RESEARCH ARTICLE OPEN ACCESS

Fabrication and Investigation of Microstructure Analysis of Surface test on Aluminum LM 25 Alloy

Selvam. S [1], Arulraj. R [2]

[1] Department of Computer Aided in Design, [2] Department of Mechanical Engineering,
Mahindra Engineering College, Mahendhirapuri, Mallasamudram, Trichengode, Namakkal DT Tamilnadu - India.

ABSTRACT

This paper presents the work is defined of the fabrication and investigation experimental analysis of mechanical properties and surface finishing characteristics of microstructure of LM25/Sic/Al_2O_3 and graphite of these three Nano particles of hybrid MMC. Composite specimens of reinforcements ranging of 30 wt-% were fabricated using liquid metallurgy stir casting process. Mechanical properties of these Nano particles of such as hardness and microstructure of surfaces were analyzed for reinforced unreinforced for well bonding of composite specimens of an alloy. Surface test were observed with SEM all wear experiment. The inner structure of the Surfaces of composites were analyzed by using Scanning Electron Microscope from experiments as the uniform distribution of the three Nano particles in the molten metal of the percentage of reinforcement was increased. Wear characteristics of composite materials of the specimens were studied using Pin-on-disc Wear test apparatus. These materials are identified in the process of investigation due to their hardness of alumina and surface roughness and excellent hardness property of Silicon Carbide and Graphite. LM25 aluminum alloy found its application in food marine, chemical, electrical, automobile and many other industries.

I. INTRODUCTION

In the present day scenario metal matrix composites (MMC's) are seems their wide importance in the fields of aerospace and automotive industry. The major problem identified in the manufacturability of these composites with non-uniform distribution of molecules of the particles due to their inter molecules and the strength on their mechanical properties.

Stir casting process is employed for the fabrication of composite component and Mechanical properties of Aluminum alloy, Alumina, Silicon carbide and graphite metal matrix Composites are experimentally determined. The composition of MMC in varied for alumina, Silicon carbide and graphite by remaining 95% by LM25 Aluminum alloy. Manufacture gravity die castings, sand castings and pressure die castings. In LM 25 Aluminum Alloy. The biggest benefit of selecting LM25 is the strength that can be achieved in heat treatment condition that LM 25 normally used in gravity casting and die casting.

This alloys contains to LM 25.Castings are standardized in the cast on the precipitation treated, stabilized and fully heat treated state.

III. OBJECTIVES OF STUDY

To develop the better surface structure finishing of the component to be manufactured of huge quantity by using the stir casting process for these consideration of an effective methodology

II. REVIEW OF LITERATURE

Surface finishing is occurred on all type of metal surface abraded it gives the uniform flatness level of the metal surface finishing has estimated that of all roughness problems in industry are due to bonded together, and as such, much laboratory work has examined and sought to rationalize the surface finishing of a wide range of aluminum alloy materials.

Often, test apparatus are designed to simulate a specific service application and thus a large number of test methods have been developed. Any mechanical devices that examines the motion of solids relative to surfaces will causes of inter molecules of strength and hardness problems.

The particular desires in the present work is the surface finish in aluminum alloy metal used in cylinder heads under the action of seating between the two heads resulting when arranging the heavy vehicles. Some authors have discussed about between the flatness and hardness. They have that the correlation between hardness and surface finishing is observed. This contradiction due to differences in contact conditions, configurations, parameters and types of test used. Specifically, the influence of smooth size and shape of fine particles on the properties of flatness on the metal surface has been discussed.

It was tested, that fine scale morphology, in addition to bulk shape, can have a specific influence on the effectiveness of particles in fine surface finishing. In this work, we will present the abrasive wear of three aluminum alloys with different structure of the surfaces submitted to friction with abrasive particles. A Electron Scanning Microscope device was to study both the influence of fine particles and their incidence angle on the smooth surface behavior of these aluminum alloys. Surface roughness tests were carried out with the standard pit sand (SPS).three

This was plotted for LM25 aluminum alloy of the aluminum alloy increases as the incident angle increases, the slope of the line brings steeper.

To identify the effect of Nano particles additional wear tests were carried out using the addition of three Nano particles of Sic, Alumina and Graphite in the LM25 Aluminum alloy. All these tests were performed variation of surfaces about the LM25 aluminum alloy.

However, for aluminum alloy there is an increase in the impact strength when using the normalized

A comparative study of surface roughness of the 5xxx family and 7xxx family (7T6 and 7T4) is summarized.

Remora and G Padmanabhan (2012) Fabricated aluminum alloy boron carbide composites using liquid metallurgy the fraction of reinforcement particulates weight of 2.5, 5 and 7.5 %. SEM images are observed a uniform distribution of Silicon carbide, Alumina and Graphite of Nano particles in aluminum matrix. Madeva Nag Aral (2013) have studied the mechanical behavior Al6061/Al_2O/Graphite reinforced MMC liquid metallurgy route the tensile strength of composite.

Gurwinder singh (2014) developed a hybrid composite of aluminum with Sic, Al_2O_3 and C particles using squeeze casting method.

With varying weight % of reinforcement .K.R. Padmavathi (2014) have studied the wear and friction behavior of Al-6061 with various percentages volumes of multiwall carbon Nano tube and silicon carbide reinforcement through stir casting and then die casting studied the wear resistance of Al/Alumina

aluminum alloys were tested, namely,5A(69 Hv),and 7T6 28 Hv).Flatness level has been defined by the measured of the specimen.

The the mass. This contradicts the Orchard theory. It was noted that wear kinetics of 7xxx aluminum alloy (7T6 and 7T4) are lower than the 5xxx aluminum alloy (5H and 5A), Sic reinforced composite with increase in surface finishing for Al_2O_3 reinforced composite. .

An alloying elements is increased, surface finishes as well as hardness was increased. With smaller section size better mechanical properties are achieved due to heat treatment process with faster cooling rate. Various casting techniques such as stir casting, squeeze and die casting mold are utilized for the fabrication of aluminum alloy.

(Al_2O_3) composites and found that the wear resistance increased with increasing Al_2O_3 particle content and size and decreased with increasing the abrasive grit size and sliding distance.

The results revealed that the reinforcement has improved the wear resisting property of LM 25 alloy Based on the above literature, LM25 alloy is selected as matrix; Al_2O_3 and Sic Nano particles are selected as reinforcements with the size of 10 – 15 µ. Hence an attempt has to improve the surface roughness of that alloy by incorporating in the reinforcements

The LM25 aluminum alloy is preferred to reinforce the Si_3N_4 particles since it has high strength with enormous applications in the automotive sector. This alloy has the density of 2.68 g/cm^3 and application in the cylinder heads, cylinder blocks and other engine components. The Si_3N_4 particles (10 wt % and avg 40 µ) have the density of 3.2 g/cm^3 and it having more hardness with fine surface finishing..

Table 1 CHEMICAL COMPOSTION

Metal	**Percentage**
Copper	0.2 max
Iron	0,5
Zinc	0.1 max
Titanium	0.2 max
Magnesium	0.2 – 0.6 max
Manganese	0.3 max
Lead	0.1 max
Silicon	6.5 -7.0
Nickel	0.1 max
Tin	0.05 max
Others	0.05 max
Aluminum	Remainder

Table 2 .MECHANICAL COMPOSITION

Name of material	**LM 25**	**LM25 TE**	**LM25 TB7**	**LM25 TF**
Type of casting	Sand Gravity	Sand Gravity	Sand Gravity	Sand Gravity
0.2 per Proof stress N/mm2	80-100 80-100	120-150 130-200	80-110 80 - 110	200-250 220-260
Tensile strength N/mm^2	130-150 160-200	150-180 190-250	160	230-280 280-320
Elongation in %	2 3	1 2	2.5 5	- 2
Impact Resistance	- - -	- - -	-	- - - -
Brunel Hardness	55 – 65 55-65	55 – 65 55 - 65	55 – 75 55– 75	90 –110 90– 110
Modulus of elasticity)103 N /mm^2	71 71	71 71	71 71 71 - 71	71 71 71 -71
Shear strength N/mm^2	- - -	- - -	- - - -	180 250

Table 3 PHYSICAL PROPERTIES

Coefficient of Thermal expansion@20 - 200̊ ° C	0.000022
Thermal Conductivity° C@25 ° C	0.36
Electrical Conductivity@20 ° C	39
Density	2.68
Freeing range ° C	615 -550

Fig 1 Stir casting machine Experimental set up

3.1 MACHINABILITY OF LM25 ALLOY

The heat treated alloys having fairly high strength and good machining properties. But tools should be preferable for high speed steel and must be kept sharp liberal cutting can be employed.

3.2 APPLICATIONS

The alloy is used to where resistance to corrosion important consideration required.
LM25 aluminum alloy found its application in food marine, chemical, electrical and many other industries.
Transport vehicle its used for wheels, cylinder block, and heads and other engine body castings.
It is used for nuclear energy installations and for aircraft pump parts.
LM25 is the superior for castings it offers better machinability and mechanical properties than LM6.

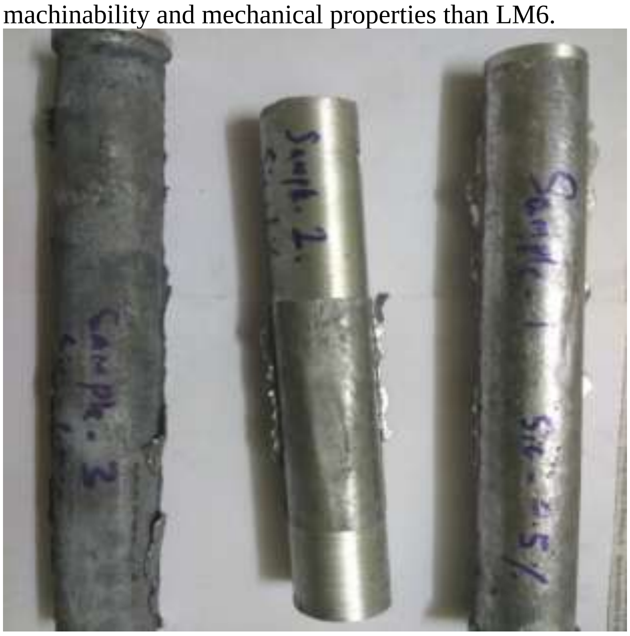


Figure 2 Specimen made by stir casting process

IV. MICROSTRUCTURE

The surfaces as the work specimen of have been taken for the microstructural examination. The outer diameter 30 mm and thick 15 mm are taken as described finite dimensional system and polished with the help of lavisher polisher to remove the scratches.

To ensure the uniform distribution of the reinforcement in the matrix, microstructure characterization was investigated by using Scanning And then, the specimen was placed on the viewing stage of the Zeiss Axiovert 25 CA inverted metallurgical microscope and then examined the microstructure with the monochromatic light A source and photograph of Electron Microscope. The specimens were cut from the central portion of the composites, and then polished on the belt grinding machine for 3 minutes, and next polished on a disc polishing machine with different grades of emery papers for 6 min each, The emery sheets are then employed for polishing to achieve good surface The specimens was kept into disc polishing machine to have a fine polishing..
microstructure was captured a magnification of 5x,10x,45x and 100

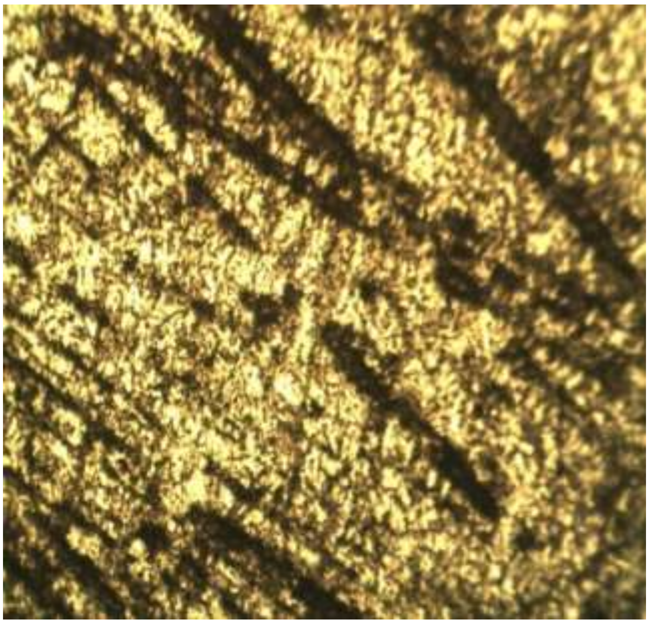
4.1 Microstructural examination

The optical micrographs of the outer 30 mm and inner thick 15 mm of the FGM are displayed in Fig. 6

4.2 Microstructures of samples

Figure shows the microstructure of sample 1 with a magnification of 5x. However, only a few deboning particles are observed

Sample



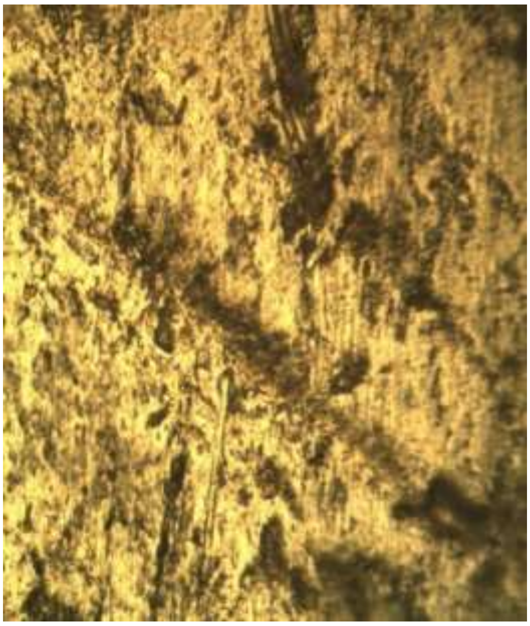


Fig7a Group 1 5x

Fig 7b Group 1 10x

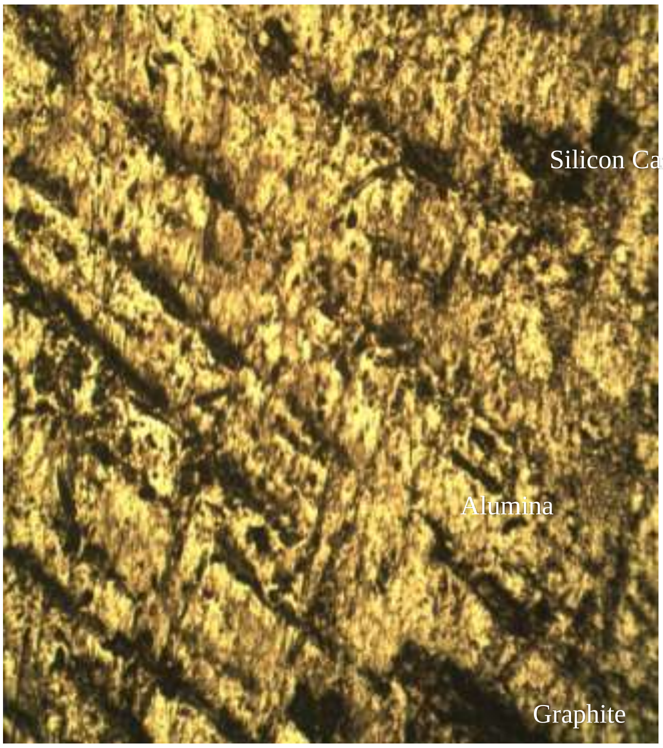


Fig7c Group1 45x

Fig7d Group1 100x

The optical micrographs of the outer 30 mm and inner thick 15 mm of the FGM are displayed in Fig.8 a
Sample

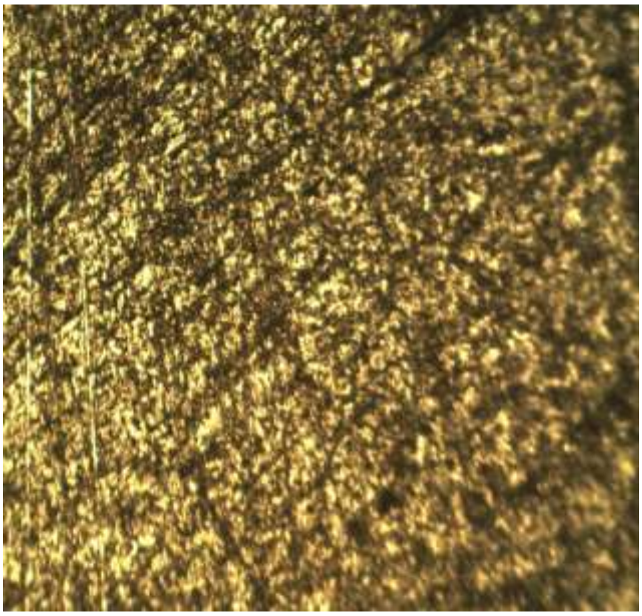


Fig 8a Group2 5 x

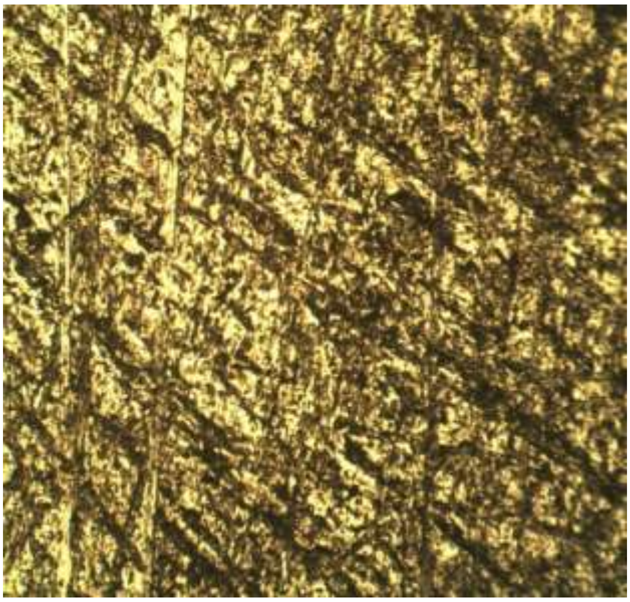


Fig 8b Group2 10x

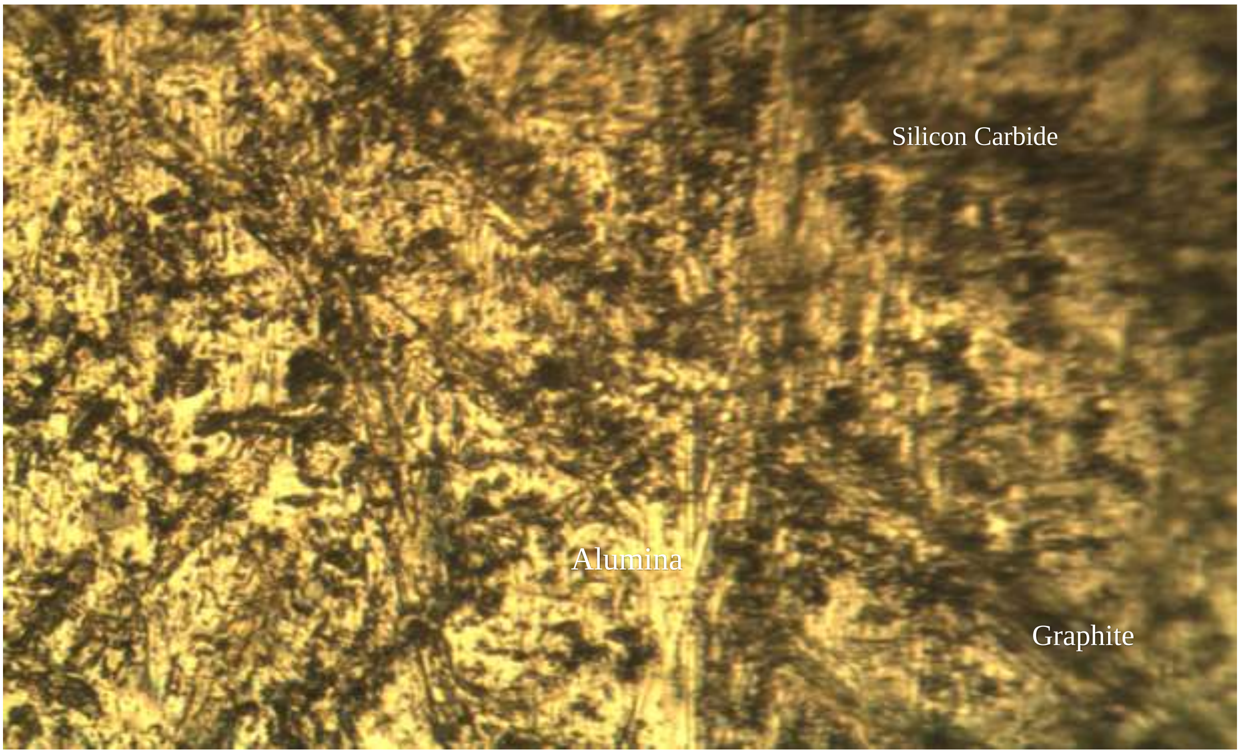


Fig 8c Group 2 45x

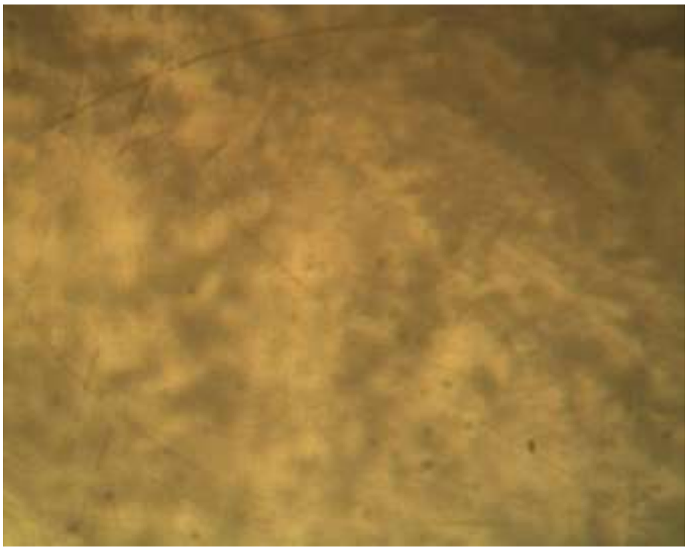


Fig 8d Group2 100x

Fig.8C shows the microstructure of sample 2 at 45x magnification. The general arrangement of Nano particles presents in the reinforcements of the aluminum alloy are fairly visible in the image. The darker particles are silicon carbide, the white indicates alumina and black color is the graphite in the presence of aluminum. The aluminum particles in the matrix are more clearly visible at a magnification of 45x as shown in Fig. 8C.The composite particulates are well uniform distributed due to stirring effect

Alumin

.4.3 Sample

The optical micrographs of the outer 30 mm and inner thick 15 mm of the FGM are displayed in Fig. 9a

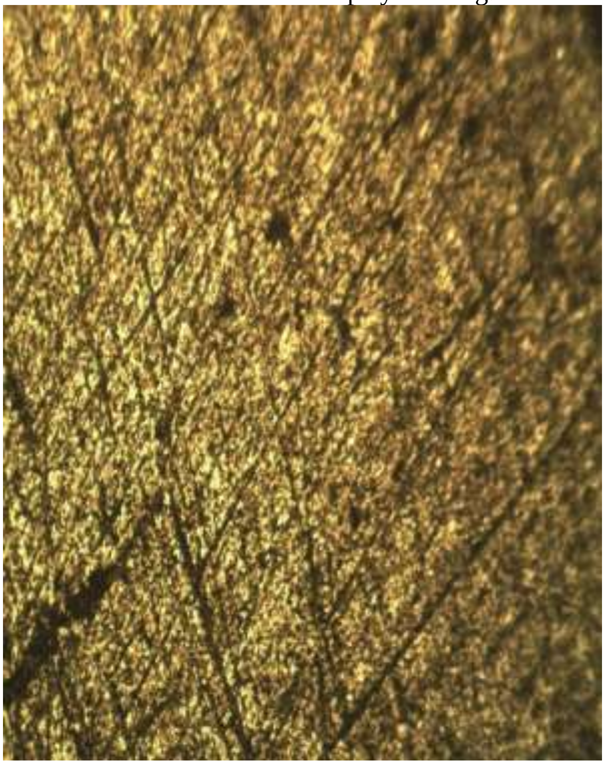


Fig 9a Group 3 5x

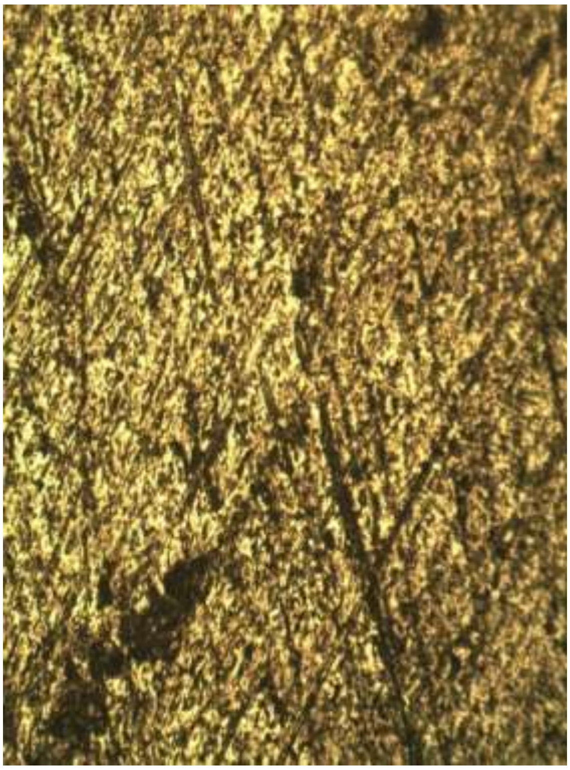


Fig 9b Group3 10x

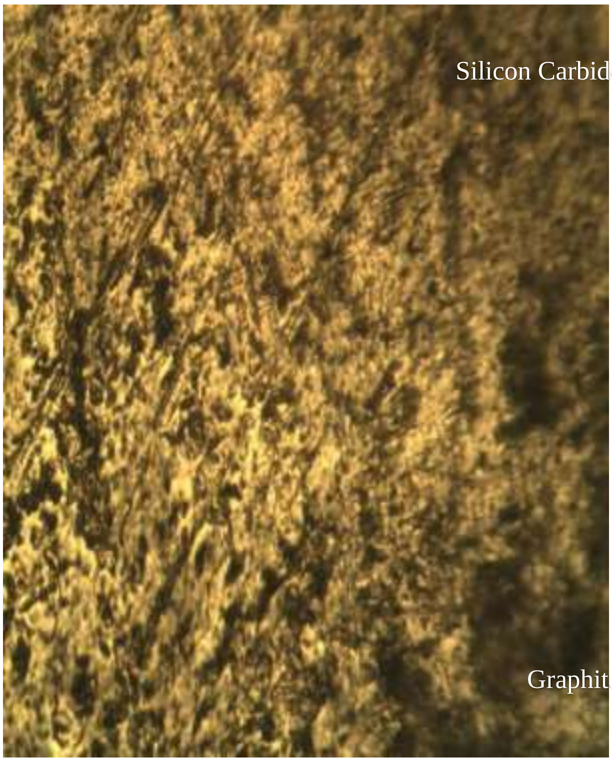


Fig 9c Group 3 45x

Fig9d Group3 100x

From Fig. 9d, the images of sample 3 can be distinguished from those of samples 1 and 2 as these images a few molecules of the reinforcements, which are invisible in the cases of samples.

Fig. 9shows the microstructure of sample 3 which consist of aluminum alloy LM 25. The picture shows the inner surface of sample 3 in its consist of aluminum and other components like alumina, silicon carbide and graphite.

V. HEAT TREATMENT PROCESS

Again one component made as the same ratio of Silicon carbide 1%, Alumina 1% and Graphite 1% by the stir casting process. It has cut it the cross section of 8mm x 8mm into three pieces which is kept at 287° C and heat is maintained at constant for 3 hours at muffle furnace.

Figure *4* Specimen kept at furnace

Figure 5 After Heat treatment specimen

VI. RESULT AND DISCUSSIONS

The microstructure test results obtained for the different combination of the surface structure as per the experimental design are shown in Figure 7a to 9d of the specimen.

The error percentage calculated falls within the range of 6 % which ensures that the constructed model is well adequate in estimating done by the experiment.

Adequacy in predicting the wear behavior of the composite protects the specimen from the sliding wear and results in decreasing of wear rate .The wear rate of the specimen increased initially with increase in load and decreases after running for some distance. Specifically, it is known that in pin-on-disc test, the wear loss from the specimen greatly depends upon the wear track condition during the whole running distance.

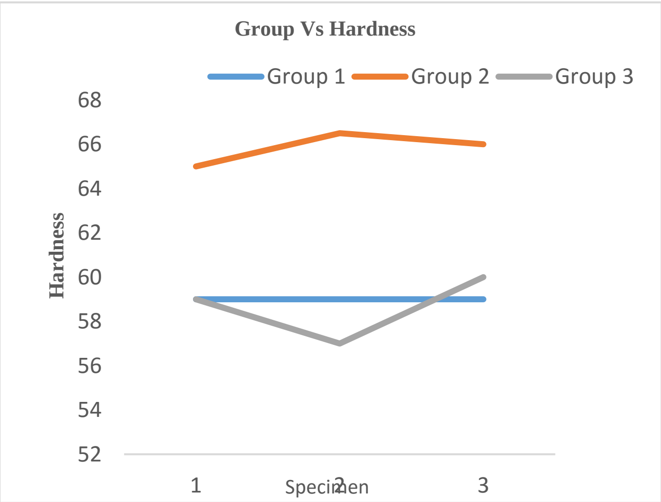
After tested all samples each samples was tested for separately for the hardness and surface structure were analyzed by using scanning electron microscope.

Table 5 **Hardness test before heat treatment process**

Sample	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
1	59	59	59	59
2	65	66.5	66	66
3	59	57	60	59

Table 6 **Hardness test after heat treatment process**

ample	**Trial 1**	**Trial 2**	**Trial 3**	**Average**
1	106	108	106	106.7



The group 2 specimen aluminum material was chosen the hardness value increases as 106.7 after heat treatment process.

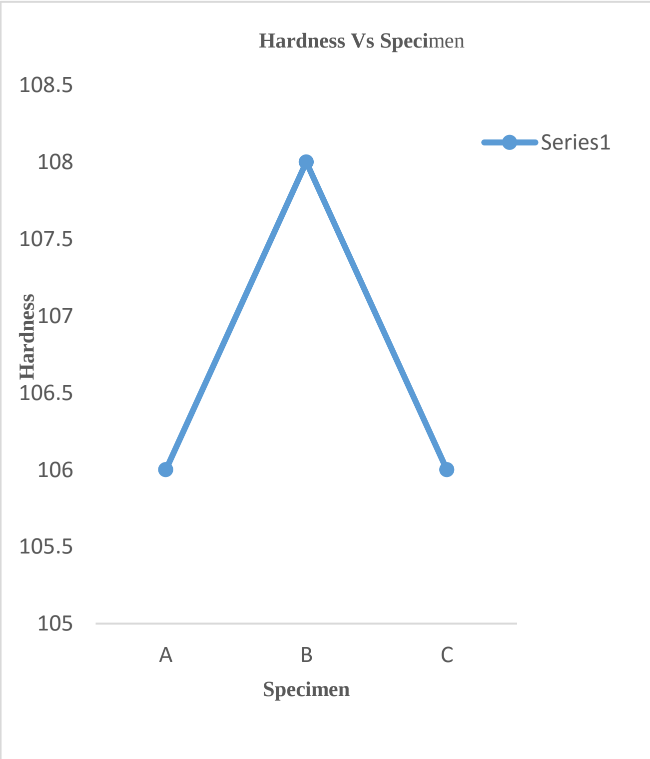
The group 2 specimen high resisting force increases it gives less wear after heat treatment processes which is designed by these effective methodology.

The aluminum LM 25 alloy material it seems better surface finishing that keeps the investigating by the Scanning Electron Microscope after heat treatment process.

The inner structure of the group B aluminum alloy LM25 material its gets uniform distribution well bonded and it's having more strength shown in figure7 Specimen B after heat treatment processes. The developed method was quite successful.

7. Hardness test before heat treatment process

Micro hardness check at diverse places changed into accomplished to understand impact of reinforced particulate at the alloy matrix as the given in table 1 Rockwell hardness has been accomplished at the embedded reinforcement debris in addition to within side the locality of debris and matrix



Graph 7.2 Hardness test by after Heat Treatment

Graph 7.1 Hardness test on before Heat Treatment

7.1 Scanning electron microscope micrographs of microstructure of the surfaces are shown in of samples

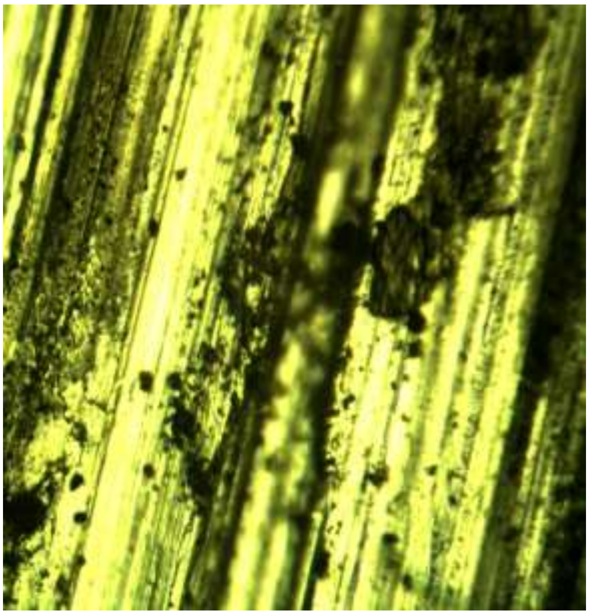


FIGURE 6 GROUP B SPECIMEN B MICRO STRUCTURE IMAGE

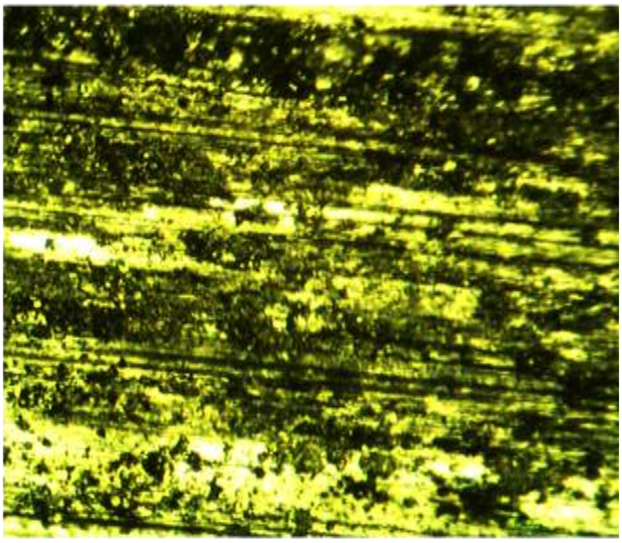
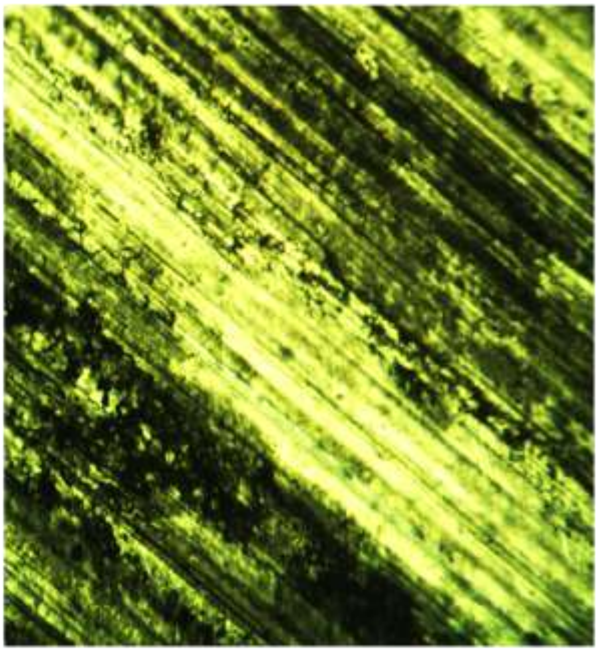


FIGURE 8 GROUP B SPECIMEN C MICRO STRUCTURE IMAGE

FIGURE7 GROUP B SPECIMEN B MICRO



STRUCTURE IMAGE

APPLICATIONS AND ADVANTAGES

Applications

This alloy has the density of 2.68 g/cm^3 and application in the cylinder heads, cylinder blocks and other engine components. The Si_3N_4 particles (10 wt % and average of 40 μ) have the density of 3.2 g/cm^3 and have high hardness with outstanding wear resistance.

The main application of metal matrix composites are.

i Automobile industry

ii Space research.

iii Electronic component of Electronic and Electrical industries

iv Rotating machines in various industries.

v Mobile applications.

vi Transportation

Advantages

It obtained good strength of the composites**.**

It increase the wear resistance

ACKNOWLEDGEMENT

The raw material of aluminum alloy LM25, Silicon Carbide Nano, Alumina Nano and Graphite Nano particles are delivered to us. The material purchased from the Coimbatore Metal Mart of Coimbatore of India. Our thanks to the technician to need the helping of this work.

VII. CONCLUSIONS

From the experimental and microstructure analysis of aluminum alloyLM25, Silicon Carbide and Graphite Composition of metal the following conclusions are drawn.

Addition of Sic will increase the mechanical properties of the composite.
By comparing with amount of Sic in the composite LM-25 with Sic 1%, Alumina 1% and graphite 1% are most suitable and improved for wear resistance.

Addition of graphite in the composite which is having increases thermal conductivity and hardness.
In the addition of three Nano particles of silicon carbide, alumina and graphite in the metal uniform distribution of molten metal in the reinforcement of aluminum alloy LM25.
The experimental and microstructure analysis of aluminum alloyLM25 the Group 2 specimen gives better surface finish In figure 7 specimen B and the more hardness of 106.7 and it gets high smooth surface finish after the heat treatment process.

REFERENCES

[1]. Fractography, fluidity, and tensile properties of aluminum/hematite particulate composites. S. C. Sharma, et al. 3, s. l. Springer US, June 1999, Journal of Materials Engineering and Performance, Vol. 8, pp. 309-314.
[2]. Aluminum Metal-Matrix Composites for Automotive Applications: Tribological Considerations. S. V. PRASAD and R.ASTHANA. 3, s. l. Kluwer Academic Publishers-Plenum Publishers, October 2004, Tribology Letters, Vol. 17, pp. 445-453.
[3]. Tribological Behavior of Aluminum/Alumina/Graphite Hybrid Metal Matrix Composite Using Taguchi’s Techniques. R Subramanian, N Radhika and S Venal Prasat. : Scientific Research Publishing Inc., 20 April 2011, Journal of Minerals & Materials Characterization & Engineering, Vol. 10, pp. 427-443.
[4]. Gyanendra Singh et al.,, Fabrication and Characterization of Aluminum-Graphite Composite Material, International Journal of Mechanical and Production Engineering Research and Development (IJMPERD) , Volume 7, Issue 4, July – August 2013,pp. 313-320
[5] Manufacturing od a MMCS using stir casting processes and testing its mechanical properties Kampala, Bazar Chandra,et al.III,s.l.:Technical journals online, July-Sept. 2013, International Journal of Advanced Engineering Technology, Vol. IV, pp. 26-29. E-ISSN 0976-3945.
[6]. Rama Rao, S. and Padmanabhan, G**.**, “Fabrication and mechanical properties of aluminum-boron carbide composites”, *Int. J. Mater. Bromate. Appl*, 2/3 (2012), 15-18.
[7]. Rocha, L.A., “Wear mechanisms in functionally graded aluminum matrix composites: effect of the lubrication by an aqueous solution”, *Mater. Sci. Eng.*, 492-493 (2005), 33-38.
[8]]Rajan, T.P.D.,Pillai, R.M.and Pai,B.C., “Characterization of centrifugal cast functionally graded aluminum-silicon carbide metal matrix composites”, *Mater. Charact*, **61** (2010), 923-928.
[9] Vettrivel, S.C.Selvakumar, N.Narayanasamy,R. and Leema, N., “Numerical modelling, prediction of Cu-W Nano powder composite in dry sliding wear condition using response surface methodology”, *Mater. Des*, 50 (2013), 977-986.
[10] Naravade, R.H. and Belkar, R.K**.**, “Statistical analysis of factors affecting the dry sliding wear behavior of Al/ Sic on automobile friction material”, *Int. J. Eng. Sic*, **3**/12 (2014), 05-13.
[11] High strength, and wear resistance Venkatesh. D and. Dinesh Kumar fabricated aluminum 6063 based alloy.
[12]Fractography, fluidity, and tensile properties of aluminum/hematite particulate composites. S. C. Sharma, et al. 3, s. l. :
Springer US, June 1999, Journal of Materials Engineering and Performance, Vol. 8, pp. 309-314.
[13] Aluminum Metal-Matrix Composites for Automotive Applications: Tribological Considerations. S. V. PRASAD and R.
ASTHANA. 3, s. l. : Kluwer Academic Publishers-Plenum Publishers, October 2004, Tribology Letters, Vol. 17, pp. 445-453.
[14]. Tribological Behavior of Aluminum/Alumina/Graphite Hybrid Metal Matrix Composite Using Taguchi’s Techniques. R
Subramanian, N Radhika and S Venkat Prasat. 5, s. l. : Scientific Research Publishing Inc., 20 April 2011, Journal of Minerals
& Materials Characterization & Engineering, Vol. 10, pp. 427-443.
[15]. Gyanendra Singh et al.,, Fabrication and Characterization of Aluminum-Graphite Composite Material, International Journal
of Mechanical and Production Engineering Research and Development (IJMPERD) , Volume 7, Issue 4, July – August 2013,
pp. 313-320
[16]. Manufacturing of a MMCS using stir casting processes and testing its mechanical properties. Kandpal, Bhaskar Chandra, et al. III, s.l.: Technical journals online, July-Sept. 2013, International Journal of Advanced Engineering Technology, Vol. IV, pp. 26-29. E-ISSN 0976-3945.
[17] G. G. Sozhamannan, S. Balasivanandha Raba, V. S. K. Venkatagalapathy, Effect of Processing Parameters on Metal Matrix Composites: Stir Casting Process, Journal of Surface Engineered Materials and Advanced Technology, 2, 11-15, 2012.
[18] Umit Cocen, Kazim Onel, Ductility and strength of extruded Sic aluminum-alloy composites, Composites Science and Technology 62 275–282, 2002.
[19] Hamid Reza Ezatpour,Seyed Abolkarim Sajjadi, Mohsen Haddad Sabzevar,Yizhong Huang, Investigation of microstructure and mechanical

properties of Al6061-nanocomposite fabricated by stir casting. Materials and Design 55, 921-928, 2014.

[20] S.Goplakrishnan,N. Murugan, Production and wear characterization of AA 6061 matrix titanium carbide particulate reinforced composite by enhanced stir casting method Composites: Part B, 43,302-308, 2012.

[21] Kadir Kocatepe. Effect of low frequency vibration on porosity of LM25 and LM6 alloys Materials and Design, 28, 1767-1775, 2007.

[22] G.Elango, B.K.Raghunath.Tribological behavior of hybrid (LM25Al+SiC+TiO2) metal matrix composites.Procedia engg, 64, 671-680, 2013

[23] G. Ramua, B. Ranjit Bauru, Effect of equal channel angular pressing (ECAP) on microstructure and properties of Al–Sic composites, Materials & Design,Volume 30, Issue 9, Pages 3554–3559, October 2009.

[24]. K. K. Chawla ,On the Applicability of the "Rule-of-Mixtures" to the Strength Properties of Metal-Matrix Composites, Revit Brasília de Física,Vol. 4, N." 3, page 411-418, 1974.

[25]Joel Hemanth, Fracture behavior of cryogenically solidified aluminum alloy reinforced with Nano-ZrO2 metal matrix composites (CNMMCs), Journal of Chemical Engineering and Materials Science Vol. 2(8), pp. 110-121, August 2011.

[26] S. Das, R. Behera, A. Date, G. Majumdar, B. Oraon, G. Sutradhar, Experimental Investigation on the Effect of Reinforcement Particles on the forgeability and the Mechanical Properties of Aluminum Metal Matrix Composites, Materials Sciences and Applications, 1, 310-316, 2010.

[27] G. Mrówka-Nowotnik, J. Sieniawski, Microstructure and mechanical properties of C355.0 cast aluminum alloy, Archives of Materials Science and E [29] Yoshimi Watanabe, Ick So Kim and Yasuyoshi Fukui, “Microstructures of functionally graded materials fabricated by centrifugal solid-particle and in-situ methods”, *Met. Mater Int*, **11**/5 (2005), 391-399.engineering, Volume 47, Pages 85-94, Issue 2 February 2011.