International Journal of Engineering Research And Advanced Technology (IJERAT)
ISSN:2454-6135 [Volume. 03 Issue.5, May– 2017]
www.ijerat.com

Study of Hardness of Aluminium(LM25) Composite

Dhanasekaran R[1] SaiKrishna N[2*] Santosh M[2] Pallavi P[2] Sreenatha Reddy S[1]

Professor[1] UG Scholar [2]

Department of Mechanical Engineering

Guru Nanak Institute of Technology

Hyderabad, Telangana

India

ABSTRACT

Metal Matrix Composites have wide range of applications in current industrial scenario. Conventional materials have limitations with respect to composite material due to their deficiency in its properties. Composites have lot of scope due to its enhanced mechanical properties like tensile strength, toughness, hardness and compressive strength. The current research includes the study of metal matrix composite of aluminum alloy (A356) reinforced with alumina, graphite and silicon carbide for the application of water cooled cylinder block, which requires good tensile strength, hardness, wear resistance and low coefficient of friction. In the present investigation, 6 primary samples are fabricated with A356 as base metal, where three samples contains the composition of Sic (10%, 15% and 20%), 3% Gr, 10% alumina and other three samples containing Sic (10%, 15% and 20%), and 10% alumina. This study is mainly focused to improve the characteristics like hardness.

KeyWords: Metal Matrix Composites, A356, Cylinder block, Hardness.

1. INTRODUCTION

Aluminum (Al) is the mostly abundant element on the earth and it became a strong competitor for all the Engineering applications by the end of the 19th century. One of the most potential characteristics is its versatility. Aluminum alloys and its composites are extensively used in structural applications, as materials in transportation (automobiles and aerospace), and engine components (cylinder block) [1]. Thus it becomes all the more vital to study the tribological characteristics of Aluminum alloys and its composite materials. Upon addition of Silicon to Aluminum gives low thermal expansion coefficient, high strength to weight ratio, and high wear resistance. This Hybrid Composite Materials show improved hardness, strength and wear properties as the silicon content is increased beyond eutectic composition. Such properties warrant the use of these materials as structural components in automotive industries [2].

The main objective of this paper is to enhance the properties of the material hardness of A356 by reinforcing with Silicon carbide, Graphite, and Aluminum oxide. It is mainly focused to know the effects of these reinforcements on A356. The base metal A356 has good tensile strength, wear properties comparing with other aluminum alloys, the only property to be improved is hardness. Properties of alloying elements mainly affect the base metal characteristics.

Silicon carbide is very hard material which gives better hardness. This study reveals best reinforcement which gives better hardness. Over the past three decades composite materials, ceramics and plastics have been the dominant emerging materials that possess high potential properties required in aero and automotive industries. The applications of composite materials have been increasing in the current industrial scenario and conquering the industrial market relentlessly. The composites industry has begun to recognize that the commercial applications of hybrid composites promise to offer much larger business opportunities than the aerospace sector due to the sheer size of transportation industry. Thus there is a change in recent era; the shift of composite applications from aircraft to other commercial uses has become prominent in recent years.

2. LITERATURE REVIEW

In an investigation made on mechanical properties of A2014, when reinforced with alumina by liquid metallurgical route has been found that hardness of Aluminum when reinforced with 7.5wt% of Alumina was greater comparing with 5% and 10% addition of alumina. The test was conducted on Brinell hardness tester [3]. The properties of aluminum by reinforcing with Si (3%-15%), it was found that hardness was Maximum at 12% addition of Si. It was observed that at 15% addition of Si, there was decrement in hardness [4]. In a research made on LM25 alloy, by reinforcing with 3% fly ash and varying the wt. % of Al_2o_3 in steps of 5 revealed that the hardness of specimen increases with increasing the wt. % of Al_2o_3. The test is been performed on Brinell hardness tester [5]. The mechanical properties of A2014 alloy by reinforcing graphite with liquid metallurgical route. Hardness of specimen was tested on Brinell hardness tester. It has been found that with 5%Gr there is greater hardness. Hardness has been improved by heat treatment (89 BHN–155 BHN). With increasing the Graphite content beyond 5% there was reduction in hardness [6]. An investigation made on Aluminum matrix composites (AMCs) by liquid metallurgical route. It was observed that whenever A356 is reinforced with sic, there was greater improvement in hardness. Addition of graphite particles reduced the hardness. The greater hardness values observed at 9% sic, when tested on Vickers diamond indenter [7].

It has been evaluated from the research made on A356, when reinforced with sic in steps of 0.5 by stir casting process that maximum hardness can be obtained by adding 3.5% of sic on Brinell hardness indicator [8]. It has been found when A356 reinforced with Al_2o_3-10% Zno_2 varied in steps of 0.5 by stir casting process that, 1vol% addition of Al_2o_3-10% Zno_2 gives maximum hardness of 80 BHN on Brinell hardness indicator [9, 15]. The mechanical properties of A356 by reinforcing with Fly ash and Alumina, was found that increasing reinforcement, increases hardness. Hardness has been increased from 90 BHN to 94 BHN. After 12%, reduction in hardness has been observed [10].

In an experimental work carried on A356, by reinforcing with Fly ash and sic varying in steps of 5%, it has been reported that A356+15% SiC+5% fly ash gives maximum hardness of 88.45 BHN on Brinell hardness indicator. Hardness was improved by heat treatment and stir casting process gives better mixing of reinforcements [11, 16]. In a research made on mechanical properties of aluminum, it was noted that hardness of 9% Al_2O_3 + 3% gr was greater comparing with other compositions [12]. It was noted from a research on A356 by reinforcing with Alumina and fly ash that hardness has been improved by addition of alumina. Greater hardness has been found at 12% Al_2O_3 [13]. The properties of A356 by reinforcing with Al_2O_3 (10%, 15% and 20%) and sic (10%, 15% and 20%). It was reported that with 10% addition of Al_2O_3, 20% addition of sic there was greater improvement in hardness.

3. EXPERIMENT

The experimental arrangement has been assembled by the coupling gear-box motor and mild steel four blade stirrer as shown in Figure 1. Aluminum and silicon carbide powder (Sic – 2 mm) was carried out in the graphite crucible in to the coal fired furnace. Aluminum pieces were preheated for 3 to 4 hours at 450˚C and Sic powder also heated with 900˚c, the graphite particles were preheated to 1200˚c, Al_2o_3 was preheated to 800˚c and all the preheated mixtures were then mechanically mixed with each other below their melting points. The percentage addition of Sic was 10%, graphite was 3% and Al_2O_3 was 10%.

Figure 3.1 Stir Casting Machine

These metal-matrix Al composites were then poured into the graphite crucible and put in to the coal-fired furnace at 760˚c temperature. The furnace temperature was first increased above the composites temperature to completely melt the pieces of the aluminum and then cooled down just below the composites temperature, kept it in a semi-solid state. At this stage the preheated sic particles were added and manually mixed with each other. It is very difficult to mix by machine or by stirrer when metal-matrix composites are in semi molten state. When the manual mixing completes then automatic stirring will carry out in 10 minutes with normal 400 rpm of stirring rate. The temperature rate of the coal-fired furnace should be controlled at 760˚c to 770˚c in the final mixing process. After completing the process the slurry has been taken in to the sand mould within the thirty seconds allow it to solidify. Test should be conducted on solidified composites.

This experiment should be repeatedly conducted by varying the composition of the composite powder of Sic (10%, 15% and 20%). Total three samples have been prepared with graphite and three samples are prepared by following the same procedure without addition of graphite. Figure 2 shows all casted samples.

Resistance offered by a material to plastic deformation caused by indentation is known as Hardness. Hardness is a measure of how resistant solid matter is to various kinds of permanent shape change when a compressive force is applied. Some materials (e.g. metals) are harder than others (e.g. plastics). Hardness is very important mechanical property that should be possessed by a composite. Hardness test was performed on all six samples in order to know the composition, which gives highest hardness.

Figure 3.2 Casted Samples of Aluminum Composite

Brinell hardness tester was used for carrying the test. The test was performed with a force of 3000 N and 5 mm diameter of carbide ball. This test was performed according to ASTM E 10 standards. The test procedure is as follows: Specimen was taken on to the tester. Adjusted the position of the sample below the indenter, applied a load of 3000 N for 12 seconds. Noted the readings, same procedure has been carried for the other samples.

4.RESULTS AND DISCUSSION

Figure 3 shows the samples taken after performing hardness test. Test was carried out by applying 3000N force. Indentation is performed at different locations on the samples.

Figure 4.1 Samples after Hardness Test

The Table 4.1 lists out the different compositions reinforced with the suitable materials and the compositions with their hardness respectively. From the below table, it was observed that by the increased addition of silicon carbide led to increment in hardness. Addition of graphite slightly affects the hardness. Addition of 15% silicon carbide and 10% Alumina gives greater hardness comparing with other compositions. Addition of graphite to this composition leads to greater reduction in hardness.

Table 4.1 Composition with their Hardness

S.No	Designation	Composition	Hardness Value (BHN)
1	C1	A356+10%Sic+3%Gr+10%Al_2O_3	107.4
2.	C2	A356+15%Sic+3%Gr+10%Al_2O_3	95.90
3.	C3	A356+20%Sic+3%Gr+10%Al_2O_3	103
4.	C4	A356+10%Sic+10%Al_2O_3	100.40
5.	C5	A356+15%Sic+10%Al_2O_3	108.33
6.	C6	A356+20%Sic+10%Al_2O_3	107

The Figure 4.2 shows the variation of hardness of A356 with the addition of different alloying elements. From the below graph, it was clear that addition of Silicon carbide with alumina gives better hardness value. Increased addition of silicon carbide leads to decrement in hardness.

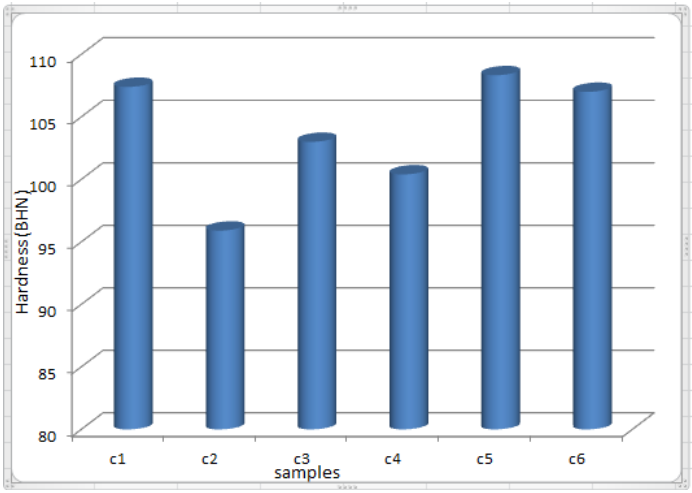

Figure 4.2 Graph Showing Hardness Variation

5. CONCLUSION

Stir casting is fairly economical and gives uniform distribution of the reinforcement particles. Inorder to reduce the difficulty in uniform distribution of the particles stir casting is used. The hardness of the composites

increases with the increase in silicon carbide content. Upon excess addition of silicon carbide decreases the hardness. Moreover, addition of graphite in excess quantities decreases the hardness.

REFERENCES

[1]Sharanabasappa R Patil and B.S Motgi., "A Study on Mechanical Properties of Fly Ash and Alumina Reinforced AluminumAlloy (LM25) Composites,"*IOSR Journal of mechanical and civil engineering*, vol.7, pp. 41-46, 2011.

[2]Sandeep Kumar Ravesh and T. K. Garg,"Preparation & Analysis for Some Mechanical Property Of Aluminum Based Metal Matrix Composite Reinforced With Sic & Fly Ash," I*nternational Journal of Engineering Research and Applications*, vol. 2, pp. 727-732, 2012.

[3] P. T. Sangeeth, T. G. Rajiv, M. H. Annaiah, R. Seetharamaiah, and G. S. Narasimha Murthy,"Mechanical Properties and Dry Sliding Wear behaviour of A2014 Reinforced With Alumina,"*International Journal of Innovative Research in Science, Engineering and Technology*, vol.2, pp. 1033-1037, 2013.

[4] G. T. Abdel-Jaber1, A. M. Omran, Khalil Abdelrazek Khalil, M. Fujii, M. Seki, and A. Yoshida, "An Investigation Into Solidification and Mechanical Properties Behaviour of Al-Si Casting Alloys,"*International Journal of Mechanical & Mechatronics Engineering*, vol. 10, pp. 30-35, 2010.

[5] R. SharanabasappaPatil, and Prof B. S. Motgi,"A Study on Mechanical Properties of Fly Ash and Alumina Reinforced Aluminium Alloy (LM25) Composite,"*Journal of Mechanical and Civil Engineering*, vol.7, pp. 41-46, 2010.

[6] K. V. Karthik Raj, M. H. Annaiah, B. Manjunatha, P. Davis Skariah, and H. V. Harendra Kumar, "Dry Sliding Wear Behaviour of Heat Treated A2014 Reinforced With Graphite,"*International Journal of Innovative Research In Science, Engineering and Technology*,vol. 2, pp. 1681-1687, 2013.

[7] B. M. Viswanath, M. Prasannakumar, S. Basavarajappa, and T. S. Kiran," Mechanical Property Evaluation of A356/Sicp/Gr Metal Matrix Composites,*Journal of Engineering Science and Technology,"* vol. 8,pp. 754 – 763, 2013. [8] Ali Mazahery, and Mohsen Ostad SHABANI, "Characterization of Cast A356 Alloy Reinforced with Nano Sic Composites,"*Trans. Nonferrous Met. Soc.China*,vol. 2, pp. 275-280, 2012.

[9] MohsenHajizamani, and HamidrezaBaharvandi, "Fabrication and Studying the Mechanical Properties of A356 Alloy Reinforced with Al2O3-10% Vol. Zro2 Nanoparticles through Stir Casting,"*Advances In Materials Physics and Chemistry*,vol. 1, pp. 26-30, 2012.

[10] Amol Mali, S. A. Sonawane, and SachinDombale,"Effect of Hybrid Reinforcement on Mechanical Behaviour of Aluminium Matrix Composite,"*International Journal of Engineering Research & Technology*,vol. 4, pp. 130-133, 2015.

[11] ShashiPrakashDwivedi, SatpalSharma,andRaghvendra Kumar Mishra, "Microstructure and Mechanical Behaviour of A356/Sic/Fly-Ash Hybrid Composites Produced By Electromagnetic Stir Casting," *J Braz. Soc. Mech. Sci. Eng*, vol. 37, pp. 57-67, 2014.

[12] N. Radhika, R. Subramanian, S. venkatprasat, and B. Anandavel, "Dry Sliding Wear Behavior of Aluminum/Alumina/Graphite Hybrid Metal Matrix Composites,"*Emerald Group Publishing Limited*, vol. 64, pp. 359-366, 2012.

[13] S. G. kulkarni, J. V. Menghani and Achchhelal, Investigation of Mechanical Properties of Fly Ash and Al_2O_3 reinforced A356 Alloy Matrix Hybrid Composite Manufactured by Improved Stir Casting, *Indian Journal of Engineering and Materials Sciences*, vol. 23, pp. 27-36, 2015.

[14] S. Dhanasekaran, S. Sunil raj, G. Ramya, and S. Ravishakar, Sic and Al_2O_3 Reinforced Aluminium Metal Matrix Composites for The Heavy Vehicle Clutch Application, *Indian Institute of metals*,vol.69,pp.699–703, 2015.

[15]G. Venkatachalam and A. Kumaravel,"Mechanical behaviour of aluminium alloy reinforced with Sic/flyash/basalt composites for brake rotor," *polymers and polymer composites*, vol.*25*, pp. 203-208, 2017.

[16] R. Dhanasekaran and K. Satishkumar," Microstructure, mechanical properties of A356/Li Aluminium alloy fabrication by stir casting method,"*International journal of applied engineering research*, vol.*10*,pp. 416 – 419, 2015.