International
OPEN ACCESS Journal
Of Modern Engineering Research (IJMER)

Synthesis and Evaluation of Properties of Al – Flyash SiCComposite

Subbaraya MohanKumar[1*], S Srinivas[2], M Ramachandra[3], K V Mahendra[4]
*1*Assistant Professor & Research Scholar, Jyothy Institute of Technology, Bangalore -560062, India*
2,3 Department of Mechanical Engineering, BMS College of Engineering, Bangalore -560019, India
4Department of Mechanical Engineering, Amrita Institute of Technology, Bangalore -562109, India
Corresponding Author: Subbaraya Mohan Kumar

ABSTRACT):—Squeeze cast technique forms the easiest way of fabrication technique to produce Aluminium Matrix Composites (AMCs). This work reveals the fabrication of AMCs reinforced with different weight percentages of SiC particulates with a constant weight percentage of Fly Ash by squeeze cast technique. Magnesium was added into the molten metal mixture to increase the wettability of SiC and Fly Ash particulates. The fabricated AMCs were analyzed for microstructure and mechanical properties. The homogenous dissemination of both SiC and Fly Ash particulates in the matrix was revealed by the Optical Microscope. Further hardnessandtensilepropertieswereevaluated asperASTMstandard. Hardness and tensile strength were enhanced with the increase in Wt. % of SiC particulates with constant weight percentage of Fly Ash in Aluminium Matrix. TheresultsshowedthatthehardnessandtensilestrengthwerehigherinthecaseofAl-4.5%Cu-7wt.%flyashand 7wt.%SiCcompositescomparedtothebasealloyandothercompositions.
***KEYWORDS** - Al - 4.5wt. % Cu Alloy, Fly ash, SiC, Squeeze Cast Technique, Ultimate Tensile Strength*

I. INTRODUCTION

Aluminium alloys which possess low densities with good mechanical and tribological properties are widely used in automotive and aerospace industries [1]. In the modern advancement technology there is tremendous demand for lightweight materials and energy saving materials in the applications of space, aircraft, and advanced fighter jets and automobiles [2-3].The various fabrication techniques like stir casting , squeeze casting, Powder metallurgy technique, infiltration and spray co depositions are used for the fabrication of Metal matrix composites and the type of reinforcement used. Squeeze casting is one of the simplest technique widely used in the fabrication which is also known as Liquid Forging. In the present scenario Squeeze casting technique is found to be the most attractive because of its simplicity and most economical in producing large size components. However the liquid processes has nearer net shape than solid phase processes which poses lower manufacturing cost[4].Several researches have conducted experiments on different aluminium alloys and ceramic reinforcements. Mahendra et al. [5] investigated the properties of Al-4.5% Cu reinforced with fly ash and silicon carbide (SiC) particulates composites. The hybrid metal matrix composite was produced using conventional foundry techniques. The fly ash and SiC were added in 5%, 10%, and 15% by weight (equal proportion) to the molten metal. The results show that there is an increase in hardness with increase in the particulates content. The density decreases with increase in fly ash content. The tensile strength, compression strength, and impact strength increases with increase in fly ash and SiC particulates. The resistances to dry wear and slurry erosive wear increases with increase in fly ash and SiC content. Corrosion increases with increase in fly ash and SiC content. This material can be used as bearing material.. Particulate reinforced metal matrix have resulted in producing high strength high wear resistance materials by introducing hard ceramic particles in the metal matrix.[6]. Addition of ceramic reinforcements such as SiC,Al_20_3, TiC& B_4C_3 to metal matrix improves hardness[7]. The second generation composites Hybrid metal matrix composites [HMMC's] are used based on the type shape and size of the reinforcement to obtain better properties [8].Hybrid composites have better mechanical properties when it is compared with single reinforcement composite as they combine the merits of constituent reinforcements [9].Aluminium matrix composites play a vital role to meet the challenges and opportunities which have been reported much better than a unreinforced matrix [10]. The heat treatment of age hardenable alloys involves solutionising the alloys, quenching, and then aging at room temperature (natural aging) or at an elevated temperature (artificial aging). [11]. t is also observed that the composites produced by squeeze cast technique results in homogenous distribution of reinforcement in metal matrix [12]. The wider applications in squeeze casting process are due to some of its good properties, Aluminium Alloys find greater usage in the production of various components [13].

From the literature survey it is observed that not much of work has been carried out on aluminium hybrid metal matrix composites. Hence in this contrast an attempt has been made to investigate and study the mechanical properties of Al -4.5wt% Cu Alloy reinforced with fly ash and Silicon carbide metal matrix composites produced by Stir Squeeze cast technique.

II. EXPERIMENTAL WORK

In the present investigation Al - 4.5 wt. % Cu alloy having theoretical density 2800 kg/m^3 is used as the base matrix. fly ash particulates with theoretical density of 2300 kg/m^3 were used as reinforcements. Average particle size of flyash were taken as 40μ m. Figure 1 & Figure 2 shows the SiC &fly ash particulates.

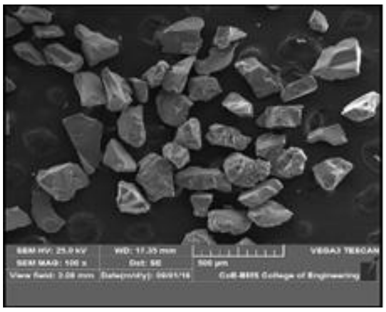


Fig.1

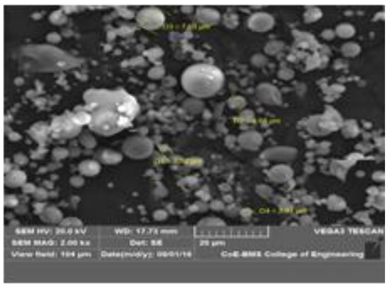


Fig.2

Fig. 1.,2 Scanning electron microphotographs of SiC &Fly Ash particulates.

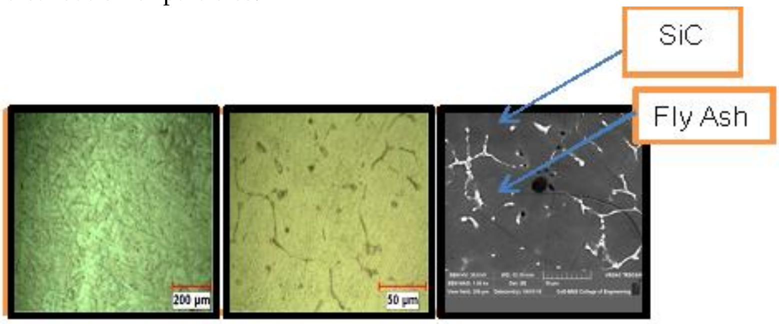
2.2Fabricationofcomposites

Al–4.5% Cualloy forms the matrix which is in the billet shapeis placedinthe graphitecrucible and heatedto 780 ºC. The reinforcement of SiC particulates is weighedin the ratios of 5% 7% by keeping the constant weight percentage of fly Ash which was preheatedto 400 ºCto removethe moisturecontents in the reinforcement.. The reinforcements were preheated priorto theiraddition in the aluminium alloy melt. The preheating of the reinforcementis necessary in orderto reduce thetemperature gradient andto improve wetting between the molten metal and the reinforcements. The molten metal mixture was degassed atatemperature of 780 ºC.usinghexa- chloroethane degassing tablet. Thetablethelps inthe removal of entrapped air inthe melt andthus prevents casting defects like porosity and blow holes. The molten metal matrix Al–4.5% Cu alloy was stirred usingaStirrer to createa vortexand 0.4% wt. of mg wasaddedtoensure good wettability andthe preheated reinforcements were added tothe molten metal mixture withacontinuous stirring speed of 300 rpmtoatime span of3 minutes. The stirred moltenmetal mixture with the reinforcementsis poured intothe preheatedcastiron die andthe die was placedinacompressiontesting machine. The plunger is placedinto thedie andaload of 120 MPa wasapplied for 4 minutes. The melt was thenallowedto solidify in the molds.

III. RESULTS AND DISCUSSION

3.1 Microstructural Studies

Fig. 3 (a) - (b) shows the optical micrographs of as Al - 4.5 wt. % Cu alloy and its composites. Fig. 1 (c) shows the SEM of Al - 4.5 wt. % Cu alloy fly ash and SiC composites. This reveals the uniform distribution of fly ash & SiC particles in Al - 4.5 wt. % Cu alloy base matrix. The vortex generated in the stirring process and squeezing action breaks the solid dendrites due to higher friction between particles and Al matrix alloy, which further induces a uniform distribution of particles.



(a) **(b)) (c)**

Fig. 3. Showing the optical micrographs of (a) cast Al - 4.5 wt. % Cu alloy and (b) Al - 4.5 wt. % Cu alloy 7 wt. % of fly ash 7 wt% of SiC composites. (c)SEM of Al -4.5 wt. % Cu alloy -7 wt. % of fly ash 7 wt% of SiC composites.

3.2 Hardness

The hardness measurements on Al - 4.5 wt. % Cu alloy --Fly ash SiC composites are shown in fig. 5. . It can be observed that the hardness of the compositeis greater than that of its cast matrix. Since thef l y a s h particles being hard dispersoids contribute positively to the hardness of the composite .The increase in hardness is attributed to the f l y a s h pa rticles which act as a barrier to the movement of dislocation within the matrix[14]. The maximum hardness of 74 BHN is obtained for 7wt% fly ash and 7wt% SiC composite when compared with the base alloy.

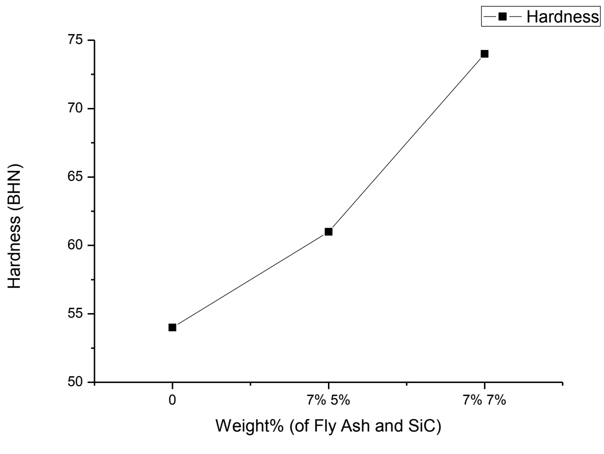


Fig.5 Hardness of Al - 4.5 wt. % Cu alloy and its composites.

3.3Tensile Strength

Fig. 6 shows the ultimate tensile strength (UTS) of the composite which is higher than that of the matrix alloy. The improvement in tensile strength of the composites may be attributed to the fact that the filler Fly ash possesses higher strength due to the better bonding and uniform dispersion of f l y a s h particulates in base matrix. In the present study, the increase in UTS of the composite specimen is obviously due to the presence offly ash & SiC particles which impart strength to the matrix alloy, imparting more resistance to the composite against the applied tensile stresses. The tensile strength increases with an increase in percentage of fly ash & SiC particulates. Castings with smaller cross sections exhibit higher tensile strength because of faster heat transfer from the mold resulting in a finer grain structure [15]. The maximum hardness of 245 MPa is obtained for 7wt% Fly ash and 7wt% SiC composite when compared with the base alloy.

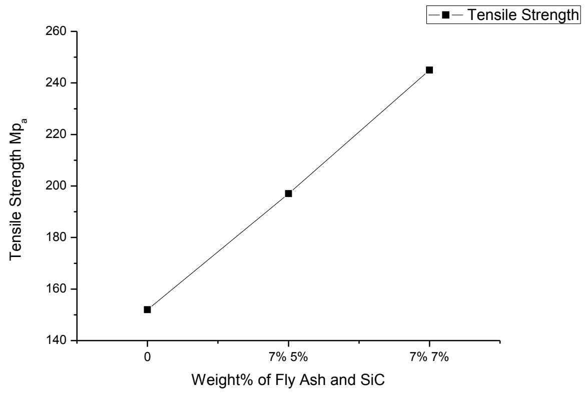


Fig 6 Tensile Strength of Al - 4.5 wt. % Cu alloy and its composites.

3.3Yield Strength

Fig.7 shows variation of yield strength (YS) of Al - 4.5 wt. % Cu alloy matrix with 5 and 7 wt. % of fly ash & SiC particulate reinforced composite. It can be seen that by adding 7 wt. % of fly ash & SiC particulates, yield strength of the Al -4.5 wt. % Cu alloy increased from 124 MPa to 202 MPa. The increase in yield strength of the composite is obviously due to presence of hard fly ash & SiC particles which impart strength to the softer Aluminium matrix resulting in greater resistance of the composite against the applied tensile load [16]. The maximum yield strength of 202 MPa is obtained for 7wt% fly ash and 7wt% SiC composite when compared with the base alloy.

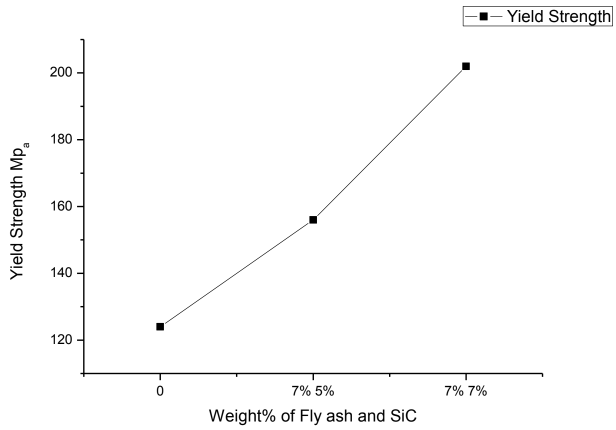


Fig 7Yield Strength of Al - 4.5 wt. % Cu alloy and its composites.

IV. CONCLUSION

Hardness of the Al - 4.5 wt. % Cu alloy composite was found to be more than base Al matrix. The ultimate tensile strength (UTS) of the composites were found to be higher than base matrix Al - 4.5 wt. % Cu alloy. The reinforcement of particles has enhanced the tensile strength of aluminium matrix from 152 MPa to 245 MPa.The yield strength of the composites found to be higher than that of the base matrix. The yield strength of base matrix Al - 4.5 wt. % Cu alloyis increased from 124 MPa to 202 MPa after addition of 7 wt. % of fly ash & 7 wt% SiC particulates.

Acknowledgements

Theauthors wouldliketo extend theiracknowledgementto BMS College of Engineering, India, and Jyothy Institute of Technology, for providing lab facilities.

REFERENCES

[1]. I.A Ibrahim , F.A. Mohamed & E.J lavernia, Particulate reinforced metal matrix composites a review, Journals of Materials Science,26,1991, 1137-1156

[2]. R. Ezatpour, Torabi, S. A. Sajjadi, Transactions of Nonferrous Metals Society of China, 23, 2013, 1262-1268.

[3]. S. A. Sajjadi, H. R. Ezatpour, M. Torabi, Materials and Design, 34, 2012,106-111.

[4]. T,R, Vijayaram, S. Sulaiman, AMS Hamouda, MHM Ahmed, Fabrication of fiber reinforced metal matrix composites, by squeeze casting technology, 178,2006, 34-38.

[5]. K. V. Mahendra, K. Radhakrishna, Journal of Composite Materials, 2010.

[6]. Zhan Y, Zhang G, Graphite and SiC hybrid particles reinforced copper composite and its tribological characteristics, Journal of Material Science, 22, 2003, pp. 1087-1089.

[7]. IJANG Y H WANG, YANG Y F WANG, YY JANG Q C, Evolution process of the synthesis of TiC in the Cu-TiC system, Journal of Alloy of compounds, 452, 2008, pp 298-303.

[8]. MATSUNAGA T, KIM JK, HARDCASTLE, S ROHATGI D.K, Casting characteristics of aluminium alloy Fly Ash composites, Transactions of AFS,104, 1996, pp 1097-1102.

[9]. THAKUR S K, KWEE G T GUPTA M, Development and characterization of magnesium composites containing nano sized silicon carbide as hybrid reinforcements, Journal of Material Science,42,2007,pp10040-10046

[10]. Surappa M K, Aluminium matrix composites ,challenges and opportunities, sadhana, 28, pp 319

[11]. A review on the heat treatment of Al-Si-Cu/Mg casting alloys .

[12]. H.C. How, T.N. Baker, “Dry sliding wear behaviour of Saffil-reinforced AA6061 composites”, Wear,210 1997, pp.263-272.10.

[13]. Liang, Y. N., Ma, Z. Y., Li, S. Z., Li, S. and Bi, J., “Effect of particle size on wear behaviour of Sic particulate-reinforced aluminium alloy composites”, Journal of Materials Science, Letters, 1995, 14, pp.114- 116.

[14]. S.M.Sayed Reihani, Processing of squeeze cast Al 6061- 30vol% SiC composites and their characterization , Materials and Design, 27,2006,pp216-222

[15]. P. K. Rohatgi, B. F. Schultz, A. Daoud, Zhang, Tribology International, 43, 2010, 455 -466.

Subbaraya Mohan Kumar ."Synthesis and Evaluation of Properties of Al – Flyash SiC Composite" International Journal Of Modern Engineering Research (IJMER), vol. 08, no. 01, 2018, pp. 92–96.