IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 7, Issue 6 (Jul. - Aug. 2013), PP 41-46
www.iosrjournals.org

A Study on Mechanical Properties of Fly Ash and Alumina Reinforced Aluminium Alloy (LM25) Composites.

Mr.Sharanabasappa R Patil[1], Prof B.S Motgi[2]
[1]Mtech in production engineering, , Department of Mechanical Engineering,PDA College of Engineering ,Gulbarga
[2]Professor, Department of Mechanical Engineering,PDA College of Engineering, Gulbarga-585 102.

Abstract: *The results of an experimental investigation of the mechanical properties of fly ash and Alumina reinforced aluminium alloy (LM25) composites samples, processed by stir casting route are reported in this paper. Three sets of composites with constant weight fraction of fly ash (particle size of 3-100 µm) and Al2O3(particle size of 150 µm) with different wt% were used. Composite samples have the reinforcement weight fractions of constant 3% fly Ash and varying %wt of 5, 10 and 15% Al2O3 . The main mechanical properties studied were the tensile strength,ductilityimpact strength & hardness. Unreinforced LM25 samples were also tested for the same properties. It was found that the tensile strength & hardness of the aluminium alloy (Lm25) composites increases with the increase in %wt of* Al_2O_3 *upto certain limit. in addition of more amount of reinforcement the Tensile strength decrease due to poor wettability of the reinforced material with metal aluminium matrix .And the charpy test shows decrease in impact load absorption with increase in %weight reinforcement.The Microstructure study of the samples indicated near uniform distribution of the fly ash and* Al_2O_3 *particles in the matrix. LM25 alloy is mainly used where good mechanical properties are required in castings of a shape or dimensions requiring an alloy of excellent castability in order to achieve the desired standard of soundness.The alloy is also used where resistance to corrosion is an important consideration particularly where highstrength is also required.*
Key Words: *LM25 Aluminum Alloy,Flyash,* Al_2O_3*, LM25 Mechanical properties.*

I. Introduction

Composite material is defined as the material which has two or more distinct phases like matrix phase and reinforcing phase and having bulk properties significantly different from those of any of the constituents present in the matrix material. Many of common materials also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents. Favorable properties of composites materials are high stiffness and high tensile strength, low density, high temperature stability, and also in some of the applications electrical and thermal conductivity properties are also taken into consideration, the properties like coefficient of thermal expansion, corrosion resistance should be low with improved wear resistance. By keeping all these parameters in mind the metal matrix composites are being produced. Improved mechanical properties can be incorporated in Metal Matrix Composites very easily. That is the reason why these MMC materials are getting more attention in recent years.Before preparing the aluminium metal matrix composite material I have studied some papers in which the addition of Fly ash and Al_2O_3 has been made and mechanical properties were studied. Few of them are as follows.

- Unlu, (2008) studied the properties of Al based Al_2O_3 and SiC particle reinforced composite materials and found that mechanical properties like hardness of the composites significantly improved by the use of reinforcements.
- Veereshkumar et al. (2009) studied the mechanical properties of Al6061- Al_2O_3 and Al7075- SiC composites and found that brinnel hardness of the composites were increased with increase in filler content in the composites, the dispersion of Al_2O_3 in Al6061 and SiC in Al7075 alloy confirmed enhancement of the mechanical properties.
- Sudarshan et al. (2008) studied characterization of A356 Al - fly ash particle composites with fly ash particles of narrow range(53-106µm) and wide size range(0.5-400 µm) and found that addition of fly ash lead to increase in hardness, elastic modulus and 0.2% proof stress.
- Mahendra et al. (2007) studied the properties of Al-4.5% Cu alloy composite with fly ash as reinforcement. They reported the increase in hardness, tensile strength, compression strength and impact strength with increase in the fly ash content.
- Charles et al. (2004) studied the properties of aluminium alloy hybrid (Al-alloy/Silicon carbide (SiC)/fly ash) composites. They reported that the wear and hardness were enhanced on increasing the volume

fraction of SiC. They also reported that the tensile strength was high at 10 volume fraction of SiC and decreased as the volume fraction increased.

From the above literature review it can be concluded that the influence of different % wt of Al_2O_3 with constant %wt of Flash on mechanical properties of Aluminium LM25 has been taken for study. And effort has been made to show the effect of reinforcement and its %wt variation on the mechanical properties to make it as an useful material in engineering field.

II. Experimental Procedure.

2.1. Specimen Preparation.

The Aluminum metal matrix composite material has been prepared by stir casting method in an induction furnace (Fig.2.1.1). The weighed quantity of LM25 metal in the form of flakes has been taken in a crucible and then melted upto 850ºC temperature been maintained. To this pre heated (at 400 ºC in muffle furnace) Fly ash and Al2O3 has been added at a proper weight %.The contents are stirred (at 600RPM, about 3-5 minutes) properly to generate vortex for proper mixing of the matrix and phases. A small amount amount of (1%) Magnesium is added to improve the wettability of the phases in matrix. After mixing the melt is poured into the pre heated (about 180ºC) CI Metal die (Fig.2.1.2) for specimen preparation.

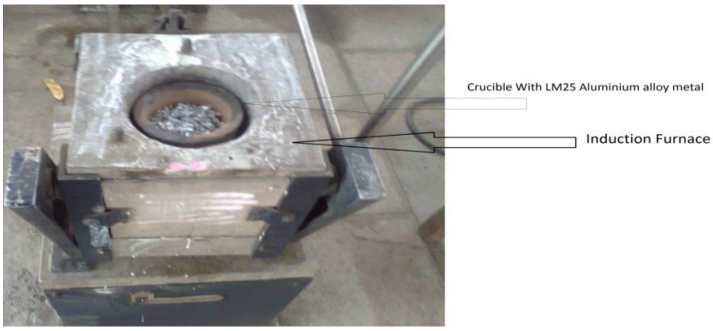

Fig.2.1.1 Induction furnace with Crucible containing LM25

Fig.2.1.2 Metal Die (CI) with proper fixtures.

Fig 2.1.3 Induction furnace with stirrer mechanism

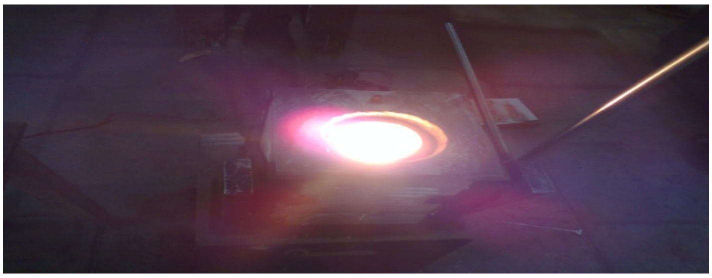

Fig 2.1.4 Induction furnace showing molten metal

Fig 2.1.5 Tensile and impact test specimen with varying composition of Al_2O_3

The table 1 & 2 shows the respective chemical compositions of LM25& Flyash

Table 1 Chemical composition (In %wt) of LM25 Aluminium alloy

Cu	Mg	Si	Fe	Mn	Ni	Zn	Sn	Ti	Al
0.1	0.2-0.6	6.5-7.5	0.5 Max	0.3	0.1	0.1	0.1	0.05	Reminder

Table 2Chemical Composition(in %wt) of Flyash

Al2O3	SiO2	Fe2O3	TiO2	Loss of ignition
28.44	59.96	8.85	2.75	1.43

2.2 Testing of mechanical properties:

According to BS:18:1962 The tensile tests were conducted on these samples at room temperature, using a universal testing machine . The specimens used were of diameter 10mm and Gauge length 50 mm, machined from the cast composites with the gauge length of the specimen parallel to the longitudinal axis of the castings. The impact tests were conducted as per BS:18:1962.The specimens used were of 10x10mm and 55mm length with V notch of 45⁰ and 2 mm depth machined from cast composites. The Brinnel hardness tests were conducted in accordance with the ASTM E10.

III. Results And Discussion

The micro structure plays an important role for analyzing the distribution of distinct phases in an Aluminium matrix material. The micro structure was studied by using scanning electron microscope and which shows that the phases are near uniformly distributed in the metal matrix. And the Images are as shown below.

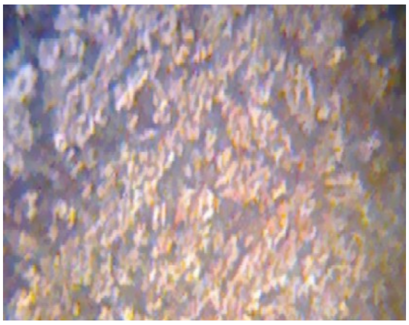

Image 3a.Micro structure of LM25 with 5% Al2O3 and 3% Flyash

Image 3b.Micro structure of LM25 with 10% Al_2O_3 and 3% Flyash

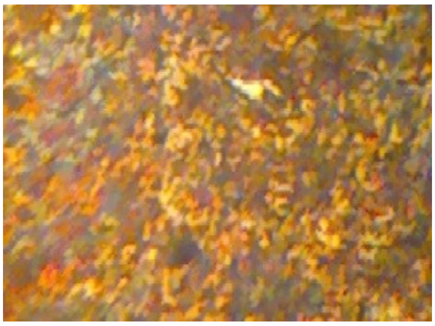

Image 3c .Micro structure of LM25 with 15 % Al_2O_3 and 3% Flyash

3.1 Tensile properties.

From the below fig 3.1.1 which has been observed that the tensile strength of the metal matrix composite material will increases due to the resistance to the dislocations and hence the strength increases with increase in weight %.But at 15% weight of Al_2O_3 the tensile strength has came down due to the poor wettability of the phases in with the matrix.

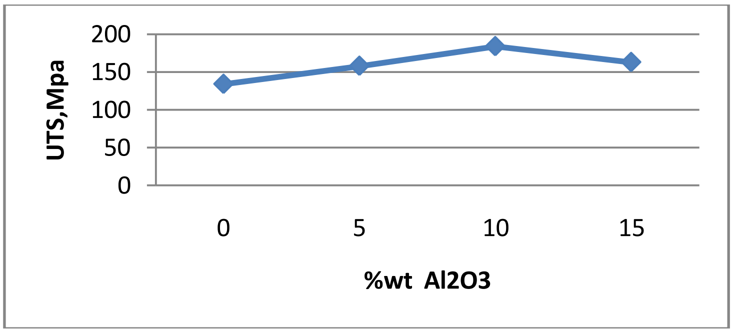

Fig: 3.1.1 Variation of UTS with % wt variation of Al_2O_3

3.2 Hardness

From fig.3.2.1 it can be observed that the hardness of the composite increases with the increase in % weight of Al_2O_3.and hence the Al_2O_3 can be used for the variation of hardness in LM25 for the application where Hardness plays a major role.

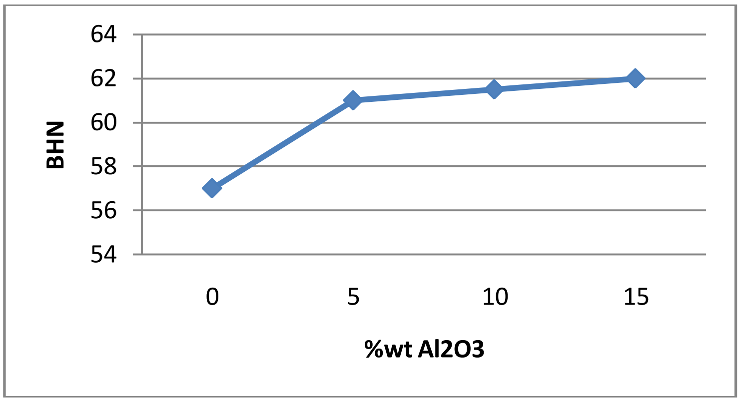

Fig:3.2.1 Hardness variation With % wt variation of AL2O3.

3.3 Ductility

From fig 3.3.1 it has been observed that the % Elongation decreases with the addition of Al_2O_3 reinforcement material. Because the hardness restricts the elongation and hence reducing the ductility of the material

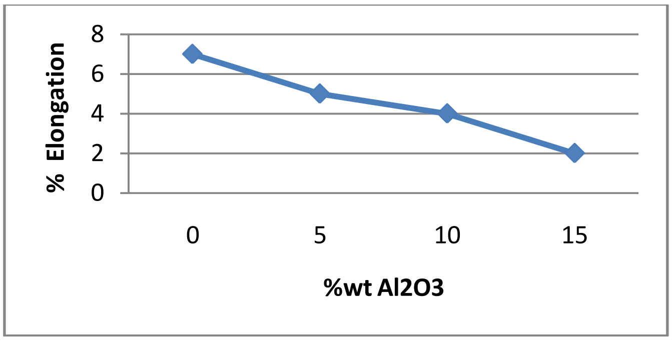

Fig:3.3.1 Variation of % Elongation with % wt Al2O3

3.4 Impact test

From fig3.4.1 it has been observed that the impact strength decrease with increase in %wt of Al_2O_3 in the metal matrix because the hardness of the composite material will increases by decreasing impact load absorption capacity.

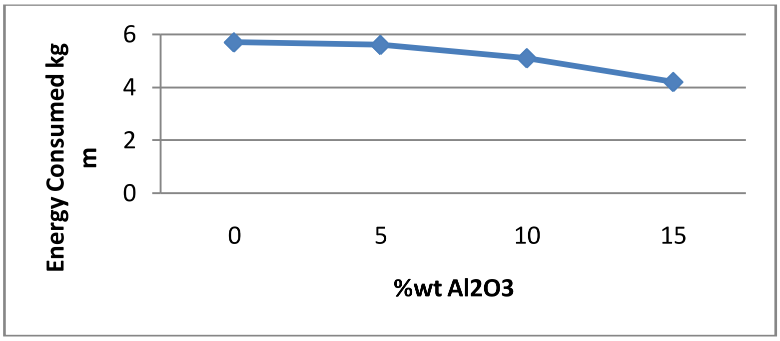

Fig:3.4.1 Impact load absorption(In kg m) with % wt Al2O3

IV. Conclusion.

From the above experiment I can conclude that aluminum composite materials can be easily prepared by stir casting method, and microstructure study shows the near uniformly distributed phases in the metal matrix. The mechanical properties like Tensile strength and Hardness increases with increase in %wt addition of Al_2O_3.While at the other end ductility and impact strength will gets reduced .The poor wettability of the phases in the matrix is the major problem at higher weight fraction of reinforcement ,due to this problem the strength decreases after certain limit. From this problem we can overcome by adding small amount of Magnesium and by pre heating the composites and the die.

References

[1]. Basavaraju.S,Arasukumar.K,Studies on Mechanical properties and tribological charecteristics of LM25 graphite-Silicon carbide and LM25-Flyash-Silicon carbide-MMCs,Vol.1,Issue1,Nov 2012.

[2]. Harish K.Garg1, Ketan Verma2, Alakesh Manna3, Rajesh Kumar4,Hybrid Metal Matrix Composites and further improvement in their machinability, Vol.1,Issue 1 :36-44,May-June(2012).

[3]. V.C.UVARAJA, N. NATARAJAN , Optimization on Friction and Wear Process Parameters Using Taguchi Technique, Volume 2 No. 4, April, 2012.

[4]. A. Anandha Moorthy, Dr. N. Natarajan, R. Sivakumar, M. Manojkumar, M. Suresh, Dry Sliding Wear and Mechanical Behavior of Aluminium/Fly ash/Graphite Hybrid Metal Matrix Composite Using Taguchi Method, Vol.2, Issue.3, May-June 2012 pp-1224-1230.

[5]. Unlu, (2008) studied the properties of Al based Al2O3 and SiC particle reinforced composite materials.

[6]. S. Venkat Prasat, R. Subramanian, N. Radhika, B. Anandavel, L. Arun, N. Praveen, Influence of Parameters on the Dry Sliding Wear Behaviour of

[7]. Aluminium/Fly ash/Graphite Hybrid Metal Matrix Composites, ISSN 1450-216X Vol.53 No.2 (2011), pp.280-290

[8]. Veereshkumar et al. (2009) studied the mechanical properties of Al6061-Al2O3 and Al7075- SiC composites.

[9]. Ashok Kr. Mishra, Rakesh Sheokand, Dr. R K Srivastava Tribological Behaviour of Al-6061 / SiC Metal Matrix Composite by Taguchi's Techniques ,Volume 2, Issue 10, October 2012 ISSN 2250-3153.

[10]. Sudarshan et al. (2008) studied characterization of A356 Al - fly ash particle composites with fly ash particles of narrow range(53-106μm) and wide size range(0.5-400 μm).

[11]. Chandrasekhar.T.S , Prabhakar Kammar, Dr.H.K.Shivanand, Santhosh Kumar.S , Mallikarjuna.B.E, Characterization of Mechanical Properties of Al 2024 Hybrid Metal Matrix Composites, ISSN 0974-309X Volume 3, Number 2 (2012), pp. 61-68

[12]. Mahendra et al. (2007) studied the properties of Al-4.5% Cu alloy composite with fly ash as reinforcement.

[13]. X.H. Lin, Y.L. Kang *, Q.H. Qin, D.H. Fu, Identification of interfacial parameters in a particle reinforced metal matrix composite Al6061–10%Al2O3 by hybrid method and genetic algorithm.