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An Investigation of Mechanical and Tribological Properties of Heat Treated Al6082 Hybrid Metal Matrix Composites

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Abstract: In recent years, there has been an ever-increasing demand for enhancing mechanical properties of Aluminum Matrix Composites (AMCs), which are finding wide applications in the field of aerospace, automobile, defense etc.,. Among all available aluminium alloys, Al6082 is extensively used owing to its excellent wear resistance and ease of processing. Newer techniques of improving the hardness and wear resistance of Al6082 by dispersing an appropriate mixture of hard ceramic powder and whiskers in the aluminium alloy are gaining popularity. The conventional aluminium based composites possess only one type of reinforcements. Addition of hard reinforcements such as silicon carbide, alumina, titanium carbide, improves hardness, strength and wear resistance of the composites. However, these composites possessing hard reinforcement do posses several problems during their machining operation. During metal matrix investigation shows higher tensile and compression value at ratio-3 (ZrO_2-4% +B_4C+ 2% Es 2%) due to higher mass basis reinforcement enhanced the properties of this metal matrix composites. Ratio four is 6%-ZrO_2 + 3% B_4C +3% Es shows highest hardness value 71 HRB. During wear investigation found the wear rate the Ratio 3 is very low wear rate occurred. Four percentage Zirconium oxide with 2% Boron carbide and 1% graphite reinforcement is occurred very low wear rate. Impact values obtain maximum at without metal matrix ratio.

Keywords: AA6082, ZrO_2, Hardness, Tensile, Wear

I. INTRODUCTION

Metal-matrix composites (MMCs) exhibit the ability to withstand high tensile and compressive stresses by the transfer and distribution of the applied load from the ductile matrix to the reinforcement phase. These MMCs are fabricated by the addition of a reinforcement phase to the matrix by the use of several techniques such as powder metallurgy, liquid metallurgy and squeeze-casting. The inclusions in MMC_S can be continuous fibres, discontinuous particulate or whiskers. Particulates make excellent inclusions, because they lead to predictable isotropic behavior in the composite. In addition some particulate metal matrix composites (PMMCs) are attracting attention because of their good mechanical, thermal and tribological properties. Particulate-reinforced composites cost less than fiber-reinforced composites owing to the lower cost of fibers and manufacturing cost.

Besides their increased strength, hardness and thermal conductivity, PMMCs have been found to have better wear resistance than the unreinforced matrix metal. Among the group of hard ceramic particles considered for inclusion in aluminum based MMCs B_4C particles have been found to have an excellent compatibility with the aluminum matrix and can be obtained at low cost. Their excellent wear resistance also makes these SiC- particle-reinforced aluminum (ZrO_2/B_4C) composites important candidate materials for use in automobiles as pistons, brake rotors, calipers, connecting rods and cylinder liners.

A. Composite

Composite material is a material composed of two or more distinct phases (matrix phase and reinforcing phase) and having bulk properties significantly different from those of any of the constituents. Many of common materials (metals, alloys, doped ceramics and polymers mixed with additives) 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 constituents (physical property of steel are similar to those of pure iron) .

Favorable properties of composites materials are high stiffness and high strength, low density, high temperature stability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, improved wear resistance etc.

Performance of Composite depends on:

1) Properties of matrix and reinforcement,
2) Size and distribution of constituents,
3) Shape of constituents,
4) Nature of interface between constituents.

B. Types of AMCs

AMCs can be classified into four types depending on the type of reinforcement.

1) Particle-reinforced AMCs (PAMCs)
2) Whisker-or short fibre-reinforced AMCs (SFAMCs)
3) Continuous fibre-reinforced AMCs (CFAMCs)
4) Mono filament-reinforced AMCs (MFAMCs)

C. Particle Reinforced Aluminum Matrix Composites (PAMCs)

These composites generally contain equated ceramic reinforcements with an aspect ratio less than about 5. Ceramic reinforcements are generally oxides or carbides or borides (Al_2O_3 or SiC or TiB_2) and present in volume fraction less than 30% when used for structural and wear resistance applications. PAMCs are less expensive compared to CFAMCs.

PAMCs are used as rotating blade sleeves in helicopters. The most notable large size and high volume use of PAMCs is in braking systems of trains and cars. Potential automotive applications of PAMCs include valves, crankshafts, gear parts and suspension arms. Particle reinforced AMCs are in use as recreational products including golf club shaft and head, skating shoe, baseball shafts, horseshoes and bicycle frames.

D. Aluminum Use In The Auto Industry

Automakers lightened average car weights by about 25 percent, to about 3,000 pounds during 1978-80, doubling fuel economy and improving performance. Some industry analysts think that the average automobile will have to be lightened further, by 500 to 700 pounds (16 to 22 percent), to meet upcoming fuel efficiency and emissions requirements. The corrosion resistance, strength, light weight, and ease of fabrication of aluminum have steadily increased its use by automakers. Automakers reduced average car weights and used much less of conventional steels and iron.

II. OBJECTIVES OF PRESENT WORK

The requirement of composite material has gained popularity in these days due to their various properties like low density, good wear resistance, good tensile strength and good surface finish. Zirconium oxide, Boron carbide and egg shell is one of the least expensive and low density reinforcement available in huge quantities as solid waste by-product in ceramic plant. The Hardness strength will also be taken into consideration. For the achievement of the above, an experimental set up is prepared where all the necessary inputs will be made. In this work a composite is developed by adding ZrO2 ,B4C & Chicken egg shell in Aluminum metal by weight ratio with various percentages. The composite has to be prepared by crucible casting technique and has to be analyzed various mechanical properties.

A. Aluminum-6082

Al 6082 has a good surface finish; high corrosion resistance is readily suited to welding and can be easily anodized. Most commonly available as T6 temper, in the T4 condition it has good formability.

B. Zirconium Oxide

Sometimes known as zirconium (not to be confused with zircon), is a white crystalline oxide of zirconium. Its most naturally occurring form, with a monoclinic crystalline structure, is the mineral baddeleyite. A dopant stabilized cubic structured zirconia, cubic zirconia, is synthesized in various colours for use as a gemstone and a diamond stimulant. Zirconium dioxide is one of the most studied ceramic materials. ZrO_2 adopts a monoclinic crystal structure at room temperature and transitions to tetragonal and cubic at higher temperatures.

C. Boron Carbide

Boron Carbide is one of the hardest materials known, ranking third behind diamond and cubic boron nitride. It is the hardest material produced in tonnage quantities.

III. CRUCIBLE CASTING

In this project we have used sand mold casting for produce the requirement size. Sand casting, also known as sand molded casting, is a metal casting process characterized by using sand as the mold material. It is relatively cheap and sufficiently refractory even for steel foundry use.

IV. HARDNESS VALUE OF HYBRID AMMC

TABLE I: HARDNESS VALUE

S.No	MATERIAL	AVERAGE-HRB
R1	Al6082-100%	62
R2	Al6082 + 2%-ZrO_2 + 1% B_4C +1% Es	65
R3	Al6082+4%-ZrO_2 + 2% B_4C +2% Es	68
R4	6%-ZrO_2 + 3% B_4C +3% Es Remaining Al-6082	71

V. IMPACT STRENGTH VALUE OF HYBRID AMMC

TABLE II: IMPACT VALUE

S.No	MATERIAL	IMPACT STRENGTH (JOULES)
R1	Al6082-100%	4
R2	Al6082 + 2%-ZrO_2 + 1% B_4C +1% Es	3
R3	Al6082+4%-ZrO_2 + 2% B_4C +2% Es	2
R4	6%-ZrO_2 + 3% B_4C +3% Es Remaining Al-6082	2

VI. TENSILE STRENGTH VALUES VALUE OF HYBRID AMMC

TABLE III: TENSILE STRENGTH

S.No	**DIA (mm)**	**CSA (mm2)**	**TL (kN)**	**TS (N/mm^2**
R1	16.41	211.58	20.19	95.42
R2	16.45	212.62	22.76	107.05
R3	16.33	209.53	24.38	116.36
R4	16.12	204.17	21.19	103.79

VII. COMPRESSIVE STRENGTH VALUES VALUE OF HYBRID AMMC

TABLE IV: COMPRESSION STRENGTH

S.No	MATERIAL	COMPRESSION STRENGTH N/mm^2
R1	Al6082-100%	174.65
R2	Al6082 + 2%-ZrO_2 + 1% B_4C +1% Es	187.64

R3	Al6082+4%-ZrO_2 + 2% B_4C +2% Es	187.77
R4	6%-ZrO_2 + 3% B_4C +3% Es Remaining Al-6082	200.60

CONCLUSION OF MACRO TEST

From the investigation the mechanical property of Al6082 metal matrix was analyzed finally found Zirconium oxide and Boron carbide reinforcement enhanced the tensile and compressive strength abnormally. It shows superior strength compared the without Zirconium oxide and Boron carbide and Egg shell metal matrix.

VIII. WEAR TEST

A tribometer is an instrument that measures tribological quantities, such as coefficient of friction, friction force, and wear volume, between two surfaces in contact. A tribotester is the general name given to a machine or device used to perform tests and simulations of wear, friction and lubrication which are the subject of the study of tribology. Often tribotesters are extremely specific in their function and are fabricated by manufacturers who desire to test and analyze the long-term performance of their products. An example is that of orthopedic implant manufactures who have spent considerable sums of money to develop tribotesters that accurately reproduce the motions and forces that occur in human hip joints so that they can perform accelerated wear tests of their products.

Specifications: Load:2 Kg, Duration :15 minutes,Dia:60 mm& RPM:400

A. Weight Of Testing Specimen Before And After

TABLE V: WEAR RATE OF THE DIFFERENT VARIOUS COMPOSITES

RATIO	BEFORE WEIGHT	AFTER WEIGHT	DIFFERENCE
Al6082-100%	6.5979	6.5821	0.016
Al6082 + 2%-ZrO_2 + 1% B_4C +1% Es	6.2458	6.2314	0.014
Al6082+4%-ZrO_2 + 2% B_4C +2% Es	6.0077	5.9944	0.013
6%-ZrO_2 + 3% B_4C +3% Es Remaining Al-6082	6.0712	6.0575	0.014

B. Conclusion of Wear Test

According to the wear test have found the wear rate the Ratio 3 is very low wear rate occurred during this wear investigation. Four percentage Zirconium oxide with 2% Boron carbide and 2% Es Remaining reinforcement is occurred very low wear rate.

IX. CONCLUSION & RESULT

Composite materials especially Aluminum 6082 and Zirconium oxide, Boron carbide & Graphite composites having good mechanical properties compared with the conventional materials. It is used in various industrial applications these materials having light weight along with high hardness. Tensile test and compression verified It shows higher tensile and compression value at ratio 3 (ZrO_2-4% +B_4C+ 2% Es 2%) due to higher mass basis reinforcement enhanced the properties of this metal matrix composites. Ratio 4 (ZrO_2-6% +3B_4C+ 3% Es) shows highest hardness value 71HRB.Highly reinforced composites show higher variations due to the agglomeration of particles. During wear investigation found the wear rate the Ratio 3 is very low wear rate occurred. Four percentage Zirconium oxide with 2% Boron carbide and 2 % Egg shell reinforcement is occurred very low wear rate.

REFERENCES

[1] N. Mathan Kumar S. Senthil Kumaran b,*, L.A. Kumaraswamidhas, Wear behaviour of Al 2618 alloy reinforced with Si3N4, AlN and ZrB2 in situ composites at elevated temperatures, Alexandria Engineering Journal (2016) 55, 19–36.
[2] Pardeep Sharmaa, Satpal Sharmab, Dinesh Khanduja, Production and some properties of Si3N4reinforced aluminum alloy composites, Journal of Asian Ceramic Societies 3 (2015) 352–359

[3] R. AMBIGAI, S. PRABHU,, Optimization of friction and wear behaviour of Al−Si3N4 nano composite and Al−Gr−Si3N4 hybrid composite under dry sliding conditions, Trans. Nonferrous Met. Soc. China 27(2017) 986−997

[4] Hongyan WANG, Shouren WANG*, Gaozhi LIU, Yingzi WANG, AlSi11/ Si3N4 interpenetrating composites Tribology properties of aluminum matris composites, 2012 world Congress on Engineering and Technology

[5] A. Lotfya,b, A.V. Pozdniakova, V.S. Zolotorevskiya, M.T. Abou El-khairb, A. Daoudb, A.G. Mochugovskiya, Novel preparation of Al-5%Cu / BN and Si3N4 composites with analyzing microstructure, thermal and mechanical properties, Materials Characterization 136 (2018) 144–151

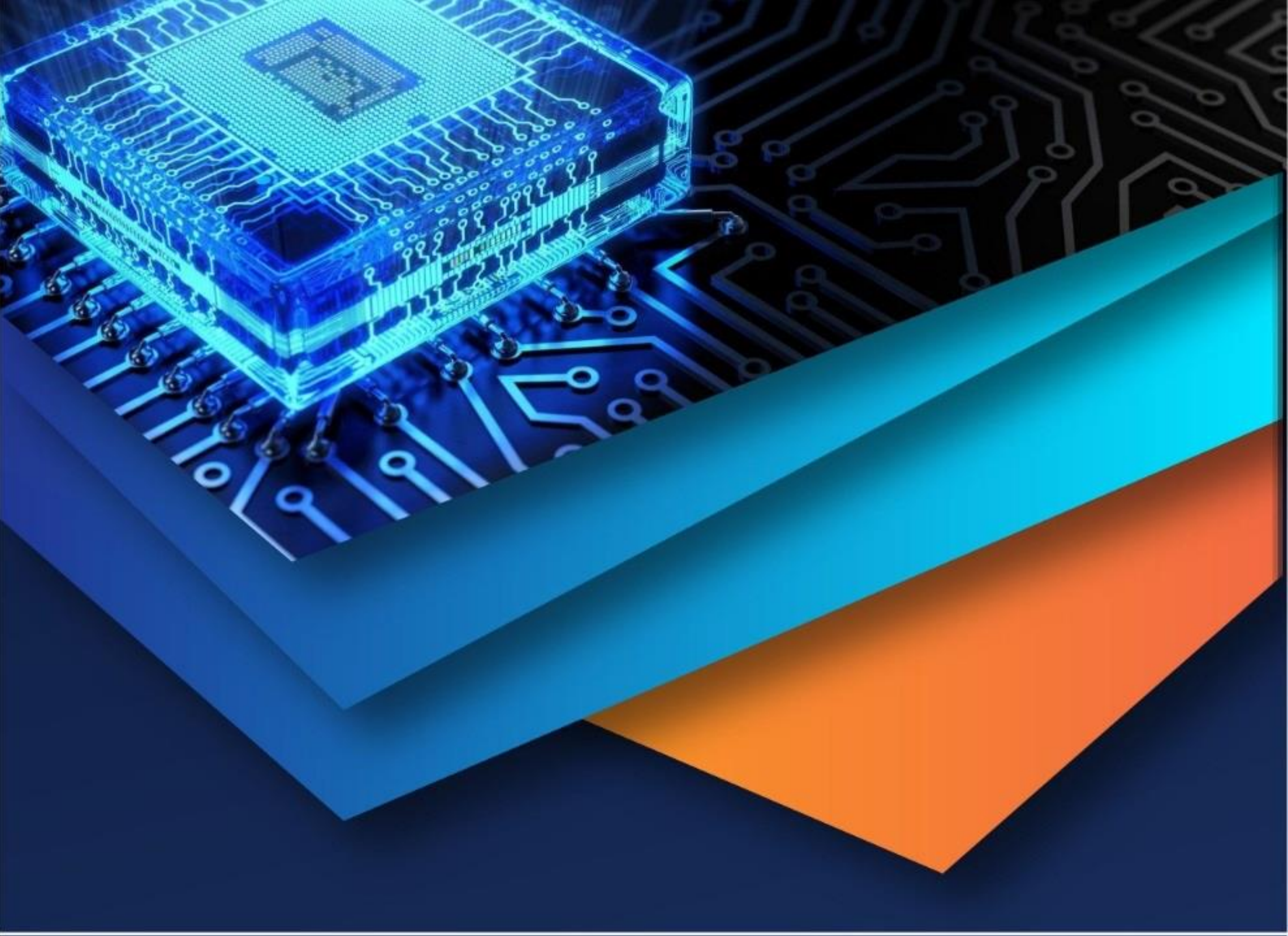
[6] Mahmut Can Şenel, Mevlüt Gürbüz*, Erdem Koç, Fabrication and Characterization of SiC and Si3N4 Reinforced Aluminum Matrix Composites, Universal Journal of Materials Science 5(4): 95-101, 2017

[7] Pardeep Sharmaa, Satpal Sharmab, Dinesh Khanduja Production and Characterization of AA6082- (Si3N4+ Gr) Stir Cast Hybrid Composites, ["Queen's University Libraries, Kingston"] at 03:35 27 January 2016

[8] Rodrigues de Araujo1,a, Marcio Marcelo Sampaio de Souza Preparation of Metal Matrix Aluminum Alloys Composites Reinforced by Silicon Nitride and Aluminum Nitride Through Powder Metallurgy Techniques, Materials Science Forum Vols. 727-728 (2012) pp 259-262

[9] Sachin Ghalme, Ankush Mankar and Y. J. Bhalerao4, Optimization of wear loss in silicon nitride (Si3N4)–hexagonal boron nitride (hBN) composite using DoE–Taguchi method, Ghalme et al. Springer Plus (2016) 5:1671

[10] Ankit Tyagi, Deepak Sharma, Characterization of AA6082/Si3N4 Composites, Frontiers in Engineering, Science & Technology, New Delhi, India, Jan 8-12, 2018.



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