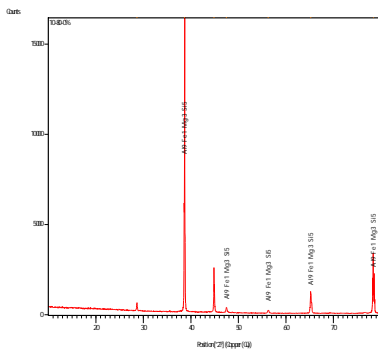
A5



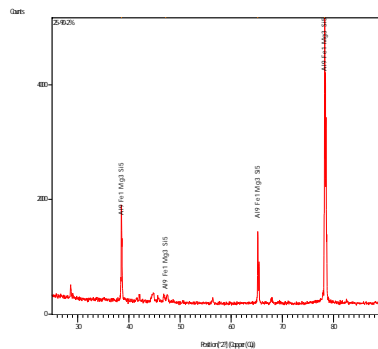
A6

Further, SEM photographs of worn surfaces after abrasion tests as shown in Fig. clearly indicate less extent of grooving in matrix alloy and its composites after heat treatment. However, A356-BA composites do exhibit the minimal extent of grooving on heat treatment which leads to lesser material removal. Also it is clearly evident that the bond between the reinforcement and matrix alloy is good. This will result in lesser probability of three body abrasive wear. The phenomena of three body abrasive wear will lead to larger material removal. It has been found that the thickness of the bottom ash layer at the sliding surface plays an important part in the wear behaviour of composites.

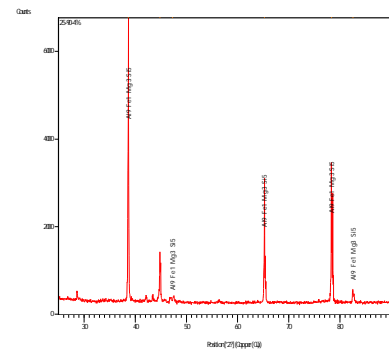
4.3 X-ray diffraction Analysis



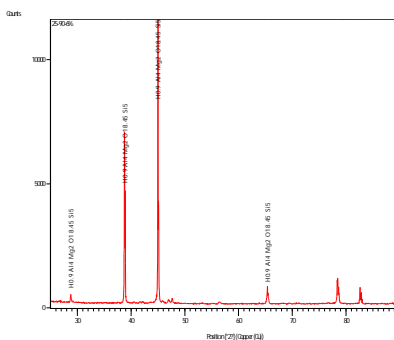
A1



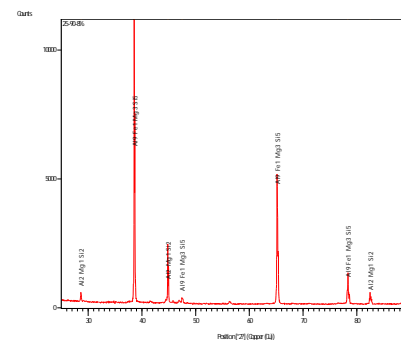
A2



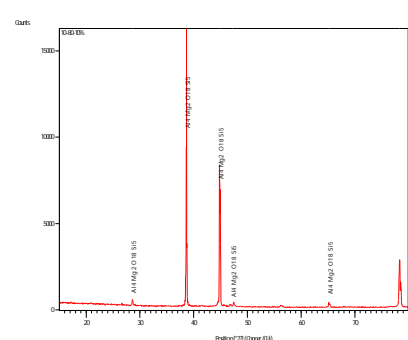
A3



A4



A5



A6

It is observed that with increased content bottom ash the extent of presence of iron on the worn surfaces which are rich in iron indicates a lower wear loss. The transferred iron layer may get oxidized due to increased localized heating under the oxidizing atmosphere leading to lowering of material transfer. The transferred layers are established on the Composite samples, the fortify counteract face can be considered to be mainly in contact with mixture of iron and its oxide. The iron oxides are known to have low co-efficient of friction. Based on the XRD result, it is shown that the Bottom ash powders have reaction with each other after sintering, and these composite which maintain their own intensities.

V. CONCLUSION

The present work deals with the preparation of characterization of waste bottom ash reinforced with A356. A laboratory study has been carried out to determine the SEM and XRD results of bottom ash reinforced with A356 composites by different methods and the following conclusions are drawn.

- [1] With the successful fabrication of A356 alloy based composites reinforced with bottom ash.
- [2] The macrostructural studies revealed the uniform distribution of the particles in the matrix system.
- [3] It is observed that with increased content bottom ash the extent of presence of iron on the worn surfaces.
- [4] Friction and wear properties are improved by adding bottom ash in A356 alloy while the hardness, the optimum adding amount of bottom ash is A5wt. %.
- [5] The SEM observation wear resistance of metal matrix composites is known for improving considerably with increasing the size of reinforcing particles.

REFERENCES

- [1] Mueller D.H and Krobjilowski A, "New Discovery in the Properties of Composites Reinforced with Natural Fibers", Journal of Industrial Textiles, 33(2), 2003, pp.111-129.
- [2] Z. Zhikai, Z. Sixun, H. Jinyu C. Xingguo, G. Qipeng, and W. Jun, Phase Behavior and Mechanical Properties of Epoxy Resin Containind.
- [3] Marij ahmed khan, Prof. Mohd. Shadab khan (2016) " Review On Abrasive Wear Behaviour Of Al 6061 And Selection Of Material And Technology For Forming Layer Resistant To Abrasive Wear" *IJETA Volume 3 , Issue 2,ISSN:2393-9516*.
- [4] R. RahmaniFard, F. Akhlaghi (2007) "Effect of extrusion temperature on the microstructure and porosity of A356-SiCp composites" *Journal of Materials Processing Technology vol.187(188), pp.433-436*.
- [5] Shashi Prakash Dwivedi, Satpal Sharma, Raghvendra Kumar (2014) "A356 Aluminum Alloy and applications- A Review" *Advanced Materials Manufacturing & Characterization Vol4 Issue 2*.
- [6] S. Suresha N. ShenbagaVinayagaMoorthi (2013) "Process development in stir casting and investigation on microstructures and wear behavior of TiB2 on Al6061 MMC" *Procedia Engineering vol.64, pp.1183 - 1190*.
- [7] Mahanthesh G, Umashankar "Preparation and Property Evaluation of Aluminium alloy (6061) Reinforced with Bottom Ash Particulate composite (ALBAP Composite)" *International Journal of Science Research Volume 01, Issue 04*.
- [8] Arda Cetin, Ali Kalkanli (2008) "Effect of solidification rate on spatial distribution of SiC particles in A356 alloy composites" *Journal of materials processing technology vol.205 pp. 1-8*.
- [9] suresh rathod , Umashankar Professor " Study of Microstructure and Sliding Wear Behavior of Al (7075) Reinforced with Bottom Ash in Metallic Mould with Water Chill" *IJSTE/ Volume 01/ Issue 05 / 001*.
- [10] BhargaviRebba, N.Ramanaiah (2014) "Studies on Mechanical Properties of 2024 Al – B4c Composites" *Advanced Materials Manufacturing & Characterization vol.4 , pp.42-46*.