2nd International Conference on Advanced Research in Biology, Engineering, Science and Technology
(ICARBEST'16)
Organized by
International Journal of Advanced Research in Biology, Engineering, Science and Technology (IJARBEST)
19th February 2016

WEAR TESTING MACHINE-PIN ON DISC METHOD

B.SATHEESH KUMAR (DOB: 25/11/1991)[1], V.NATARAJAN[2], S.MOHAMED ABDULLAH SULAIMAN[3], P.LOKESH[4]

U.G. Scholars, Department of Civil Engineering, PSN College of Engineering and Technology (Autonomous), Tirunelveli, India [1,2,3,4]

***Abstract*— Particulate reinforced metal matrix composites (MMCs) improves both mechanical and physical properties with increasing metal working characteristics and powder metallurgy processing is one of the methods proper for fabricating these materials. MMCs are very important because of their high ratio of strength and weight, high Young modulus and high abrasive properties. Aluminium is one of the best materials for matrix because of its low density, high conductivity and high toughness. Moreover, Al is cheaper than other light metals like magnesium (Mg).**

The other advantage of using Al as matrix of MMCs is its corrosion resistance which is very important for using composites in different environments. In contrast, Al does not have enough tensile strength for many applications. Because of this weakness, ceramic particles (e.g. zircon sand) can be added for better hardness and tolerating high temperatures.

***Index Terms*— Metal matrix composites, Pin On Disc Wear - Testing Machine, SEM analysis**

I. INTRODUCTION

Boron carbide (B_4C) is an extremely hard boron–carbon ceramic material used in tank armour, bullet proof vests, and numerous industrial applications. With a **Mohs hardness** [This scale is a chart of relative hardness of the various minerals (1 - softest to 10 - hardest)] of about 9.497, it is one of the hardest materials known, behind cubic boron nitride and diamond. Boron carbide is characterised by its Extreme hardness, Difficult to sinter to high relative densities without the use of sintering aids, Good chemical resistance and Low density.

Boron carbide is known as a robust material having high hardness, high cross section for absorption of neutrons (i.e. good shielding properties against neutrons), stability to ionizing radiation and most chemicals.

Table I
TYPICAL PROPERTIES OF BORON CARBIDE

PROPERTY	VALUE
Density (g.cm^{-3})	2.52
Melting Point (°C)	2445
Hardness (Knoop 100g) (kg.mm^{-2})	2900-3580
Fracture Toughness (MPa.m$^{-½}$)	2.9 - 3.7
Young's Modulus (GPa)	450 – 470
Electrical Conductivity (at 25°C) (S)	140
Thermal Conductivity (at 25°C) (W/m.K)	30 – 42
Thermal Expansion Co-eff. x10^{-6} (°C)	5
Thermal neutron capture cross section (barn)	600

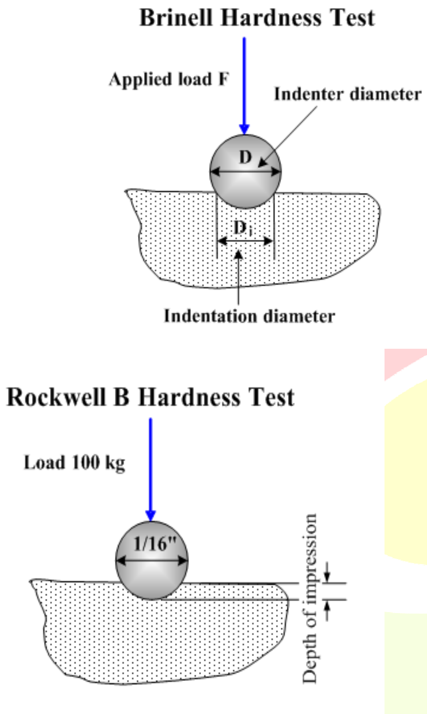
Boron carbide was first synthesized by Henri Moissan in 1899, by reduction of boron trioxide either with carbon or magnesium in presence of carbon in an electric arc furnace. In the case of carbon, the reaction occurs at temperatures above the melting point of B_4C and is accompanied by liberation of large amount of carbon monoxide.

$$2\,B_2O_3 + 7\,C \rightarrow B_4C + 6\,CO$$

Often materials are subject to forces (loads) when they are used. Mechanical engineers calculate those forces and material scientists how materials deform (elongate, compress, twist) or break as a function of applied load, time, temperature, and other conditions. Materials scientists learn about these mechanical properties by testing materials. Results from the tests depend on the size and shape of material to be tested (specimen), how it is held, and the way of performing the test. That is why we use common procedures, or standards, which are published by the ASTM.

Hardness is the resistance to plastic deformation (e.g., a local dent or scratch). Thus, it is a measure of *plastic* deformation, as is the tensile strength, so they are well correlated. Historically, it was measured on an empirically scale, determined by the ability of a material to scratch another, diamond being the hardest and talc the softer. Now we use standard tests, where a ball or point is pressed into a material and the size of the dent is measured. There are a few different hardness tests: Rockwell, Brinell, Vickers, etc. They are popular because they are easy and non-destructive (except for the small dent)

All Rights Reserved © 2015 ICARBEST16



a) Brinell hardness test b) Rockwell hardness test
Fig.1. Schematic diagrams of hardness test

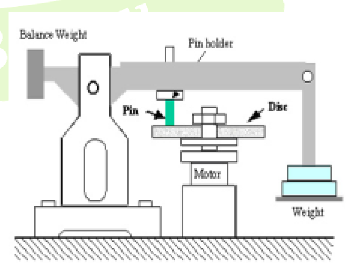
II. LITERATURE SURVEY

Sheidi Haruna Maihankuri [1] studied about the production of castings that is essential to the industrial development of a Country. The manufacture of every machine and each piece of equipment used in transportation, farming, construction and mining, petroleum and in water-supply and sanitation facilities is dependent on castings. Equipment and Machineries components may be broken or wear out and may be replaced. Effective local sources for these replacement parts are essential to avoid long delays in obtaining them from the original manufacturer or from more industrialized neighbouring Countries. Quality Zircon sand is a vital ingredient for foundry production of high content Manganese steel castings. The need for this investigation arose out of the desire to establish the availability and locations of local quality zircon sand for foundry practice. The Azara-Lafia zircon sand deposit is a good source for quality foundry sand. The service properties (chemical and physical) of the sand were determined. These include permeability, green strength and sintering point. Sample casting was conducted using high manganese alloy containing (13.2% Mn). The investigation revealed the suitability of the sand for the production of quality castings.

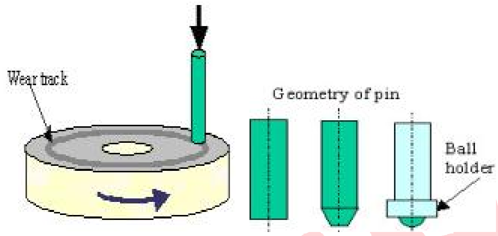
R. Ipek [2] studied about the Adhesive wear characteristics of 4147 Al/B4C, 10, 15 and 20 wt.% B_4C particle and Al/SiC metal matrix composites 20 wt.% SiC contain produced by liquid metallurgy have been investigated under the dry sliding conditions and their wear behaviours are compared with 4147 Al/SiC-reinforced 20 wt.% SiC. The results showed that the wear resistance of Al/B_4C matrix increases considerably with increasing wt.% B_4C particle content in Al alloy matrix. When Al alloy matrix material is in severe adhesive-abrasive wear, the Al/B4C composites are in light-mild adhesive wear stage at the same wear condition. B_4C content and its behaviour in Al matrix is determined factor for wear rate and mechanism of the MMC. The relationship between the w-ear resistance and wear mechanism is also observed, and it depends on soakabality of B_4C particle by the matrix. When Al/B_4C wear behaviour is compared with Al/SiC MMC, Al/SiC wear resist is high, and the worn sample of Al/SiC only shows a light adhesive wear traces at the same conditions. Christo Ananth et al. [3] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

III. EXPERIMENTAL WORK

In a pin-on-disc wear tester, a pin is loaded against a flat rotating disc specimen such that a circular wear path is described by the machine. The machine can be used to evaluate wear and friction properties of materials under pure sliding conditions. Either disc or pin can serve as specimen, while the other as counterface. Pin with various geometry can be used. A convenient way is to use ball of commercially available materials such as bearing steel, tungsten carbide or alumina (Al_2O_3) as counterface, so that the name of ball-on-disc is used.



All Rights Reserved © 2015 ICARBEST16



A) Pin-On-Disc-Machine B) Arrangement On Samples

C) Geometry Of Pin

Fig.2. Schematic Of A Pin-On-Disc Wear Test And The Arrangement Of Samples

In pin on disc wear testing process, the specimen is loaded on the machine and various tests are to be carried out by varying the load and velocity of pin sliding on the disc. The varying load of about 1kg and 1.5kg with respect to variation of speed about 350rpm, 500rpm and 650 rpm by maintaining the time interval as constant 30 minutes respectively. Each and every samples mentioned above are tested by the condition of varying velocity and load. The weight loss due to wear on the sample surface are determined in microns.

These specimens are then subjected to analysis using SEM imaging technique which will clearly shows the micro structure of the sample. This will be very useful in determining the wear resistance property of the sample which is supposed to have very less amount of weight loss and having more wear resistance capacity.

TABLE -I
WEAR TEST RESULT FOR AL 5083– (AL-0% B_4C-0%$ZRSIO_4$)

Load (kg)	Speed (rpm)	SlidingDistance (m)	Velocity (m/s)	Time (min)	Experimental Wear loss (Microns)
1	353	1110	66.7	30	39
1.5	353	1110	66.7	30	62
1	520	1635	54.5	30	27
1.5	520	1635	54.5	30	28
1	637	2001	37	30	12
1.5	637	2001	37	30	5

TABLE – II
WEAR TEST RESULT FOR AL 5083 – BORON CARBIDE(B_4C) (AL-3% B_4C) (5%$ZRSIO_4$)

Load (kg)	Speed (rpm)	SlidingDistance (m)	Velocity (m/s)	Time (min)	Experimental Wear loss (Microns)
1	353	1110	66.7	30	3
1.5	353	1110	66.7	30	47
1	520	1635	54.5	30	22
1.5	520	1635	54.5	30	27
1	637	2001	37	30	11
1.5	637	2001	37	30	20

TABLE – III
WEAR TEST RESULT FOR AL 5083– BORON CARBIDE(B_4C) (AL-5% B_4C) (5%$ZRSIO_4$)

Load (kg)	Speed (rpm)	Sliding Distance (m)	Velocity (m/s)	Time (min)	Experimental Wear loss (Microns)
1	353	1110	66.7	30	6
1.5	353	1110	66.7	30	69
1	520	1635	54.5	30	21
1.5	520	1635	54.5	30	24
1	637	2001	37	30	19
1.5	637	2001	37	30	25

IV. CONCLUSION

Particulate reinforced metal matrix composites (MMCs) improves both mechanical and physical properties with increasing metal working characteristics and powder metallurgy processing is one of the methods proper for fabricating these materials. MMCs are very important because of their high ratio of strength and weight, high Young modulus and high abrasive properties. Aluminium is one of the best materials for matrix because of its low density, high conductivity and high toughness. Moreover, Al is cheaper than other light metals like magnesium (Mg).

The other advantage of using Al as matrix of MMCs is its corrosion resistance which is very important for using composites in different environments. In contrast, Al does not have enough tensile strength for many applications. Because of this weakness, ceramic particles (e.g. zircon sand) can be added for better hardness and tolerating high temperatures.

REFERENCES

[1] Sheidi haruna maihankuri, 'Investigation on properties of local zircon sand for sound casting' Research Journal in Engineering and Applied Sciences 1(6) 404-407.

All Rights Reserved © 2015 ICARBEST16

[2] R. Ipek. 'Adhesive wear behaviour of B4C and SiC reinforced 4147 Al matrix composites (Al/B4C–Al/SiC)' Journal of Materials Processing Technology 162–163 (2005) 71–75.

[3] M.A.Fathima, M.Gnana Soundarya, M.L.Jothi Alphonsa Sundari, B.Gayathri, Praghash.K., Christo Ananth, "Fully Automatic Vehicle For Multipurpose Applications", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Vol 1,Special Issue 2,November 2015, pp: 8- 12.

[4] M.A.Fathima, M.Gnana Soundarya, M.L.Jothi Alphonsa Sundari, B.Gayathri, Praghash.K., Christo Ananth, "Fully Automatic Vehicle For Multipurpose Applications", International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST), Vol 1,Special Issue 2,November 2015, pp: 8- 12.

[5] Sheidi haruna maihankuri, 'Investigation on properties of local zircon sand for sound casting' Research Journal in Engineering and Applied Sciences 1(6) 404-407.

[6] Limit State Design of Reinforced Concrete Structures, N. Krishna Raju.

[7] Cemal Meran,"Prediction of optimized welding parameters for joined brass plates using genetic algorithm"(2014),Materials and Design, Vol.27,pp.356-363.

All Rights Reserved © 2015 ICARBEST16