LITERATURE SURVEY FOR WEAR BEHAVIOUR OF DIFFERENT METAL MATRIX COMPOSITE

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ABSTRACT

Now a days to produce light automobiles a great deal of research on the construction of new and light materials. For this purpose and particularly metal matrix composites (MMC) are already used in automobiles, but some properties of metal matrix composite (MMC) require further investigation. Material to be used in automobile engine must have good tribological and mechanical properties. So with the use of different reinforcement in metal matrix, wear properties of metal matrix composite (MMC) can be increased.

Keyword: - *wear behavior, universal wear tester, molybdenum matrix composite, metal matrix composite,*

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1. INTRODUCTION

Wear is one of the most frequently encountered industrial issue where the material is affected mainly by speed, environmental conditions, and working load. Wear is a slow and progressive loss of material which are subjected to repeated rubbing action. Wear causes an enormous amount of expenditure by repairing or replacing the worn-out parts or equipment [17].The wear resistance of metal matrix composite depends mainly on various microstructural characteristics like particle size, volume fraction, distribution of reinforcement material, and shape. Among the different types of reinforcement, particulate form of ceramics reinforced with MMC has desirable and attractive properties like ease of fabrication and can withstand higher operating temperature and oxidation resistance compared to other geometries of reinforcement such as fiber and flakes. The tribological properties of MMCs play an important role in the selection of materials for the manufacture of automobile parts. A great deal of research on MMCs has been conducted over the past three decades, and many methods have been proposed for the fabrication of these materials: extrusion, casting, powder metallurgy, squeezer casting, and centrifugal casting. As the demand is increasing for low cost reinforcement composites an attempt is made in these paper to identify MMC suitable for engineering application where wear properties is needed.

2. WEAR TEST

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 tungsten carbide as counterface, so that the name of ball-on-disc is used.

Wear measurement is carried out to determine the amount of materials removed (or worn away) after a wear test, (and in reality after a part in service for a period of time). The material worn away can be expressed either as weight (mass) loss, volume loss, or linear dimension change depending on the purpose of the test, the type of wear, the geometry and size of the test specimens, and sometimes on the availability of a measurement facility.

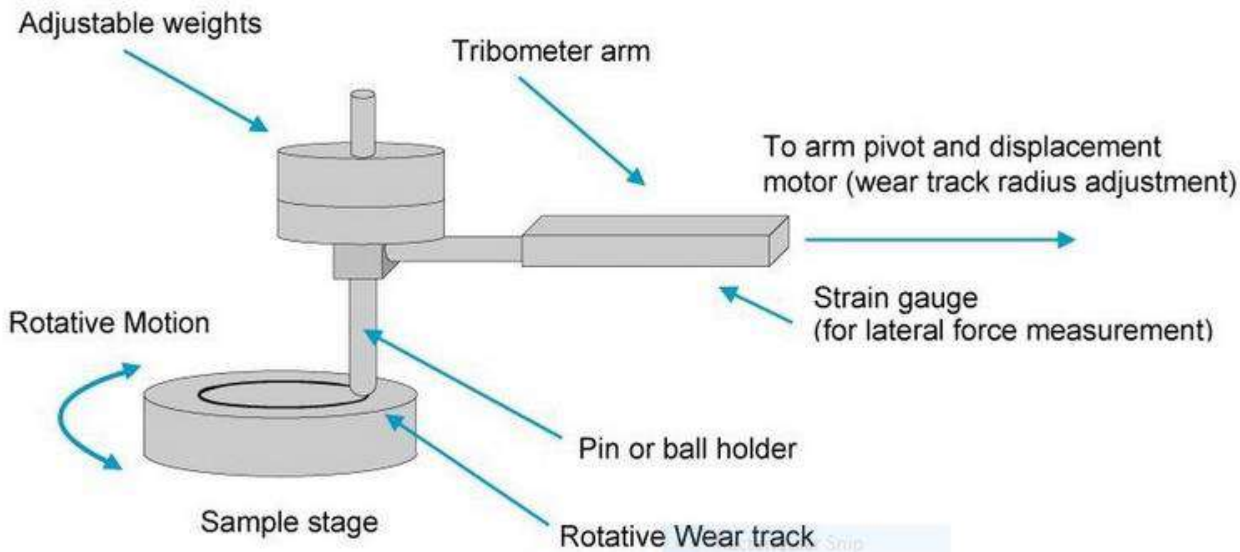

Fig -1: Universal wear tester

3. LITERATURE REVIEW

Gutierrez Mora et, 2016 [13] The tribological behaviour of Alumina – carbon nanofibers (CNF) and alumina – graphene oxide (GO) composites was studied using the ball-on-disk technique in dry sliding at ambient conditions and compared to a monolithic alumina used as a reference. At low loads there was little difference between friction and wear behaviour, whereas at moderate loads the composites showed anoticeable reduction in wear rate over monolithic alumina, five and 2.5 times for the GO and the CNF composite respectively; the friction coefficient slightly decreased for the alumina – GO material. This behaviour is related to the presence of a carbon-rich protecting tribofilm. The film present in the alumina– GO showed better tribological performance due to the absence of coalescence of cracks that led todelamination events in the case of the alumina – CNF composite.
N. I. Novokhatskaya,et al, 2015 [1] Work on high temperature materials are designed to achieve an acceptable balance between three basic characteristics cracking resistance, creep Resistance and gas corrosion resistance. The molybdate forming elements that are present in the matrix substantially retard molybdenum oxidation in the composite material. The strength of the composite material weakly depends on the time of holding in quiet air at 1250°C for 12 h. The strength of the composite material as a function of the Al :Y ratio in the oxide matrix changes non monotonically. The maximum strength shifts from the Al_2O_3–$Al_5Y_3O_{12}$ eutectic point toward garnet.

Sergei T. Mileiko,2017 [9] A study was conducted on molybdenum matrix composites reinforced with fibres containing yttrium and ytterbium silicates. In these study for the first time, such fibres are obtained as reinforcements of molybdenum matrix and mechanical properties of the oxide/molybdenum composites are studied. The raw mixtures of oxide powders Y_2O_3– SiO_2 for melting and crystallising Composite and Advanced Materials them to form fibres in molybdenum matrix had molar ratios: 0.5 - 0.5. Also Yb_2O_3 - SiO_2 with molar ratio 0.6305:0.3695 to produce fibre close to yttrbiasilicate eutectic composition. This finding makes molybdenum matrix composites be a candidate for future heat resistant materials with high creep resistance at high temperatures and sufficiently high fracture toughness at low temperatures

S. Selvakumar, 2017 [4] In these study Aluminium matrix composites (AMCs) reinforced with hard metallic particles can be used as reinforcement to improve ductility. The present investigation focuses on using molybdenum (Mo) as potential reinforcement for Mo (0,6,12 and 18 vol.%)/6082Al AMCs. Mo particles were successfully retained in the aluminium matrix in its elemental form without any interfacial reaction. A homogenous distribution of Mo particles in the composite was achieved. The tensile test results showed that Mo particles improved the strength of the composite without compromising on ductility.

K. Bouhamla,2013 [2] A study was conducted to determine the effect of alloying elements on the friction and wear behaviour of high chromium cast iron with various concentrations of molybdenum and niobium**.** The highest abrasion and friction resistance are given by samples containing 3% Mo and 3% Nb, witch exhibited the smaller abrasion loose. Friction results are different from those given by abrasion. Abrasion and friction behaviour do not take place in the same way. The best wear resistance is obtained by abrasion after heat treatment with samples alloyed with 3% molybdenum.

N.I. Novokhatskaya,2015 [5] Work on development of heat resistance, high fracture toughness and sufficiently high gas corrosion resistance materials based on a refractory metals is suggested. The method is based on the reinforcement of a refractory metal matrix with creep resistant oxide fibers containing at least one element providing an enhanced gas corrosion resistance of the matrix. Reinforcing molybdenum with oxide fibers is performed by using the internal crystallization method (ICM). Oxide fibre containing rare earth elements into molybdenum matrix yields an essential decrease in the oxidation rate of molybdenum at elevated and high temperatures as compared to composites reinforced with fibers without such elements.

Shivakumar Nagavelly, 2017 [6] In these study MoS2 particles with 0.5, 1 and 1.5 (wt%) weight percentages were reinforced in ZA-27 alloy to form composites. The mechanical properties such as ultimate tensile strength (UTS), yield strength (YS) and hardness of the ZA-27/MoS2 composites improved for the 0.5 wt% MoS2 particulate composite compared to the composites with $\geq$1.0 wt% MoS2. The percentage elongation of the composites monotonically decreased with increase in the weight percentage of the MoS2 particles in the ZA-27 alloy.

A.Arora, et al, 2016 [12] Work to produce a superficial MMC layer on the Al plate in order to increase the mechanical properties of the as received Al plate. Superficial Al-Mo MMC was produced by means of FSP (Friction stir process). The method under investigation appears to be suitable to produce a dispersion of Mo particles in a superficial layer on the top surface of the Al sample. The results obtained showed a good dispersion of the Mo powders on the top surface of the samples, conversely in the cross section no molybdenum powders were observed. It is useful to produce a superficial layer with improved performances due to the dispersion of the powders to surface metal matrix composite.

J. J. Penagos, 2016 [3] Study of the effects of niobium and molybdenum in high chromium cast iron (HCCI). Four 18% Cr /2.7% C alloys were melted in a base alloy, an alloy containing 1% Mo (free-Nb), an alloy containing 1% Nb (free-Mo) and a fourth alloy containing 1% Nb and 1% Mo. In general, Nb and Mo additions slightly increased (3% to 10%) the Vickers hardness and the micro hardness of the matrix. Regarding niobium carbides (NbC), Nano hardness was measured. The fourth alloy (containing Nb and Mo) presented a higher abrasion resistance (16%) than the base alloy and the wear predominantly occurred in the matrix. Concluding that rather small amounts of Nb and Mo (in combination), can lead to significant gains in abrasion resistance of HCCI.

M. Abdulwahab et, 2017 [16] In these study wear characteristics of A356/melon shell ash particulate composites were examined. The wear resistance of A356 increased considerably with percentage reinforcement. In other words, the abrasive mass loss decreased with increasing percentage of reinforcement addition at the both applied loads. It is found that the weight of the base alloy lost under load of 5 N is 2.5 times greater than that for the alloy reinforced with 20 wt% reinforcement. Wear rate of the base alloy on the other hand, is about 1.23 times higher than that for the alloy reinforced with 20 wt% melon shell ash particles. Thus, composite with 20 wt% reinforcement showed better wear resistance compared with all other composites.

M.B.Karamis, 2012 [8] Work on metal matrix composite to determine the tribological properties of AA2124 matrix material, reinforced by SiC, B4C or Al2O3. Tribological tests were conducted at 50N loading with 900 rpm revolution for 30 minute dry conditions. The specific wear rates of the composites reinforced with 10% volume fraction of B4C or SiC a reach lower than that of the GGG40 material. While the composite having 30% volume fraction of 20 μm SiC gives the best wear performance, the sample with B4C shows the best performance at 10%vf.

Shouvik Ghosh,2012 [7] An analysis of variance is employed to investigate the influence of four controlling parameters, viz., SiC content, normal load, sliding speed and sliding time on dry sliding wear of the Metal Matrix Composite Al-SiCp. It is observed that SiC content, sliding speed and normal load significantly affect the dry sliding wear. In these study it is revealed that a proper control of process parameters can result in improved design of the

Al-SiC composite for tribological applications. From the microstructure study of worn surfaces, it is observed that mostly abrasive wear mechanism has occurred on the wear tracks with some traces of adhesive wear mechanism.

Pardeep Sharma, et al 2016 [11] Work on aluminium alloy 6101-graphite composites for their mechanical and tribological behaviour in dry sliding environments. Hardness, tensile strength and flexural strength decreases with increasing volume fraction of graphite reinforcement as compared to cast Al6101 metal matrix. Wear tests were performed on pin on disc apparatus to assess the tribological behaviour of composites and to determine the optimum volume fraction of graphite for its minimum wear rate. The average co-efficient of friction also reduces with graphite addition and its minimum value was found to be at 4 wt.% graphite. The worn surfaces of wear specimens were studied through scanning electron microscopy. The occurrence of 4 wt% of graphite reinforcement in the composites can reveal loftier wear possessions as compared to cast Al6101 metal matrix.

J.W.Kaczmar, et al, 2010 [18] Investigation on wear improvement of aluminium matrix composite materials reinforced with alumina fibres. Wear process of unreinforced as cast 2024 alloy proceeded with plastic deformation of surface grains especially under higher pressure. .Reinforcing of 2024 aluminium alloy with 10 vol. % of Al2O3 Saffil fibres improved wear resistance of as cast composites only under high pressures of 1.2 and 1.5 MPa.

Liujie Xu, et al, 2017 [15] Work on the microstructures and frictional wear behaviours of high-speed steel (HSS) with high molybdenum content under different rolling-sliding conditions using self-made wear tester. As sliding ratio increases from approximately 1% to 10%, the frictional coefficient rises and then decreases, and the wear weight loss rises obviously because the wear mode varies from fatigue to sliding wear. The high stress rolling and sliding contact can cause not only fracture and desquamating of M2C, but also martensitic transformation in subsurface. The sliding ratio has a significant influence on the frictional wear properties and failure behaviours of HSS. As the sliding ratio increases, the frictional coefficient rises and then decreases. Furthermore the wear weight loss evidently rises given that the wear failure mode varies from fatigue to sliding wear.

P.Deepak, et al, 2017 [19] In these work Molybdenum disulphide was added to the epoxy resin at various weight fractions of 5%, 10% and 15% to increase the wear properties of the composites. Also a standard composite without modification was formed to study and compare the modification in various properties. The composite samples were studied for its wear, tensile, flexural and impact properties. The micrograph of the worn surfaces of various samples formed was studied using the scanning electron microscopy. Fibre reinforced, molybdenum disulphide modified epoxy composites SN, S5, S10 and S15, formed using hand layup technique at room temperature was analysed for its various properties and the outcome is that the tensile properties of the S15 composites were found to be better And the flexural strength of the S15 composites was 21.9% more than that of other composites.

K.Sooryaprakash, et al, 2015 [10] To developed composite exhibit increase in hardness when compared to base material, which could be attributed to the presence of hard SiC. The tribological properties of the developed composite materials were investigated using pin-on-disc wear test apparatus under dry sliding conditions. The wear resistance of the developed composites improved significantly than that of the magnesium matrix due to the upright effect offered by both of the reinforcements. Micro hardness, density and wear resistance of the magnesium increase with increase in SiC content.

S.T.Mileiko, 2017 [20] Work to decrease essentially oxidation rate of molybdenum by choosing as reinforcing fibres those containing oxides, which can react with molybdenum oxide to form a molybdate that has saturated vapor pressure much lower than that of molybdenum oxide, was discovered. This finding makes molybdenum matrix composites be a candidate for future heat resistant materials with high creep resistance at high temperatures and sufficiently high fracture toughness at low temperatures. 14

Sandan Kumar Sharma, et al, 2017 [14] Hot pressed silicon carbide (SiC) composites prepared with 10, 30 or 50 wt% tungsten carbide (WC) were subjected to unlubricated reciprocating sliding wear against SiC balls at 19 N load at room temperature and 500 °C. The coefficient of friction decreased from 0.4 to 0.3 with WC content at room temperature. SEM-EDS analysis of worn SiC-WC composts advocated the role of tribochemistry and microfracture in sliding at ambient temperature, whereas microfracture dominates for the wear at 500 °C. Softened SiC grains are responsible for easy fracture and removal of WC particles in sliding at high temperature.

L. Francis Xavier, 2015 [17] In this work, Aluminium Metal Matrix Composite is prepared by reinforcing 10 wt% and 20 wt% of wet grinder stone dust particles an industrial waste obtained during processing of quarry rocks which are available in nature. In the composite materials design wear is a very important criterion requiring consideration which ensures the materials reliability in applications where they come in contact with the environment and other surfaces. Dry sliding wear test was carried out using pin-on-disc apparatus on the prepared composites. The results reveal that increasing the reinforcement content from10 wt% to 20wt% increases the resistance to wear rate.

S.T. Mileiko, 2005 [21] In these work variety of single crystalline oxide fibres have been obtained by using the internal crystallisation method. The fibres retain high strength up to high temperatures. They have high-creep resistance at temperatures up to about 1600ºC.

3.1 FINDING FROM LITERATURE REVIEW

- Wear analysis has been done for various composite material.
- MO particles improved the tensile strength of the composite without any abrupt reduction in ductility.
- Molybdenum compound is used to reduce the friction between sliding or rolling parts.
- If the reinforcement particle size is smaller than that of matrix material powder size, the wear rate is decreased by increasing reinforcement size.
- Molybdenum matrix composites being prospective heat resistant materials with high wear resistance at high temperatures

4. CONCLUSIONS

From the literature review it is found that lack research or performance done on the material like molybdenum matrix composites and wear analysis of these composite material. Material like molybdenum matrix composites reinforced with oxide fibre Y_2O_3-SiO_2 and Yb_2O_3 - SiO_2 of chemical composition makes molybdenum matrix composites being prospective heat resistant materials with high wear resistance at high temperatures and sufficiently high fracture toughness at low temperatures. The property of these material is suitable to automobile cam material and many more.

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