ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

A Study on Mechanical Properties of Aluminium Alloy (LM6) Reinforced with Al2O3

[1] Samant Gaurish Mahabaleshwar, [2] Dr Krupashankara M S, [3] Dr Mahesh B Parappagoudar
[1] Asst Professor, Department of Mechanical Engineering, Padre Conceicao College of Engineering, Goa Bangalore.
[2] Dean PG Studies, R V College of engineering, Bangalore.
[3] Principal, Padre Conceicao College of Engineering Goa.

***Abstract*— A phrase heard often in recent years, advanced composite materials like Al/Al2O3 metal matrix composite is gradually becoming very important materials in industries due to their superior properties. The present study examines the mechanical properties of aluminum (LM6)/ Al2O3 reinforced particles metal-matrix composites (MMCs) by varying weight fractions of Al2O3. For this (LM6)/ Al2O3 reinforced particles MMCs are fabricated by stir casting method at air atmosphere . The MMCs are prepared in the form of bars with varying the reinforced particles by weight fraction ranging from 3 %, 5 % and 7 %. The reinforced particles size of Al2O3 is varying between 25-40 microns. The Mechanical properties like, Brinell Hardness, Rockwell hardness & Wear test are investigated on prepared specimens of MMCs. It was observed that the hardness of the composite is increased gradually from 5 % to 7%.**

Key words: Aluminium, SiC, Metal Matrix Composite, stir casting, weight fraction.

I. INTRODUCTION

Metal Matrix Composite (MMC) is one of the major renovations in recent years and is engineered combination of metal (Matrix) and hard particles (Reinforcement) to mechanical properties. the mechanical properties of MMCs increases their usage in automobile industries [1] Metal Matrix Composites (MMC's) have very light weight, high strength, and exhibit greater resistance to corrosion, oxidation and wear [2]. The improvement of tribological properties of materials has been studied to raise the load bearing capacity of materials [3-4]. The effect of wire electrical discharge machining) parameters of the Al6063 reinforced with SiC in the form of particles with 5%, 10% and 15% volume fractions has been studied [5]. Fatigue resistance is an especially important property of Al-MMC, which is essential for automotive application. These properties are not achievable with lightweight monolithic titanium, magnesium, and aluminium alloys. Particulate metal matrix composites have nearly isotropic properties when compared to long fibre reinforced composite. Only the mechanical behavior of the composite depends on the matrix material composition, size, and weight fraction of the reinforcement and method employed to construct the composite. The dispersion of the reinforcement particles in the matrix alloy is influenced by various genes such as behavior of the matrix melt, the particle incorporation method, interaction of particles and the matrix before, during, and after mixing [6 - 7]. Non homogeneous particle distribution is one of the greatest problems in casting of metal matrix composites. The distribution of the reinforcement material in the matrix must be uniform and the wettability or bonding between these substances should be optimized. Aluminum-Al2O3 metal matrix composite has low density and light weight, high temperature strength, hardness and stiffness, high fatigue strength and wear resistance etc. in comparison to the monolithic materials [8-10]. This paper presents the study of mechanical behavior when aluminium is reinforced with different weight fraction of Al2O3.

II. MATERIALS AND METHODS

Aluminum with Al2O3: The reinforced metal matrix composite material selected for present investigation was based on LM6 matrix alloy source of materials in Table.1.and its chemical composition is shown in Table (2). The matrix material used in the present investigation was pure aluminium The different volume fraction of Al2O3 aluminum alloy composite was used for this investigation. The equipment used includes a crucible furnace, stainless steel stirrer (powered by a motor), a thermocouple, heat treatment furnace, tensile, impact and hardness testing machines and an optical microscope is used for micro structural evaluation [11-15]

Table (1): Source of Materials

Si No	Material	Supplied by
1	LM6	Prism Industry
2	AL2O3	Hindalco, Belgaum

Table (2): Chemical composition of LM6

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

Element	Composition	Element	Composition
Si	0.4430	Mn	0.0132
Fe	0.1638	Zn	0.0001
Cu	0.0041	Cr	0.0024
Mg	0.5382	Ti	0.0078
Mn	0.0132	Ca	0.0003

Final metal matrix composite material undergoes the fabrication and testing methods as stated below:
a) Stir casting method
b) Hardness test
c) Wear test

B. Manufacturing process

a) Stir casting method: First of all stirring system has been developed by coupling motor with gearbox and a mild steel stirrer. All the melting was carried out in a graphite crucible in an Induction furnace. Scraps of aluminum were preheated at 450 0C for 3 to 4 hours before melting and mixing the AL2O3 powdered particles were preheated at 1100 0C for 1 to 3 hours to make their surfaces oxidized. The furnace temperature was first raised above the liquids to melt the alloy scraps completely and was then cooled down just below the liquids to keep the slurry in a semi-solid state. At this stage the preheated AL2O3 powdered particles were added and mixed manually. Manual mixing was used because it was very difficult to mix using automatic device when the alloy was in a semisolid state. After sufficient manual mixing was done, the composite slurry was reheated to a fully liquid state and then automatic mechanical mixing was carried out for about 10 minutes at a normal stirring rate of 600 rpm. In the final mixing process, the furnace temperature was controlled within 760 ± 100 0C. Pouring of the composite slurry has been carried out in the Permanent Die shown fig 1.

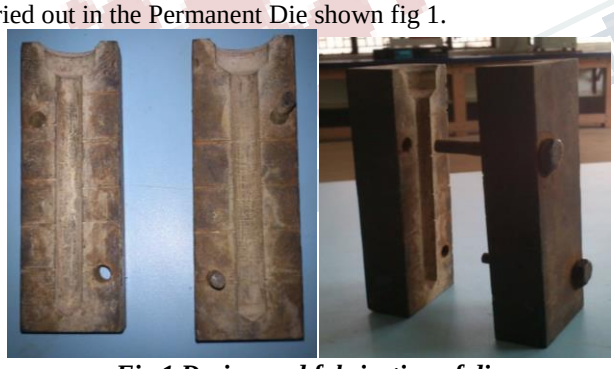


Fig 1 Design and fabrication of die

b) Hardness Test: The Brinell hardness test for the cast samples was conducted on a 15 mm x 10 mm test pieces. Both grinding and polishing were carried out starting with coarse filing and finishing using a motor-driven emery belt. A load of 187 kg was applied on the test piece for 15 seconds and the diameter of the impression measured. The average hardness values of the test pieces are displayed in Table (4) & (5).

c) Wear Test: A cylindrical pin of size 8mm diameter and 24mm length Hybrid composite specimens were prepared and loaded in a pin- on -disc wear testing rig as shown in Fig.2. Before testing, the surface of the specimens was polished by using 1000 grit paper. Wear tests were carried out at room temperature for 5 minutes. The figure 2 shows Wear test setup.

Fig2 a picture showing a component tested on wear testing machine.

III. RESULT AND DISCUSSION

a) Wear Test

Wear, the progressive loss of material from the sliding surfaces of the elements of a tribo system can be determined in terms of weight loss. Material properties of the sliding elements, applied load and disc speed determine the wear rate. The result of wear test is shown in Table 3. By these result we can see that the wear resistance is increased by increase in addition of AL2O3 in a LM6- AL2O3 Hybrid composite. The results of wear test is shown in Table 3

b) Hardness Test

The hardness of the samples was determined using Brinell and Rockwell hardness testing machine which is shown in fig 3. In Brinell the load applied was of 187.5 kgs and 2.5 mm ball indenter. In Rockwell the load applied is of 100 kgs and 1/16" ball indenter of red dial B scale is used.The test results of Rockwell & Brinell hardness is shown in Table 4 & Table 5

Fig 3 a picture showing the Brinell and Rockwell Hardness Testing machine.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 4, April 2018

Sr. No.	MATERIAL (Weight % of reinforcement)	INITIAL WEIGHT (gms)	FINAL WEIGHT (gms)	WEAR VOLUME (mm^3)
1	LM6	11.615	11.595	9.22×10^3
2	AL2O3 (3%)	17.995	17.975	$7.38x\ 10^3$
3	AL2O3 (5%)	14.87	14.85	$5.53x\ 10^3$
4	AL2O3 (7%)	17.92	17.915	$1.85x\ 10^3$

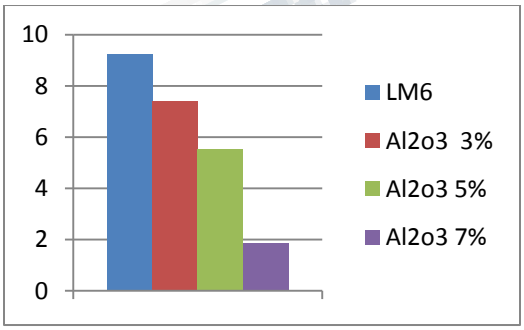
Table 3 shows the result of wear rate by keeping Load.5kg; Time 5min., & 500 rpm Disc Speed.

Sr. No.	MATERIAL (Weight % of reinforcement)	DIA OF IDENTATION 1st READING	2nd	3rd	BHN
1	LM6	1.5	1.5	1.5	80.45
2	AL2O3 (3%)	1.6	1.6	1.6	82.45
3	AL2O3 (5%)	1.6	1.6	1.5	86.52
4	AL2O3 (7%)	1.5	1.5	1.5	95.49

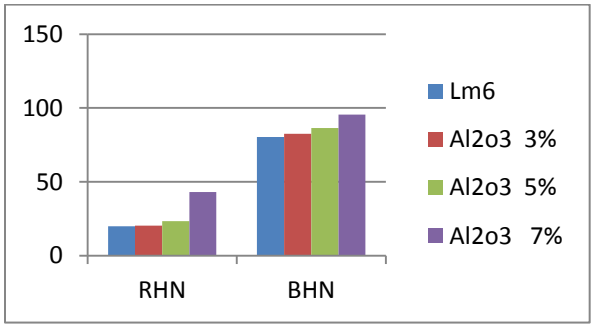
Table 4 shows the result of Brinell hardness test results

Sr. No.	MATERIAL (Weight % of reinforcement)	1st READING	2nd	3rd	AVERAGE
1	LM6	23	19	19	20
2	AL2O3 (3%)	23	19	19	20.33
3	AL2O3 (5%)	22	25	23	23.33
4	AL2O3 (7%)	43	42	44	43

Table 5 shows the result of Rockwell Hardness test results



Graph 1 shows the representation of Wear rate.



Graph 1 shows the representation of RHN & BHN.

V. CONCLUSION

The mechanical behavior of reinforced of aluminium with different weight fraction of Al2o3 has been studied. The specimens were prepared by stir casting method with weight fractions of Al2o3 standard of as per ASTM G99 to find the mechanical behavior. Brinell hardness test and wear test were carried out on test specimen to determine hardness and wear rate respectively. From the test results it was observed that the hardness of the composite has increased gradually from 5 % to 7 %. From the wear test result analysis it has been observed that the percentage of Al2o3 increases the wear rate decreases.

REFERENCES

[1] E. Candan, H. Ahlatci, H. Çimenoğlu Abrasive wear behaviour of Al–SiC composites produced by pressure infiltration technique. Wear 247 (2001) 133 – 138.

[2] Daniel B. Miracle and Steven L. Donaldson,'Introduction to composites', ASM Hand Book of Composite Materials,Volume-21.

[3] K. R. Suresh, H. B. Niranjan, P. Martin Jebaraj M. P. Chowdiah, 'Tensile and wear properties of aluminum composites', Wear 255 (2003) 638 – 642.

[4] Ashok Kr. Mishra, Rakesh Sheokand, R. K. Srivastava, 'Tribological behaviour of Al- 6061/SiC metal matrix composite by Taguchi's techniques", International Journal of Scientific and Research Publications, 2 (2012).

[5] D. Satishkumar, M. Kanthababu, V. Vajjiravelu, R. Anburaj, N. Thirumalai Sundarrajan, H. Arul, 'Investigation of wire electrical discharge machinin characteristics 394 of Al6063/SiCp composites', The International Journal of Advanced Manufacturing Technology 56 / 9-12 (2011) 975 - 986

[6] Manjunath C. Melgi and G. K. Purohit, 'A Study of Microstructure and Mechanical Properties of Aluminium Silicon Carbide Metal Matrix Composites (MMC's)', International Journal of Engineering Research & Technology 2 (2013).

[7] K. L. Meena, A. Manna, S. S. Banwait and Jaswanti, 'An Analysis of mechanical properties of the developed Al/SiCMMC's', American Journal of Mechanical Engineering 1/1 (2013) 14 – 19.

[8] Balamurugan Adhithan, A. Syed bava bakrudeen and Hari Prasada Rao Pydi, 'Contemplation of mechanical and thermal properties of aluminum (1100) with silicon carbide', International Journal of Engineering and Advanced Technology 2/2 (2012).

[9] Sandeep Kumar Ravesh and T. K. Garg, 'Prepration and analysis for some mechanical property of aluminium based metal matrix composite reinforced with SiC and fly ash", International Journal of Engineering Research and Applications 2 / 6 (2012) 727– 731.

[10] M. Boopathi, K. P. Arulshri and N. Iyandurai, 'Evaluation of mechanical properties of aluminium alloy 2024 reinforced with silicon carbide and fly ash hybrid metal matrix composites', American Journal of Applied Sciences 10/3 (2013) 219 – 229.

[11] S. Basavarajappa, G. Chandramohan, A. Dinesh, 'Mechanical properties of MMC's an experimental investigation', International Symposium of Research Students on Materials and Engineering, Indian Institute of Technology, Chennai, India 20 – 22 December 2004.

[12] K. Hemalatha, V. S. K. Venkatachalapathy, N. Alagumurthy, 'Processing and synthesis of metal matrix Al6063/Al203 metal matrix composite by stir casting process", Journal of Engineering Research and Applications. 3/ 6 (2013) 1390 - 1394.

[13] G. B. Veeresh Kumar, C. S. P. Rao, N. Selvaraj, M. S. Bhagyashekar, 'Studies on Al6061-SiC and Al7075-Al2O3 metal matrix composites', Journal of Minerals & Materials Characterization & Engineering 9/1 (2010) 43 - 55.

[14] Khalid Mahmood Ghauri, Liaqat Ali, Akhlaq Ahmad, Rafiq Ahmad, Kashif Meraj Din. Ijaz Ahmad Chaudhary and Ramzan Abdul Karim, 'Synthesis and characterization of Al/SiC composite made by stir casting method', Pak. J. Engg. & Appl. Sci. 12 (2013) 102 - 110.

[15] K. Mahmood Ghauri, Liaqat Ali, Akhlaq Ahmad, Rafiq Ahmad, Kashif Meraj Din, Ijaz Ahmad Chaudhary, Ramzan Abdul Karim, 'Synthesis and characterization of Al/SiC composite made by stir casting method', Pak. J. Engg. & Appl. Sci. 12 (2013) 102 – 110.