International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763
Issue 08, Volume 3 (August 2016) www.ijirae.com

Experimental Study of Wear Rate Coefficient of Aluminium Hybrid Composites Manufactured By Stir Casting Technique

L. Prince Jeya Lal*
Department of Mechanical Engineering
KCG College of Technology

R. Manigantan
Department of Material science
CARE Group of Institutions

Suryanarayan. C.P
Department of Manufacturing Engineering
KCG College of Technology

Abstract - ***In current decade, demand in material characteristics like light weight, superior strength to weight ratio, improved surface properties and enhanced wear resistance for complex engineering applications like automobile, aerospace and nuclear are researcher's interest. However, performance of hybrid composites depends on right combination of reinforcements. Silicon carbide, silicon nitride, boron nitride and titanium carbide are few reinforcements available at present. In this work, Al356 is reinforced with SiC and B4C to enhance the mechanical properties, surface hardness and wear resistance. This hybrid composite is prepared by stir casting technique and the morphology of composite is studied using optical microscope to investigate the dispersion of reinforcements. In the present study, the wear and friction characteristics of hybrid composites are investigated using pin on disc dry wear tests by varying the load and speed and the results are tabulated for load vs mass loss, load vs wear rate and load vs wear coefficient. The results report that wear rate of hybrid composites are lower than that of binary composites. Mechanical properties, surface hardness and wear characteristics of aluminium hybrid composites are compared with that of aluminium binary composites available at present.***

Keywords – Hybrid MMC, Silicon Carbide, Boron Carbide, Wear coefficient etc.

I. INTRODUCTION

S.L Promod et.al [1] studied the effect of addition of Sc and TIB_2 on the wear properties of A356. Hardness was found to increase due to addition of Sc and TiB_2. Pin-on-disk wear tests indicated that Sc addition increase the wear resistance of A356 alloy but reduced the wear resistance of A356–TiB_2 composite. Sathish Kumar Thandalam et.al [2] details the current development on the synthesis, microstructure and mechanical properties of zircon reinforced MMCs, with specific attention on the abrasive wear behavior of the composites. This review also summarizes the work done by various research groups on zircon reinforced MMCs in achieving higher hardness and wear resistance in these composites.Narayana Yuvaraj et.al [3] fabricated 5083 aluminum alloy with reinforced layers of boron carbide (B_4C) through FSP. Micro and nano sized B_4C particles were used as reinforcements. The friction processed surface composite layer was analyzed through optical and scanning electron microscope.

The number of passes and the size of reinforcement play a vital role in the development of surface composites by FSP. Mechanical properties of the friction stir processed surface composites were evaluated through micro-hardness and universal tensile tests. The results were compared with the properties of the base metal. The role of reinforcement and number of passes on properties were also evaluated. Tribological performance of the surface composites is tested through pin on disk test. Ch. Shoba et.al [4] studied the influence of machining parameters, e.g. cutting speed, feed and depth of cut on the cutting force components, namely feed force (Ff), cutting force (Fc), and radial force. A comparison was made between the reinforced and unreinforced composites. The results proved that all the cutting force components decrease with the increase in the weight percentage of the reinforcement. Experimental evidence also showed that built-up edge (BUE) is formed during machining of low percentage reinforced composites at high speed and high depth of cut. The formation of BUE was captured by SEM, therefore confirming the result. The decrease of cutting force components with lower cutting speed and higher feed and depth of cut was also highlighted. The related mechanisms are explained and presented.by Michael et.al [5] reviewed the different combination of reinforcing materials used in the processing of hybrid aluminium matrix composites and how it affects the mechanical, corrosion and wear performance of the materials.

© 2014- 16, IJIRAE- All Rights Reserved

The major techniques for fabricating these materials are briefly discussed and research areas for further improvement on aluminium hybrid composites are suggested by.Padmavathi et.al [6] found that, under mild wear conditions, the composite displayed lower wear rate and friction coefficient compared to Aluminium. However, for severe wear conditions, the composite displayed higher wear rate and friction coefficient and it was clarified that the friction and wear behaviour of Al–SiC-MWCNT composite is largely influenced by the applied load and there exists a critical load beyond which CNTs could have a negative impact on the wear resistance of aluminium alloy. Johny James et.al [7] fabricated and compared the properties of aluminium metal matrix composites. The hardness test was carried out to find out the hardness of the cast composites using Vickers hardness testing machine. The hardness test and its comparison show that the hardness value of SiC composite is higher than TiB_2 composite.

II. MATERIALS AND METHODS

BORON CARBIDE

Boron carbide is an extremely hard boron–carbon ceramic material used in tank armour, bulletproof vests, and numerous industrial applications. With a Mohs hardness of about 9.497, it is one of the hardest materials known, behind cubic boron nitride and diamond. The ability of boron carbide to absorb neutrons without forming long lived radionuclide makes it attractive as an absorbent for neutron radiation arising in nuclear power plants.

CHEMICAL COMPOSITION

Boron carbide has a complex crystal structure typical of icosahedrons-based borides. There, B12 icosahedra form a rhombohedral lattice unit (space group: R3m (No. 166), lattice constants: a = 0.56 nm and c = 1.212 nm) surrounding a C-B-C chain that resides at the centre of the unit cell, and both carbon atoms bridge the neighbouring three icosahedra. This structure is layered: the B12icosahedra and bridging carbons form a network plane that spreads parallel to the c-plane and stacks along the c-axis. The lattice has two basic structure units – the B12icosahedron and the B6 octahedron. Because of the small size of the B6 octahedral, they cannot interconnect. Instead, they bond to the B12 icosahedra in the neighbouring layer, and this decreases bonding strength in the c-plane.

SILICON CARBIDE

Silicon carbide (SiC), also known as carborundum, is a compound of silicon and carbon with chemical formula SiC. It occurs in nature as the extremely rare mineral moissanite. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as synthetic moissanite. Silicon carbide with high surface area can be produced from SiO2 contained in plant material.

COMPOSITION OF SIC POWDER IS LISTED BELOW.

CONSTITUENTS	SiC	Si+SiO2	Free C	Fe2O3
%	98.72	0.76	0.12	0.17

STIR CASTING TECHNIQUE

The term stir casting is the process of stirring molten metal that are used for continuous stirring particles into metal alloy to melt and immediately pour into the sand mould, then cooled and allowed to solidify. In stir casting, the particles often tend to form agglomerates, which can only be dissolved by vigorous stirring with high temperature. The whirlpool technique provides the high strength homogeneous set of aluminium composite materials.

III.RESULTS AND DISCUSSIONS

WEAR TEST

For the pin on disc wear test, two specimens are required. A pin with a curvy tip is positioned perpendicular to the other, usually a flat circular disc. A ball rigidly held is often used as the pins specimen. The tests machine causes either the disc specimen or the pin specimen to revolve about the disc centre. In either case, the sliding path is a circle on the disc surface. The pin specimen is pressed against the disc at a specified load by means of an arm or lever and attached weights. Wear results are reported as volume loss in cubic millimetres for the pin and the disc separately. Linear measures of wear are converted to wear volume by using appropriate geometric relations.

© 2014- 16, IJIRAE- All Rights Reserved

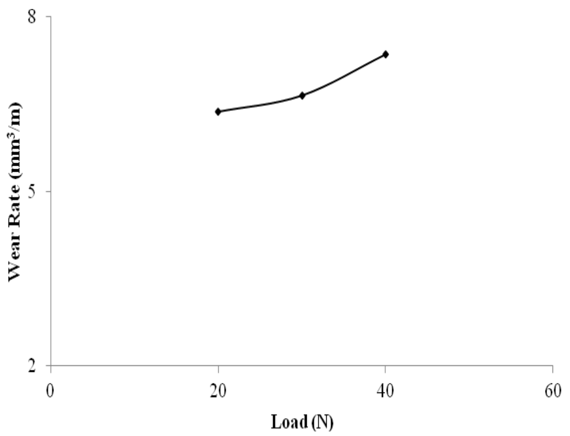
International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2763
Issue 08, Volume 3 (August 2016) www.ijirae.com

TABLE 1 - WEAR TEST RESULTS

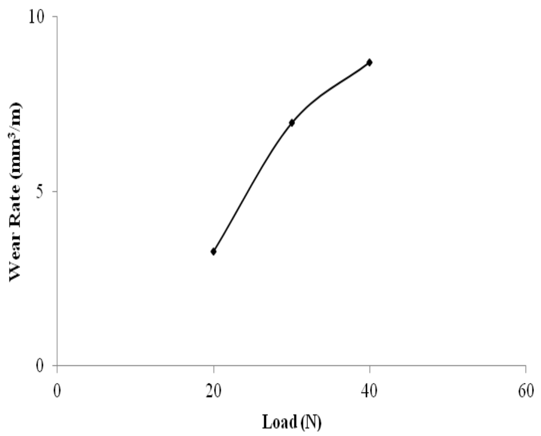
S. NO	LOAD N	MASS LOSS G	VOLUME LOSS MM3	WEAR RATE MM3/M	WEAR COEFFICIENT MM3/N-M
1	20	0.0095	3.518	3.518*10-3	0.000176
2	30	0.0198	7.333	7.333*10-3	0.000244
3	40	0.0242	8.963	8.963*10-3	0.000224
4	20	0.0341	12.629	6.315*10-3	0.000315
5	30	0.0369	13.667	6.833*10-3	0.000228
6	40	0.0411	15.222	7.611*10-3	0.000190
7	20	0.0423	15.667	5.222*10-3	0.000261
8	30	0.0581	21.519	7.173*10-3	0.000239
9	40	0.0655	24.259	8.086*10-3	0.000202

LOAD VS WEAR RATE GRAPHS - HYBRID COMPOSITES

GRAPH 1
FOR SLIDING DISTANCE = 1KM

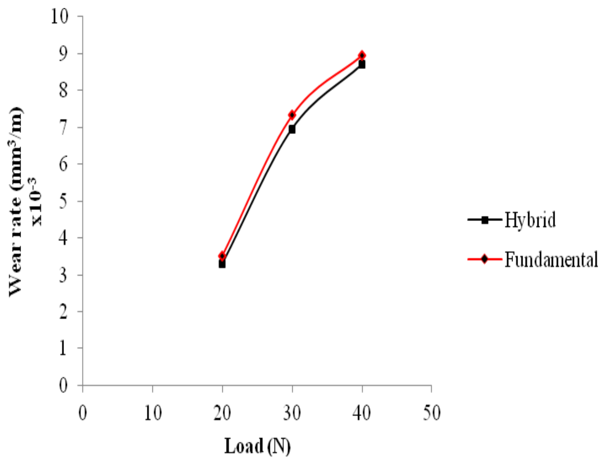


GRAPH 2
FOR SLIDING DISTANCE = 2KM



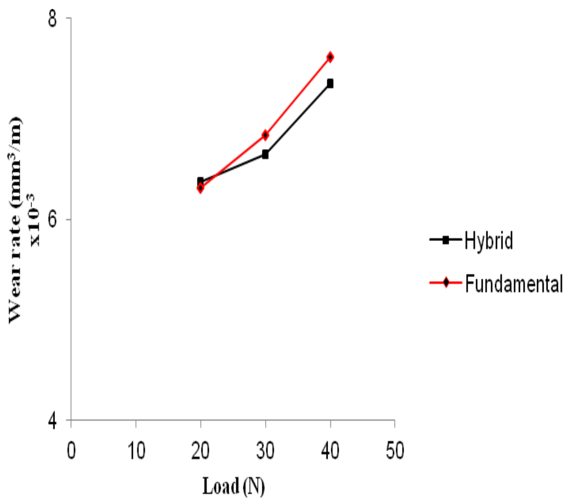
COMPARISON GRAPHS BETWEEN HYBRID AND BINARY COMPOSITES

GRAPH 4
LOAD VS WEAR RATE FOR SLIDING DISTANCE 1KM



GRAPH 6

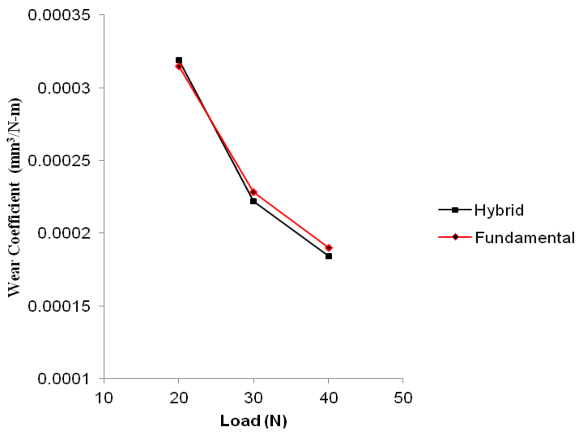
GRAPH 5
LOAD VS WEAR RATE FOR SLIDING DISTANCE 2KM



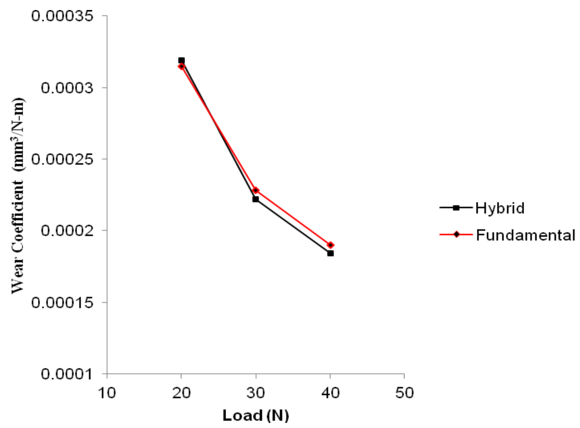
GRAPH 7

© 2014- 16, IJIRAE- All Rights Reserved

LOAD VS WEAR COEFFICIENT FOR SLIDING DISTANCE 1KM



LOAD VS WEAR COEFFICIENT FOR SLIDING DISTANCE 2KM



IV. CONCLUSIONS

The wear test was carried out to investigate the amount of wear of hybrid and binary composites when it was subjected to three different distances. The mass loss was determined from the difference in masses of the pin before and after the test. The volume loss, wear rates and wear coefficient is calculated. The values were tabulated and the graphs were plotted. A comparison is done between the wear rates of hybrid and binary composites and it was evident that the wear rate occurring in hybrid is less than the binary composite. The wear coefficients were also compared and it was found that, hybrid composite has better wear properties when compared to binary composites.

ACKNOWLEDGMENT

We wish to thank the management and the department of mechanical engineering, KCG College of Technology, Chennai for permitting us to use the Stir Casting Machine.

REFERENCES

[1]. S.L. Pramod, A.K. Prasada Rao, B.S. Murty, Srinivasa R. Bakshi, 2015, *"Effect of Sc addition on the microstructure and wear properties of A356 alloy and A356–TiB2 in situ composite"*, Materials and Design 78 pp. 85–94
[2]. Satish Kumar Thandalama, Subramanian Ramanathana, Shalini Sundarrajanb, 2015, *"Synthesis, micro structural and mechanical properties of ex situ zircon particles (ZrSiO4) reinforced Metal Matrix Composites (MMCs): a review"*, j m a t e r r e s t e c h n o l . ;4 (3):pp. 333–347
[3]. Narayana Yuvaraja, Sivanandam Aravindanb, Vipin, 2015, *"Article Fabrication of Al5083/B4C surface composite byfriction stir processing and its tribological characterization"*, j m a t e r r e s t e c h n o l
[4]. Ch. Shoba a, N. Ramanaiah, D. Nageswara Rao, 2015, *"Effect of reinforcement on the cutting forces while machining metal matrix composites-An experimental approach"*, Engineering Science and Technology, an International Journal 18, pp. 658-663
[5]. Michael Oluwatosin Bodunrina,b, Kenneth Kanayo Alanemea, Lesley Heath Chown, 2015, *"Aluminium matrix hybrid composites: a review of reinforcement philosophies; mechanical, corrosion and tribological characteristics"*, JMRTEC-169
[6]. K.R.Padmavathia, Dr. R.Ramakrishnan, 2014, *"Tribological behaviour of Aluminium Hybrid Metal Matrix Composite"*, Procedia Engineering 97, pp. 660 – 667
[7]. Johny James.S, Venkatesan.K, Kuppan.P, Ramanujam, 2014, *"Comparative Study of Composites Reinforced With SiC and TiB^2*, Procedia Engineering 97, pp. 1012 – 1017
[8]. Viney Kumara, Rahul Dev Guptab N K Batra, 2014, *"Comparison of Mechanical Properties and effect of sliding velocity on wear properties of Al 6061"*, Procedia Materials Science 6, pp. 1365 – 1375
[9]. M.Vamsi Krishnaa, Anthony.M.Xavior, 2014, *"An Investigation on the Mechanical Properties of Hybrid Metal Matrix Composites"*, Procedia Engineering 97, pp. 918 – 924
[10]. Himanshu Kalaa, K.K.S Merb, Sandeep Kumar, 2014, *"A Review on Mechanical and Tribological Behaviours of Stir Cast Aluminium Matrix Composites"* Procedia Materials Science 6, pp1951 – 1960

© 2014- 16, IJIRAE- All Rights Reserved