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REVIEW ON PROCESSING AND PROPERTIES OF METAL MATRIX COMPOSITES

Shashidhar S.*[1], Shantharaja M.[2], P. Vijaya Kumar[3], Madeva Nagaral[4] and Shivananda B. K.[5]

[1]Research Scholar, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, India.
[2]Associate Professor, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, India.
[3]Professor, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, India.
[4]Design Engineer, Aircraft Research and Design Centre, HAL, Bangalore-560037, Karnataka, India.
[5]R&D Centre, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, India.

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***Corresponding Author**
Shashidhar S.
Research Scholar, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, India.

ABSTRACT

Over the years, materials in R&D and manufacturing industries has shifted from monolithic materials to the present composites materials, benefiting to low economy and improved properties. In metal matrix composites, aluminum based composites are widely used in various manufacturing industries like aerospace and automobile due to their low weight compared to other various alloys. The various reinforced aluminum metal matrix composites (AMMCs) leads to improved Physical, mechanical, and tri biological properties for specific applications required. Different methods and various processing techniques are employed for the fabrication of metal matrix composites aiming to achieve specific required properties by controlling the parameters. In this paper an attempt has been made to combine overall aspects of metal matrix composites and various reinforcement materials by using different processing method and further mechanical and wear properties are discussed in brief. More research in this domain is still awaited to study the mechanical and tribological properties with microstructure characterization of MMCs by using optical microscope, SEM, TEM.

KEYWORDS: Metal Matrix Composites, Reinforcement, Processing, Ceramics, Properties

INTRODUCTION

From the ancient years, materials are shifted giving importance to obtain high strength with low weight, low cost, quality, and better performance. Among various materials, the composite materials are used in aerospace and automobile sectors owing to their enhanced properties like high strength, hardness, good tribological properties resulting to wear resistance with significant weight saving property compared to other metals and unreinforced alloys. In many countries and in several developing countries still there exists the research in metal matrix composites. The composites metal matrix materials are the combination of two or more different materials with different physical and mechanical properties when combined with different various techniques like stir casting, squeeze casting, compo casting, liquid metallurgical and in situ process leading to form a new material than compared to monolithic alloys[1-3] The enhanced properties of MMCs are strongly depends on the interfacial bonding strength of matrix and reinforcement.

Though composites are accepted broadly, but they have positive limits with regards to a secondary forming process which do pose a real task for the further scope of MMCs applications. This limitation is caused because of the anisotropic form the composites.[4] Some of the most used various types of metallic alloys as matrix to produce MMCs are aluminum, zinc, magnesium, titanium etc, and along with reinforcements like fiber, whiskers, and particulates. For MMCs ceramic particulates like SiC, Al2O3, B4C, and graphite are mainly used but the current method makes use of nano particulates of the above mentioned which will still lead to enhance properties like improved abrasion resistance, heat resistant. Because of high temperature resistance the ceramic particulates find application as brake disks, piston rings, pistons.[5,6]

The structure and the properties are mainly controlled by type and the amount of volume particulates which are reinforced into the base matrix.[7] Similarly, when two or more materials present, then it is called hybrid metal matrix composites. The increasing in demand for light weight and high performance materials is likely to increase the need for aluminum matrix composites.[8] AMCs are the interesting in the field of particulates counterpart which is discussed in future. Therefore, this paper presents and summarizes the processing and the overall studies of aluminum metal matrix composites.

COMPOSITE MATERIALS

A composite material is also known as composition material or in shortly knowns as composites. The composites are basically a combination of two or more dissimilar materials which are in different chemical and physical properties, but when the combined together with various techniques produces a material of different characteristic from the individual materials which are mixed. When more than two or three materials mixed then it is termed as hybrid composites. The prepared material will have good enhanced properties like hardness, less in weight compared to monolithic materials.

Composites are broadly classified into three different major fields based on the nature of matrix material such as metal matrix composites (MMCs), polymer matrix composites (PMCs), & ceramic matrix composites (CMCs).[9] Each of these composites makes use of continuous fiber and discontinuous fiber or either particulates as the reinforcement for the better enhancement for various properties such as mechanical and physical which are used accordingly.

MATRIX MATERIALS

A metal matrix composite (MMC) is composite material with at least two constituent parts, one being a metal necessarily, the other material must be a different metal or any another material, such as a ceramic or organic compound. When at least three materials are present, it is called a hybrid composite. In most of the MMCs work the matrix phase is considered as major content. The most commonly used matrix materials in metal matrix composites are as follows.

Aluminium

To replace the conventional materials aluminum based composites are finding broad production applications in different areas, for example, aviation, automotive sectors and structural applications owing to their attractive properties such low weight, good ductility, corrosion resistance, and low coast. But in few applications Al alloys are restricted because they are soft and have poor wear resistance. This problem has overcome by reinforcing the hard-ceramic materials in the aluminum and its alloy, termed as aluminium matrix composites (AMCs). These composites are broadly acknowledged materials, but they also have certain limitations as to secondary shaping procedure which does represent a real enlarged challenge for the extent utilizations of aluminum based composites. This restriction is mainly for anisotropic nature of the formed composites.[10]

When the particles are reinforced they won't react with aluminium there by eliminating any reaction at the interface between aluminium and reinforcement. The major advantages by using AMCs include high strength to low density, controlled & improved thermal property; good wear resistance and damping capabilities. The aluminium alloys are classified into wrought alloys and cast alloys and both are further subdivided into heat treatable and non-heat treatable. The designation or the identification of wrought aluminium alloy is based on four digits which correspond to principal alloying element. The most vital alloying elements in aluminum composites are copper (2xxx), manganese (3xxx), silicon (4xxx), magnesium (5xxx), magnesium & silicon (6xxx), and zinc (7xxx). Almost 85-90% of aluminium is used for wrought products.[11] The cast alloy is designated by three digits; these cast alloys have low melting point and have low strength. Therefore, the use of cast alloy less compared to wrought alloys. Wrought aluminum is used in the shaping process like rolling, forging, extrusion, pressing and stamping. Cast aluminium are non-heat treatable alloy and used in the application of sand cast products.

Copper

Copper as a chemical element with the symbol Cu and as an atomic number of 29. The copper is soft, malleable and ductile material with high thermal and electrical conductivity. Copper usually will not react with water, but slowly reacts with the atmospheric oxygen to form a layer of brown-black copper oxide which, dissimilar to the rust that forms on iron in moist air which shields the original metal from further corrosion. The copper alloys are the metal alloys that have the copper in high volume. The copper is mainly found in two series of aluminum alloy containing around 2 to 10% copper as the major alloying element, with the small addition of other elements which are basically knows as Al-Cu alloys. Due to the introduction of copper to aluminum alloy it reduces the ductility, corrosion and increase the strength and facilities precipitation hardening. The weakness to solidification cracking of Al-Cu alloys is increased; and subsequently, some of these alloys can be the most difficult aluminum alloys to weld. Al-Cu alloys are heat treatable, the yield strength increases six times because of the solution treatment which is followed either by artificial or natural aging.

The main applications of Al-Cu alloy are aircraft structure, propellers, automotive bodies, and screw fittings.

Magnesium

Some 2% of the earth's crust is made up of the element magnesium. It is present in significant quantities in seawater and in many common rocks, such as limestone and shale. Magnesium has the distinction of being the lightest engineering metal, with a specific gravity of 1.738. It also has one of the highest coefficients of thermal expansion, and fairly high electrical and thermal conductivity, and it is said to have high damping capacity. Magnesium does show an advantage over other metal systems in weight reduction when section size is limited. Another redeeming property of magnesium, in addition to its light weight, it its machinability. It has better machinability than any metal.

Zinc

Zinc has a hexagonal close-packed structure. It has limited solid solubility with other elements, and pure zinc has single phase structure. Melting temperature for zinc alloys range from about 370 to 482 ˚C. Pure zinc has a specific gravity of 7.14 and compared with 7.85 for steel. Zinc alloys are soft, and hardening processes, both thermal and mechanical, usually are not applied. Alloys usually are used as cast or wrought.

Nickel

Nickel as an element was discovered in 1750, but had limited uses until the twentieth century, when it became an essential alloying element in stainless steels and high alloys. Nickel and most high-nickel alloys have the same physical appearance as steels. Pure nickel has a melting point of 1455 ˚C and a modulus elasticity of 207 GPa. Both of these qualities are similar to those of steel. Nickel is ferro-magnetic up to 360˚C, and its density is 8.9 g/cm3, compared with 7.85 g/cm3 for most steels. Nickel alloys often are used because they have unique physical property characteristics. Some high nickel-iron alloys have magnetic permeability characteristics that make them superior for magnetic shielding of electronic devices.

Titanium

Titanium probably is the newest engineering metal. As an element, it was discovered in 1791, but it was not produced in metallic form until 1910. It remained laboratory curiosity until commercial processes were developed for its manufacture in the 1940s. As a pure metal, titanium has a melting point higher than that of steel, 1671˚C, a specific gravity of 4.5 and tensile modulus of elasticity as high as 12.7x104 MPa. The physical properties of prime importance are its density and modulus. Its mechanical properties can be better than those of many alloy steels, and thus it has a very high specific strength. The same thing is true about stiffness. It has a much higher modulus than the other light metals, magnesium and aluminum.

Reinforcements

The reinforcement is a kind of material which is reinforced into the matrix material. The main aim of reinforcing the reinforcements is to change the physical and mechanical properties of the base material. In most of the times, the reinforcement is harder, stronger, and stiffer than the matrix. The selection of the reinforcements depends on the type of the method of production, the chemical stability with the matrix phase and majorly depends on various aspects such as shape, size, and surface morphology. The reinforcement can be either discontinuous or continuous. The two main categories of reinforcements are particle reinforcement and fiber reinforcement. Meanwhile the particulate reinforcements are further sub classified in two types i.e dispersion strengthened and particle strengthened, which are cheapest and widely used.

The dispersion strengthened particles are hard having a small size varying from Φ 0.01 to 0.1 μm which are uniformly dispersed in the base material (matrix) to strengthen metals and metal alloys and acts the load bearing constituent because the particles do not oxides and react so it can maintain the same strengthening action also at high temperature. When this type of reinforcements used in composites the strengthening occurs at the atomic level i.e. strengthening of mechanism is same as that of perception hardening in metals, where base material accepts the main portion of the load applied.

The particle-strengthened reinforcement is the other type of reinforcement which are larger in size compared to dispersion strengthened particles having a size greater Φ> 0.1 μm and are incorporated in the matrix and the load is shared by the matrix and the particles, if well bonded the matrix acts as restraining. The particle reinforcements are reinforced in metals, polymers, and ceramics. These particles are reinforced in to softer matrix which increases the wear and abrasion resistance. Particle reinforcements are generally oxides or borides or carbides and are present in volume fraction less than 25-30% when used for wear resistance and structural applications. But however, for electronic packaging applications the particle reinforcement volume fraction might be as high as 65-70%. The particle reinforcements are used to increase the modulus of the matrix to decrease the permeability and ductility of the matrix Rule of mixture is used to determine the physical and mechanical properties od composites.

Another class of important reinforcement which provides high strength to weight to ratio and enhanced mechanical properties is the fiber reinforcement when reinforced into a soft and ductile matrix. When fiber is reinforced into the matrix, the matrix acts as medium to transfer the load to the fibers and gives protection from external load. The fibers may be continuous or discontinuous. Usually the strength and stiffness is obtained by continues fiber reinforcement, but the discontinuous fibers are used when the manufacturing process commands when the fibers must be in required form. When fiber is reinforced is into the matrix, the mechanical properties of the composite material depends on the fiber orientation, length of fiber, volume fraction and the degree of the load applied. Based on the preparation of the composites, continuous fibers are parallel, oven mats, having a diameter less than 20µm. When the continuous fibers are processed into composites they are in unidirectional. These unidirectional fibers create raw composites which are highly anisotropic and are totally different when evaluated in the parallel direction.

There are several reinforcements are available in the form of oxides, carbides and nitrides, which are most suitable for metal matrix composites. The most commonly used ceramic reinforcements in metal matrix composites are SiC, TiC, WC, Al2O3, Graphite, B4C, TiO2, ZnO and Fly ash.[12-14]

Processing of Metal Matrix Composites

Different numbers of processing techniques have grown over the last two decades to optimize the properties and structure of particulate reinforced MMCs. The processing techniques which are used to production of particulates reinforced MMCs can be based on temperature of metallic matrix during the processes, i.e. whether the matrix is in liquid, solid, or vapor phase when combining with the reinforcements. The main challenge is to obtain uniform homogeneous distribution of the reinforcement phase in the matrix phase by various processing techniques which determine the microstructure and interfacial bonding condition between the matrix and reinforcement. For the wide spread applications of MMCs the review of manufacturing processing techniques gives importance for the development of MMCS which leads in the necessities of low coast and ease of manufacturing. The processing techniques of MMCs can be classified into main groups (a) Solid state processing (b) Liquid state processing.[15]

Solid state processing

Powder Blending and consolidation (PM processing): To produce MMCs, blending of various alloys powder (aluminum, zinc, magnesium) with short whisker or fiber is an adaptable technique. Blending can be done in liquid or dry suspension. After blending different methods are followed like canning, cold compaction, extrusion or high isostatic pressing.

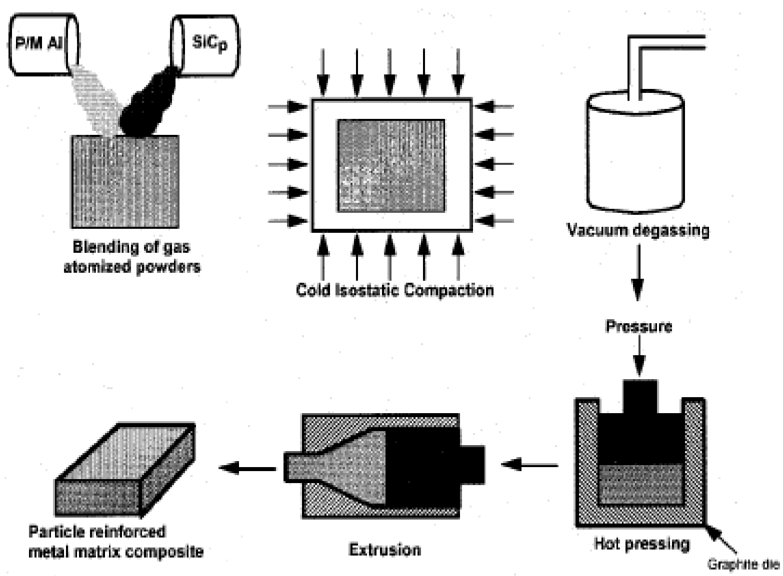

Figure 1: Powder Processing, hot pressing and extrusion process for fabricating Particulate or Short fiber Reinforced MMCS.

Based on the powder history and processing conditions, the MMCS which are produced may contain oxide particles in the form of plate like particles with volume fraction of 0.05 to 0.5 and having a thickness of 10nm. These flakes like fine particles tend to perform as a dispersion-strengthening agent and often have very strong effect on the matrix properties mainly during heat treatment. Figure 1 show the various steps involved in the preparation of composites by this method.

Diffusion Bonding: Mono filament reinforced composites are mainly produced by diffusion bonding technique or by evaporation of comparatively thick layers of base material on the surface of fiber reinforcement. For example, Al6061-boron fiber composites have been produced by diffusion bonding technique via through foil fiber foil process. However, this process mainly and commonly used to produce Ti fiber based reinforced composites. This process is uncooperative to obtain high volume fraction of fiber content along with uniform distribution and not suitable for producing complex shapes.

Physical Vapor Deposition: This method involves a continuous passage of the fiber through an area of high limited pressure of the metal to be deposited where condensation takes place to produce a moderately thick coating on fiber. By directing the high-power electron beam at the end of solid bar feed stock an vapour is produced. The typical vapour deposited is 6-10μm per minute. The fabrication of composites is completed by assembling the fibers which are coated into a collection of bundles and consolidated by hot pressing operation. Using this technique, the composites with volume fraction of 80-85% along with uniform distribution can be achieved.

Liquid State Processing Stir Casting Process: In this process the reinforcing ceramic particles is uniformly distributed into the molten matrix metal with the help of the mechanical stirring. The mechanical stirrer is placed in the crucible inside the furnace for constant stirring purpose which is the major element of this processing technique. Stir casting process is capable of manufacturing composites up to 25-30% volume fraction of the reinforcement.

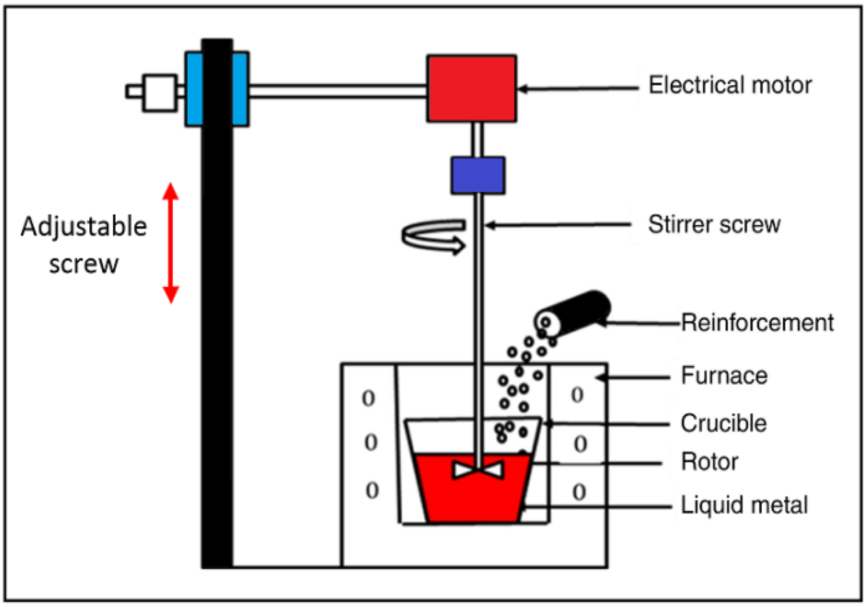

Fig. 2: A Schematic Setup of Stir Casting.

The melted molten metal is feed directly to prepared mold and allowed to solidify in the form of rods or billets. This rods or billets can be further subjected heat treatment process for high strengthen of the composites. Due to the surfacing and settling of particles in the crucible a foremost concern must be taken with the stir casting technique for the segregation of the reinforcement phase. To obtain homogenous distribution of the reinforcement and to reduce the porosity, the cast composites are further extruded. Difficulties can occur due to increase in the viscosity by adding particles or mainly in the case of fiber to melt. If the particles are not uniformly distributed it may have led to agglomeration and sedimentation in the melt.[16] The distribution of the reinforced phase depends on the design of stirrer, stirring parameters, melting temperature and properties of materials. Compared to other processing techniques stir casting coasts one third to one tenth of for mass production, for this purpose currently stir casting is most popular and commercial method for producing composites special aluminum metal matrix composites. Figure 2 show the schematic diagram of stir casting.

Infiltration Process: this process is mainly used to produce AMCs with different kinds of reinforcement phase. Molten liquid aluminum alloy is infiltrated into the interstices of the porous pre-formed reinforcement phase. Based on with or without the application of vacuum and pressure the reinforcing phase can be infiltrated. Aluminum matrix composites having the reinforcement volume ranging from 10-60% tend be produced by various kinds of infiltration techniques. Most of often silica and alumina based mixtures are used as binder in order to perform and to retains its integrity and shape. Small amount of porosity and local variations in the volume fraction of reinforcement phase are often noticed in inflation method while processing of AMCs.

Spray Deposition Process: for composite production, it is one the primary process where the metal is sprayed on the substrate. For composites the reinforcements is already incorporated in the melt which is sprayed. Spray deposition falls into two different processing techniques depending whether the stream of droplet is produced from a molten bath or by thermal spray process. By injecting the different kinds of reinforcement like ceramics, whisker, fibers have extensively explored in the production of Aluminum matrix composites. AMCs produced in this way exhibit inhomogeneous distribution of reinforcement ceramic particles. Porosity around 5-10% can be found in the sprayed state. By subsequent processing depositions of this type are typically consolidated to full density. To produce continues reinforced aluminum matrix composites spray process is one of the best principal technique. For these kind of production, the matrix is sprayed on to the surface and fibers are wrapped everywhere around a mandrel with a control internal spacing as required. Monotype composites are formed; by hot pressing of monotype composites a bulk type composites are formed. By adjusting the fiber spacing and fiber layers there is a control in volume fraction and distribution of the fibers. AMCs processed by this technique are moderately inexpensive with in-between stir cast and PM process.

In Situ Process: This process is also known as reactive process. Other fabrication method involves in expensive reinforcement materials along with involving complex procedure and high cost equipment's. However, the alternative route method for coast effective fabrication of metal matrix composites is in situ synthesis method developed recently few years back. This method offers number of attractive features like good comp ability of matrix and reinforcement phase, uniform homogenous distribution of reinforcement and mainly low coast. By controlling the metallurgical reactions, the composites are formed by which the reinforcements are formed in the matrix. During fabrication, one of the reacting elements is typically a constituent of molten matrix alloy. The other kind of reacting elements may be any externally added powder or gaseous phase. One of best final reaction product is the homogeneous distribution of reinforcement in matrix alloy. However, this process requires a carefully screening while handling.

Properties of Composites

From the microstructure and nature of composites, their properties and behavior can be predicted and the factors such as intrinsic properties, structural arrangement and the interface between the constituents are very much important. The composites, display the general order of properties by the intrinsic properties of constituents. The new properties are obtained from interaction of composites. The size and shape of each constituent material and their distribution of the reinforcement materials lead to complete performance of composite. Some of the various properties that determine the performance of composites are volume fraction, microstructure, homogeneity and isotropy of system.

Physical Properties

Density is the one of the physical property that replicates the characteristics of composites. In composites the proportion of reinforcement and matrix are stated as weight fraction or volume fraction. To calculate the density of composite experimentally a displacement technique using physical balance of measuring density kit is used as per ASTM D792-66 standard test method. Still further the density value can also be calculated from porosity along sample mass and dimensions. The increase volume fraction of ceramic particle contributes in increasing the density of composites and the theoretical and measured density of both values of composites matches each other. This increase in density can be reasoned because of the few ceramic particles possessing higher density than the base material.

Mechanical Properties

Mechanical properties of metal matrix composites are fundamental function of manufacturing process. Roughness, surface conditions and heat treatment process along with the type of materials used (matrix and reinforcement) influences the mechanical behavior of MMCs. Factors like particle size, porosity of matrix, volume percentage of reinforcement and agglomeration influences on mechanical properties such as hardness, tensile strength, elastic modulus, creep, toughness, and fatigue resistance which are the major attraction of composites.

Hardness

The resistance to indentation or a scratch on a given test material is termed as hardness. Several instruments are used for the measurement of hardness, which are highly significant like Brinell, Rockwell, and Vickers hardness testers. Theoretically the rule mixture formula for composites materials $Hc= vrHr+Hmvm$ helps in determining the value of hardness, the suffixes c, r, m, v, H stands for composites, reinforcement, matrix, volume, hardness respectively. Among different kind of reinforcements, the hardness of fiber reinforced MMCs is lesser than whisker reinforced MMCs and much lesser than particle dispersed MMCs. As mentioned particulates reinforced MMCs generally chosen to convey much higher hardness, but when particulates are coated with Nickel or copper it leads to very good interface characteristics between reinforcement and matrix there by contribute in improving the hardness value. For the measuring the interface bonding between matrix and reinforcement, micro hardness is a direct, easy and simple method. Comparing to whisker or fiber reinforced composites, particle reinforced composites possess better plasticity forming. Moreover, these composites exhibit very good wear property along high hardness number and heat resistance character of the particulates which are dispersed in the matrix, but over aged condition will tend reduce the hardness of the composites.

Tensile Strength

Based on the applications, the mechanical properties of the prepared composites are of enormous importance. The modified rule of composites proposed by various researchers is difficult in predicting lower and upper values of both strength and modulus of the composite materials. In general, the MMCs are originated to have higher values in different properties like elastic modulus, tensile and fatigue over the other monolithic alloys. With relating to the heat treatable alloys, the yield strength of composites increases after the certain time of heat treatment processes there by reducing the crack tendency and improves the perception hardening. Before the fabrication process the composites are heat treated to an under aged condition to deliver an improved mechanical property. But still there is no clear relation between mechanical properties of composites, volume portion, reinforcement's type, nature of reinforcements, is supposed to be more effective in improving the strength of composites. But the improved interface strength and better dispersion of particles in base material can be gained by preheating of the reinforcements before the process. The strength of SiC, Al2O3, TiC, and TiB2 particles when added with aluminum base material is found to increase coast of ductility, by increasing the volume percentage of reinforcement phase, and thereby minimizing the size of the ceramic particulates in matrix. Further the studies on Al-MMCs are mainly concentrated on nano particulates to achieve excellent mechanical properties.

Creep

It is defined as the dynamic twisting of a material under the activity of a consistent applied load. The property of creep in particulate reinforced MMCs is categorized by a gradually increasing creep rate over most of the creep life. By utilizing a quasi-three-dimensional finite element method, the macroscopic creep behavior of the composites with regular fiber packing is gained, by giving the orthotropic creep law. Due to precipitation hardening the improved strength is mainly due to the actual blocking of dislocation movement by insoluble particulates on the slip plane, slightly then the particles carrying load. Hence power-law creep rates are significantly curtailed, even at low volume fractions (1%).The creep rate of each phase is defined by a combined constitutive equation that can account for the effective of stress, strain-hardening, and high temperature. The increase of creep resistance is attributed by the decrease of grain size through the Hall–Petch effect, but a continuous decrease of grain size would increase the presence of the softer grain boundary affected zone.

Wear

Wear is the progressive loss of material when two surfaces are interact each other during the relative motion. The one third of our global energy consumption is consumed wastefully because of friction. Because of the wear there is an enormous expenditure by both industry and consumers. The surface which is subjected to wear can no longer be replaced and repaired as it no longer performs a useful function. The wear damage caused is in form localized plastic deformation or micro cracks. Wear can be classified as adhesive wear, abrasive wear, erosion wear, tribo chemical wear, surface fatigue and cavitation wear. Wear is a complex phenomenon between solid surfaces having a real contact of invariably very small. The load to the surface is transferred through the points of contact and restricted forces can be large. The wear rate can be determined by intrinsic material surface property, the surface, load, temperature and speed which oppose the surface. Wear loss of a substance may be measured in terms of volume loss or weight loss. Different terms like sliding friction, and wear characteristics like applied load, sliding velocity, temperature and sliding distance ate the commonly available tests which can easily conducted and controlled on pin on disc, pin on flat, pin on cylinder, pin to bushing, and thrust washers. In basic laboratory conditions the tests are conducted at ambient temperature by varying load and speed, under varying frictional force, and environment conditions.[17,18] Some of the factors influencing the wear of MMCs are discussed.

Applied Load

By the applying the normal load the wear rate is affected of the composites or any alloy or a material, which are the most significant and dominating factor for controlling the wear behavior. With respect to normal load the wear rate varies which is an indicative of Archard's law and is lesser in case of composites. The collective volume loss increases with increasing normal load applied. Further in increase of normal load the temperature of contact surface also increases. But as the wear rate increases by increasing the applied normal load, the wear mechanism tends to oxidation at low loads and diamantine at higher loads. Only a maximum load on composites can be supported during the sliding without any excessive wear by the fracture toughness of reinforcement.

Sliding Speed or Velocity

By increasing the wear speed or velocity, the wear rate and the overall collective wear loss will increases for all materials and the curve tend to along straight line. The sliding speed as high impact on wear mechanism and at the lower the sliding speed the wear rate of any material will be less and specially in case of composite because of high speed the matrix leads of thermal softening, which further slows down the bonding effect between particulates and matrix. But higher the sliding velocity lower is the wear rate for MMCs and it is due to the formation of compact transfer layer at the region of worn surfaces and thus forming a protective cover which tends to reduce wear rate.

Reinforcement Size and Shape

Several researchers have projected that wear resistance based on the material hardness, strength, toughness, ductility, kind of reinforcement used, and its volume fraction along with size of reinforcement. The reinforcing of particle is the most promising in enhancing the wear resistance of MMCs and providing good bonding between matric and reinforcement. By preventing direct metallic contacts that induce subsurface deformation, the wear resistance of the composites is improved. By addition of hard ceramic particles recovers the resistance to seizure at elevated temperatures. The particulate allows substantial thermal softening effects without having opposing effects on the wear behavior. The reinforcement also causes higher hardness, superior elastic modulus, greater dynamic modulus, better damping capacity and less coefficient of thermal expansion of the matrix alloy. The occurrence of the ceramic particles provides a higher thermal stability, increased abrasion and sliding wear resistance at high temperature and delays the changeover from mild to severe wear.

Effect of Interfacial Bonding

The wear behavior of hard ceramic particles when reinforced into matrix phase it depends primarily on the type of interfacial bonding between materials used. This is because of the strong interfacial bond which plays a serious role in transferring the loads from matrix phase to the hard particles, resulting in less wear of the material. Suppose in case of bad interfacial bonding, the interface offers for crack nucleation and tends to pull out the particle from the wear surface leading to higher wear loss. Generally coated reinforced composites lead to good interface characteristics and enhance the improved wear properties.

CONCLUSION

Materials plays very important role in fabrication of any component, which is directly depend on the properties of materials used. Especially for aerospace and other space applications, designers are badly required high strength and low weight and less density materials. Metal matrix composites are in line with basic needs required for the development of products. There are several methods are available to synthesize these metal matrix composites by using matrices like aluminium, copper, nickel, titanium, magnesium and zinc. Reinforcements in the form of oxides, nitrides and carbides are most suitable to enhance the properties of these matrices. To evaluate the composites properties several testing method are available as per ASTM standards, most commonly used properties for engineering materials are hardness, tensile strength, compression strength, bending, torsional, fatigue and creep behavior. Since, metal based composites are good in ttribological properties, so gaining wide range of applications in automotive industries as piston rings, connecting rods, and cylinder heads.

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