AN OVERVIEW OF METAL MATRIX COMPOSITE: PROCESSING AND SiC BASED MECHANICAL PROPERTIES

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ABSTRACT
In view of large interest in the improve of Al/Al alloy based Metal matrix Composite and high-temperature ceramics on the base of silicon carbide, a comprehensive review of the data on structure, properties and the known methods of processing of silicon carbide seems timely. The most striking feature of silicon carbide is its polytypism, i.e. formation of a great number of structural changes without any change in composition. Although this feature of silicon carbide was extensively studied, no systematic up to date analysis was done. The widely used reinforcing materials for these composites are silicon carbide, aluminum oxide and graphite in the form of particles or whiskers. The ceramic particles reinforced aluminum composites termed as new generation material and these tailored and engineered with specific required properties for specific application requirements. However, Al-SiC alloys based MMC provides significantly enhanced mechanical properties, high wearing resistance of the SiC/Al alloy composite is due to added SiC whiskers to the aluminum matrix and the aluminum diffuses into the SiC whisker, which leads to a high bonding strength between the whisker and matrix. The aim of this paper is to review the current research and development of Al-SiC based alloy MMC and highlighted the basic properties of silicon carbide and the advantages of using SiC over other Al/Al alloy based Metal Matrix by scrupulously choosing, balance of reinforcing phases and particularly focusing on SiC content, together with some technological reason of the manufacturing process, it is possible to optimize the properties of metal matrix composites.

KEYWORDS: silicon carbide particulate, Metal Matrix Composites, Mechanical properties.

1. INTRODUCTION
Increasing quantities of metal matrix composites (MMCs) being used to replace conventional materials in many applications, especially in the automobile and recreational industries. The most popular types of MMCs are aluminum alloys reinforcing with ceramic particles. These low-cost composites provide higher strength, stiffness and fatigue resistance [1,2] with a minimal enhance in density over the base alloy. The major advantages of aluminum Matrix Composites (AMCs) include greater strength, reduced density, improved high temperature properties, controlled thermal expansion coefficient, thermal/heat management, enhanced and tailored electrical performance, improved abrasion and wear resistance and improved damping capabilities [3,4]. Low induced radioactivity under nuclear environments, stiffness and weight saving in materials and energy. Silicon Carbide is the only chemical compound of carbon and silicon. It was originally produced by a high temperature electro-chemical reaction of sand and carbon. Silicon carbide is an excellent abrasive and has produced and made into grinding wheels and other abrasive products for over one hundred years. Today the material has developed into a high quality technical grade ceramic with very good mechanical properties. It's used in abrasives, refractoriness, ceramics, and numerous high-performance applications. The material can also be made an electrical conductor and has applications in resistance heating, flame igniter and electronic components. Structural and wear applications are constantly developing. Silicon carbide composed of tetrahedral of carbon and silicon atoms with strong bonds in the crystal lattice. This produces a very hard and strong material. Silicon carbide is not attacked by any acids or alkalis or molten salts up to 800°C. In air, SiC forms a protective silicon oxide coating at 1200°C and is able to be used up to 1600°C. The high thermal conductivity coupled with low thermal expansion and high strength gives this material exceptional thermal shock resistant qualities. Silicon carbide ceramics with little or no grain boundary impurities maintain their strength to very high temperatures, approaching 1600°C with no strength loss. Chemical purity, resistance to chemical attack at temperature, and strength retention at high temperatures has made this material very popular as wafer tray supports and paddles in semiconductor furnaces. The electrical conduction of the material has lead to its use in resistance heating elements for electric furnaces, and as a key component in thermistors i.e. temperature variable resistors. The alloy designation for Al is based on four digits corresponding to the principal alloying elements. The most important alloying elements in aluminum alloy systems are copper (2xxx), manganese (3xxx), silicon (4xxx), magnesium (5xxx) and zinc (7xxx) [5,6]. The SiC particles used in aluminum matrix composites are harder than tungsten carbide [7] this is the reason why SiC is recommended by many researchers. MMCs generally, consist of continuous or discontinuous fibers, whiskers, or particulates dispersed in a metallic alloy matrix. These reinforcements provide the composite with properties not achievable in monolithic alloys [8]. The most commonly used route for fabrication of these composites has been through infiltration of molten metal into preformed and porous ceramic bodies. For example, Al-alloys have been successfully infiltrated with hydraulic or gas pressure into SiC, Al2O3 and AlN performs [9]. It is very interesting to emphasize the influence that the reinforcing particle volume fraction has to exert on the mechanical properties of MMCs [10].
2. MMC systems and issues for their processing

Metal Matrix Composites are self-possessed of a metallic matrix (Aluminum, magnesium, copper, iron, Silicon, cobalt and a dispersed ceramic (oxides, carbides) or metallic (lead, tungsten, molybdenum) phase. The various Matrix of metal are Aluminum Matrix Composites (AMC), Magnesium Matrix composite, Titanium Matrix Composite, copper matrix composites used in the field of composites. Aluminum Matrix Composites (AMC), this is the widest group of Metal Matrix Composites. Matrices of Aluminum Matrix Composites are usually based on aluminum-silicon (Al-Si) alloys and on the alloys of 2xxx and 6xxx series. Aluminum Matrix Composites (AMC) are reinforced by, Alumina (Al₂O₃) or silicon carbide (SiC) particles (particulate Composites) in amounts 15-70 vol.%, Continuous fibers of alumina, silicon carbide, Graphite (long-fiber reinforced composites). Discontinuous fibers of alumina (short-fiber reinforced composites). Silicon carbide composites are attractive as structural materials in fusion environments because of their low activation, high operating temperature and strength. The physical properties of composites are generally anisotropic. Silicon carbide particles, ranging in size from about 12 to 38 microns, added to the standard aluminum alloys in volumes of 20 to 40 percent. 20% or 30% are more commonly specified to achieve the following advantages with lower density than other alloy alternatives. Cast metal matrix composites has achieve much success and expertise in casting of 20-40% silicon carbide and these alloys to the increased use of these alloys has numerous applications in the field of CMMCs. High Speed automated Precision machinery, Silicon wafer processing equipment, seals, bearings, heat exchangers, hot flow gas liners, robotics, high quality reflective mirrors, high performance bicycle junctions and components, Ball valve parts, fixed and moving turbine components, brake parts, optical and laser equipment, semiconductor manufacturing equipment. CMMCs materials satisfy these needs and requirements. The material is readily melted and cast into complex geometries utilizing our counter gravity casting techniques. Cast Silicon carbide metal matrix composites also can offer a lower cost alternative to high beryllium content alloy applications. Composite Parameters considered for a given matrix/dispersed phase system:

- Concentration
- Size
- Shape
- Distribution
- Orientation

2.1 Particle Reinforced MMCs

Particles used for reinforcing include ceramics and glasses such as small mineral particles, metal particles such as aluminum, and amorphous materials, including polymers and carbon black. Particles used to increase the modulus of the matrix to decrease the permeability and ductility of the matrix. Particles are also used to produce inexpensive composites. Rein-forcers and matrices will be common, inexpensive materials and are easily processed.

![Figure 1. Photo Micro-graphic image of Al-SiC<sub>p</sub>](image)

MMC made by dispersing a reinforcing material (SiC) into a metal matrix (Al) as shown in figure 1. The reinforcement surface will be coated to prevent a chemical reaction with the matrix. For example, carbon fibers are commonly used in aluminum matrix to synthesize composites showing low density and high strength. However, carbon reacts with aluminum to generate a brittle and water-soluble compound on the surface of the fiber. To prevent this reaction, the carbon fibers coated with nickel or titanium boride. The matrix is the monolithic material into which the reinforcement embedded, and is completely continuous.

2.2 Short Fiber-reinforced MMCs

Production rates for short-fiber composites (both aligned and randomly oriented) are rapid and intricate shapes formed which are not possible with continuous fiber reinforcement. The reinforcement material embedded into the matrix. The reinforcement does not always serve a purely structural task (reinforcing the compound), but is also used to change physical properties such as wear resistance, friction coefficient, or thermal conductivity. The reinforcement will be either continuous or discontinuous as shown figure 2 (a) and (b).

![Figure 2. Short fiber reinforces composite (a) Aligned and (b) Random.](image)

Discontinuous MMCs will be isotropic, and worked with standard metalworking techniques, such as extrusion, forging or rolling. In addition, they machined by using conventional techniques, but commonly would need the use polycrystalline diamond tooling (PCD) [11]. Discontinuous reinforcement uses “whiskers”, short fibers, or particles. The most common reinforcing materials in this category are alumina and silicon carbide. Short-fiber reinforced composites consist of a matrix
reinforced by a dispersed phase in form of discontinuous fibers (length < 100*diameter). Applications involving totally multi directional applied stresses normally use discontinuous fibers, which are randomly oriented in the matrix material. Consideration of orientation and fiber length for particular composites depends on the level and nature of the applied stress as well as fabrication cost.

### 2.3 Long Fiber MMCs

Long-fiber reinforced composites consist of a matrix reinforced by a dispersed phase in form of continuous fibers. Continuous reinforcement uses monofilament are large diameter (about 100-150 µm) wires or fibers such as carbon fiber or silicon carbide. Monofilament are much less flexible than multifilament’s, so they handled as single fiber, rather than bundles, and precautions are necessary to avoid causing damage by imposition of sharp curvature during handling. The fibers embedded into the matrix in a certain direction; the result is an anisotropic structure in which alignment of the material affects its strength. One of the first MMCs used boron filament as reinforcement. The term “multifilament” refers to relatively small diameter (about 5-30 µm diameter) fibers, which are flexible enough handled as tows or bundles.

![Figure 3. Long fiber reinforced fiber.](image)

These woven, braided, filament wound. The material concerned includes carbon, SiC and various oxides. There has also been interest in carbon fiber reinforced zinc alloys, another system in which interfacial reaction are limited. While SiC has been successful in particulate MMCs, multi-filament SiC fiber suitable for incorporation into metallic matrices are not commercially available. Products on the market, under trade names such as Nicalon, tend to have high levels of free carbon and silica, leading to excessive reaction with most metallic matrices during processing.

### 2.4 Cermets

Cermets are a composite material composed of ceramic (cer) and metallic (met) materials. Cermets are ideally, designed to have the ideal properties of both a ceramic, such as high temperature resistance and hardness, and those of a metal, such as the ability to undergo plastic deformation. The metal used as a binder for an oxide, boride, or carbide. Generally, the metallic elements used are nickel, molybdenum, and cobalt. Depending on the physical structure of the material, cermets can also be Metal matrix composites, but cermets are usually less than 20% metal by volume. Typically, the ceramic particles are 1-10 µm in diameter. One or more carbide compounds bonded in a metallic matrix. The term cermets are not used for these materials, even though it is technically correct. Common cemented carbides based on tungsten carbide (WC), titanium carbide (TiC), and chromium carbide (Cr7C3) .Tantalum carbide (TaC) and others less common. Metallic binders: usually cobalt (Co) or nickel (Ni) Cermets used instead of tungsten carbide in saws and other brazed tools due to their superior wear and corrosion properties. Titanium nitride (TiN), titanium carbon nitride (TiCN), titanium carbide (TiC) and similar brazed like tungsten carbide if properly prepared however they need special handling during grinding. The Al-, Ti- and Mg-based matrices commonly used for MMCs are attractive in these terms, but are very reactive in the liquid state, which often leads to problems during this type of processing.

### 2.5 Structural MMCs

The structural composites made up of sandwiches or laminated panels i.e. When a fiber reinforced composite consists of several layers with different fiber orientations, its multilayered (angle-ply) composite in layered form. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the reinforcement in high temperature applications, cobalt and cobalt-nickel alloy. The manufacturing processes usually hand lay-up and atmospheric curing or vacuum curing are used. Metallic forms have attracted interest recently – partly because processing advances have led to material becoming available at competitive cost and partly because attractive property combinations obtained, particularly in terms of specific stiffness and specific energy absorption. Several approaches are available to metallic forms. Some of these, particularly those generating closed cell structures, involve processing the metal in the liquid or semisolid state. A problem then arises from the low viscosity of liquid metals. Depending upon the processing methodology employed but this is commonly achieved by introducing dispersion of ceramic into the melt, either as oxide films or as ceramic particles, which raise its viscosity. 3.

### Processing Routes

The processes classified according to whether the matrix is in the liquid, solid or vapor phase while it is combined with the reinforcement.

#### 3.1.1 Stir Casting

Stir casting is a primary process of composite production whereby the reinforcement ingredient material incorporated into the molten metal by stirring. This involves stirring the melt with ceramic particles and then allowing the mixture to solidify. This can usually be prepared by fairly conventional processing equipment and carried out on a continuous and semi continuous basis by the use of stirring mechanism as shown figure 4. A concern is to make
sure that good particle wetting occurs. Difficulties can occur from the increase in viscosity on adding particles or, especially, fiber to a melt. However, the viscosity is sufficiently low to allow casting operations carried out. Microstructure inhomogeneities can arise, notably particles agglomeration and sedimentation in the melt. Redistribution as a result of particle pushing by an advancing solidification front can also be a problem. This reduced when solidification is rapid. Stir casting often involves prolonged liquid-ceramic contact, which can cause extensive interfacial reaction. This has studied in detailed for Al-SiC, where formation of Al₄C₃ and silicon will be widespread.

**3.1.2 Squeeze infiltration**

Infiltration is a primary process of composite production whereby the molten metal is made to fill, spontaneously or using external mechanical work, pores within a preform of the reinforcement ingredient. Pressure infiltration is an infiltration process where hydrostatic pressure applied onto the molten matrix surface to drive the liquid into the preform. Pressure die infiltration is an infiltration process which uses a moving solid piston causing turbulent flow of the melt upstream of the perform. In connection with mechanical pressure infiltration is a pressure infiltration process which uses a moving solid part to apply pressure on the melt surface driving the liquid into a preform. Liquid metal is injected into the interstices of an assembly of short fibers, usually called a preform. Preform are commonly fabricated by sedimentation of short fibers from liquid suspension. Squeeze casting infiltration is a mechanical pressure infiltration process where a preform is placed into a solid mould, and pressure infiltration affected with a moving solid piston providing laminar flow of the molten matrix into the mould. Variants include direct squeeze casting, in which the piston surface represents the final casting surface; and indirect squeeze casting, in which the piston acts on the ingate to the die. Various silica-and aluminum based mixtures have been popular as high temperature binders. Squeeze Casting Infiltration is a forced infiltration method of liquid phase fabrication of Metal matrix Composites, using a movable mould part (ram) for applying pressure on the molten metal and forcing it to penetrate into a performed dispersed phase, placed into the lower fixed mould part, squeeze Casting infiltration method is similar to the Squeeze Casting technique used for metal alloys casting. Squeeze casting infiltration has the following steps:

A perform of dispersed phase (particles, fibers) placed into the lower fixed mould half.

1. A molten metal in a predetermined amount poured into the lower mould half
2. The upper movable mould half moves downwards and forces the liquid metal to infiltrate the perform
3. The Infiltrated material solidifies under the pressure.
4. The part removed from the mould by means of the ejector pin.

The method used for manufacturing simple small parts (automotive engine pistons from aluminum alloy reinforced by alumina short fibers). Two main techniques used to form and consolidate the powder are sintering and metal injection molding. Recent developments have made it possible to use rapid manufacturing techniques which use the metal powder for the products. In practice, substantial pressures in the MPa range are likely needed. However, this technique the powder melted and not sintered, better mechanical strength accomplished.

**3.1.3 Spray Deposition**

Spray casting/deposition is a primary process of composite production whereby the metal sprayed onto a substrate. For composites, the reinforcement is either already incorporated in the sprayed melt (e.g., by stir-casting), combined during spraying with the metal, by injection of the reinforcement ingredient material into the sprayed metal droplet stream, or is co-sprayed, i.e., sprayed at the same time as the
matrix onto the substrate. Spray deposition techniques fall into distinct classes, depending whether the droplet stream produced from a molten bath, or by continuous feeding of cold metal into a zone of rapid heat injection. Adaptation to particulate MMC production by injection of ceramic powder into the spray has been extensively explored, although with limited commercial success. Droplet velocities typically average about 20-40 ms⁻¹. A thin layer of liquid, or semi-solid, is normally present on the top of the ingot as it forms. MMC material produced in this way often exhibits inhomogeneous distributions of ceramic particles. Porosity in the as-sprayed state is typically about 5-10%. Thermal spraying is slower, but velocities are higher. Porosity levels are typically at least a few %. Unfortunately, it has very difficult to spray onto fiber arrays to produce MMCs with acceptably low void contents and there are also problem in maintaining uniform fiber distribution.

### 3.1.4 Reactive Processing
Many processes have developed in which constituents brought together under conditions such that a chemical reaction occurs while the mixtures consolidate. In some such processes, liquid metal introduced and progressively oxidizes. The work originated in attempts to ease melt infiltration, particularly with Al based melts, by reducing the pressure required for infiltration. Ideally, “wetting” and / or chemical reaction occurring at the infiltration front would be such as to promote spontaneous infiltration without the need for external application of pressure. While it has proved difficult to promote rapid infiltration under these conditions, MMC products made in this way with good near net shape characteristics, particularly ceramic content is high while thermodynamic and Kinetic details are complex and reaction takes place to promote spontaneous penetration of an Al-based melt into an array of ceramic particles or fibers. The Al, - SiC, - Ti, - and Mg based matrices commonly used for MMCs are attractive in these terms, but are very reactive in the liquid state, which often leads to problems during this type of processing. As applications continue to expand, the spectrum of materials and processes employed will remain relatively wide.

### 3.2 Solid state processing

#### 3.2.1 Powder Blending and consolidation
MMC diffusion bonding is a primary process for composite fabrication in the solid state, in which stacks of matrix metal and reinforcement ingredients (usually parallel fiber monolayer’s and matrix foils, see also fiber winding) encapsulated and bonded together after evacuation by mechanical pressure at elevated temperature to enhance diffusion powder consolidation is a diffusion bonding (primary) process in which matrix in powder form blended or otherwise placed next to the reinforcing ingredient material, and consolidated with or without pressure and elevated temperature. Blending of metallic powder with ceramic fibers or particulate is a versatile technique for MMC production. MMC produces by Powder blending are commonly extruded. While MMC powder extrusion is a consolidation of ingredient materials with application of pressure with an extrusion press. Cold extrusion occurs below the re-crystallization temperature of the metal, hot extrusion at higher temperatures. This is usually followed by cold compaction, canning, evacuation, degassing and a high temperature consolidation stage such as Hot Isocratic Pressing (HIP) or extrusion. A feature of much powder route material presence of fine oxide particles, usually present in Al-MMCs in the form of plate like particles a few tens of nm thick, constituting about 0.05-0.5vol%, depending on powder history and processing conditions. This fine oxide tends to act as a dispersion strengthening agent and often has a strong influence on the matrix properties, particularly at high temperature. Processes such as rolling i.e. MMC powder rolling is ingredient materials with application of pressure with a rolling mill. And forging i.e. MMC powder forging is consolidation of ingredient materials with application of pressure with a forging press. Involving high deviatory strains being imposed quickly and hence can cause damage such as cavitations, particle fracture and macroscopic cracking, at particularly at low temperature. Very high temperatures, and possibility of matrix liqation, on the other hand, can cause macroscopic defects such as hot tearing or hot shortness. In contrast to these forming processes, Hot Isostatic Pressing (HIPing) generates no (volume-averaged) deviatoric stresses and so is unlikely to give rise to either micro structural or macroscopic defects. MMC hot isostatic pressing (HIP) is diffusion bonding of ingredient materials with application of hydrostatic pressure with a gas, at temperatures high enough to effect concurrent sintering of the matrix, which for metal matrices is generally above the matrix re-crystallization temperature. However, it’s very difficult to remove residual porosity in regions of very high ceramic content, such as within particle clusters, and absence of any microscopic shear stress means that such clusters are not readily dispersed during HIPing, leading to poor inter-particle bonding.

#### 3.2.2 Diffusion Bonding of Foils
Foil-fiber-foil method (also called foil-fiber method) is a primary composite production process wherein layers of metal foil and ceramic monofilament fibers are alternatively stacked to produce precursor materials for subsequent diffusion bonding, specifically hot pressing. While wire winding is a method for production of precursor MFRM, material produced by co-winding metal wires and ceramic fibers for subsequent diffusion bonding, specifically hot pressing (MMC hot pressing is consolidation of ingredient materials by diffusion bonding with application of pressure with a piston (a hot press) at temperatures high enough to effect concurrent
sintering of the matrix, which for metal matrices is generally above the matrix re-crystallization temperature, a liquid phase (at least temporarily) in the compact. In connection with, powder cloth method are variant, foil-fiber-foil method for production of MFRM, in which matrix metal powders and a binder mixed and formed into a cloth or foil before stacking. One of the main problems lies in avoiding excessive chemical reaction at the fiber/metal interface. Additions of Al, Mo or V slow the kinetics of interfacial reaction, but also tend to make the rolling of thin foils difficult. In general, the foil-fiber-foil route is cumbersome and obtaining high fiber volume fractions and homogeneous fiber distribution is difficult unless special techniques used. Also, the process becomes difficult when the aim is to produce parts of complex shape.

3.3 Vapor State Processing
3.3.1 Physical vapor Deposition (PVD)
Coating processes is a primary processes which coat the matrix onto individual reinforcement elements of the ingredient material (i.e. vapor deposition, or electrolytic coating) creating composite elements, which generally require subsequent consolidation. Vapor deposition (in the context of composite production) is a primary process wherein the matrix deposited from the vapor phase onto individual reinforcement elements of the ingredient. Physical vapor Deposition processes are relatively slow, but the fastest is evaporation involving thermal vaporization to the target species in a vacuum. It may be noted that there is little or no mechanical disturbance of the interfacial region; this of significance when the fibers have diffusion barrier layer, or tailored surface chemistry. Composite fabrication is usually completed by assembling the coated fiber into a bundle and consolidating this in a hot pressing or HIPing operation. A very uniform distribution of fibers produced in this way, with fiber contents of up to about 80%. The fiber volume fraction accurately controlled through the thickness of the deposited coatings and the fiber distribution is always very homogeneous. While Electrolytic coating (in the context of composite production) is a primary process wherein the matrix deposited from solution using electrochemical means onto individual reinforcement elements of the ingredient material. In connection with matrix coated fiber method is a family of primary coating process whereby continuous or monofilament fibers coated with metal matrix material by physical vapor deposition, or by sputtering techniques or by chemical means prior to composite consolidation.

4. MECHANICAL PROPERTIES
Composite materials either isotropic or anisotropic, which determined by the Structure of composites. Isotropic material is a material, properties of which do not depend on direction of measuring. Anisotropic material is a material, properties of which along a particular axis or parallel to a particular plane are different from the properties measured along other directions. As shown in figure 5, Rule of Mixtures [ROM] is a method of approach to approximate estimation [12] of composite material properties, based on an assumption that a composite property is the volume weighed average of the phases (matrix and dispersed phase) properties.

4.1 Experimental
The paper highlighted on the Silicon Carbide properties (in connection with mechanical characteristics) of some particulate reinforced composites, based on a commercial aluminum alloy. Several techniques followed by researchers for the processing of particulate reinforced MMCs. Homogenous dispersion of SiC particles in the Al matrix shows an increase trend in the samples prepared with manual stirring and with 2-step method (both manual and automatic) of stir casting technique respectively. The composites meant for improving the tribological properties of the base, and made by Vortex casting, in laboratory conditions, at the Material Science and Engineering Faculty, in Technical University lasi [13]. Most of the test for density, tensile strength, hardness and elastic modulus and wear resistance of the prepared cast matrix and their composition carried out as per ASTM standards.

4.2 Heat Treatments
In order to attenuate the above cited negative effect of the soft particles, a heat treatment could be applied on the composite specimens. Optimization of the temperature and duration of the treatment plays an important role towards obtaining a good combination of the matrix pattern and certain properties of the composite. In view of this, the composite samples submitted to a solution hardening treatments, First of all stirring system has followed by rotating mechanism. And the melting has done in an oil fired furnace.

Figure 6. Effect of wt% SiC liquidus temperature of composite casting.
Aluminum were pre-heated before melting and mixing and the SiC particles were also preheated to make their surfaces oxidized as shown figure 6. The temperature of the furnace was first raised then cooled down just below the liquidus to keep the slurry in a semi solid state. The preheated SiC particles added and mixed manually. Manual mixing are used because it was very difficult to mix using automatic device when the alloy was in a semi-solid state.

4.3 Test Methods

The suitable heat treatment parameters established, for the studied composites, by analyzing their influence on the ultimate tensile strength (UTS), elastic modulus (E) and Brinell hardness (HBS) values. The mechanical tests according to the corresponding standards for metals, and conducted in laboratory atmosphere, at room temperature. In addition, an incremental content of SiC particles has various effects on the composite properties:

1. The Brinell hardness is little influenced, and an increase over 7% of ceramic particles content seems inefficient (see Fig. 7a);

2. The tensile strength has a permanent enlargement, which is quasi-proportional with the SiC content (see Fig.7b);

3. The elastic modulus has a non-linear, but continuous increase in dependence of SiC particle volume fraction (see fig.7c). Therefore, those properties could be controlled, too, by a suitable choice of the above mentioned parameters.

SUMMARY

This paper is to review the ongoing research and development of metal matrix composites and worldwide range of materials, which includes cermets and metallic foams, as well as more conventional particle and fiber reinforced metals. Techniques employed for production of metal matrix composite material and components depend on the types of matrix and reinforced concerned; these classified according to whether the matrix is in the liquid, solid or vapor state when it's combined with the reinforcement. Each of these processing routes has advantages and disadvantages. In particular, some are far more expensive than others. The lowest cast routes are generally those in which particle reinforcement aluminum produced using liquid metal handling particularly stir casting. Metal matrix composites derive their excellent mechanical properties from combination of a hard reinforcement phase such as silicon carbide (SiC) and a ductile matrix material such as aluminum or magnesium. While current applications for this class of material are primarily limited to aerospace and automobile applications, their development continuous with resulting new products such as high voltage transmission lines and heat sinks for electronic components. It is likely that, as MMC applications continue to expand, the spectrum of materials and processes employed will remain relatively wide.

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