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Research Article

Technological Relevance, Research Prospect and Applications of Aluminium-Silicon Carbide-Graphite Hybrid Metal Matrix Composites for Thermal Characterization

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Abstract

Aluminium matrix composites belong to the family of materials whose mechanical, tribological, thermal and electrical properties can be customized effectively. Most of the commercial work on MMCs has been highlighted on Aluminium as the matrix material. The combination of light weight, environmental resistance and beneficial mechanical properties has made Aluminium alloys exceedingly popular; these properties also make Aluminium best suited for use as a matrix metal. The thermophysical properties of these composites can be tailor made and have excellent specific mechanical properties. These composites can be fabricated with ease. Aluminium matrix composites reinforced with the particles of Silicon Carbide possess high yield strength, low coefficient of thermal expansion or thermal expansivity, high modulus of elasticity and excellent wear resistance by maintaining volume proportion up to 20%. Aluminium hybrid composites can be customized to provide moderate Coefficient of Thermal Expansion (CTE) and high thermal conductivity that are favorable for the applications pertaining to thermal management equipment. However, it is necessary to evaluate different percentage combinations of reinforcements with matrix Aluminium to check for thermal stability and to measure thermal conductivity and coefficient of thermal expansion. It is expected that, Aluminium-Silicon Carbide-Graphite hybrid composites can be used as load bearing material for the above applications. In this paper, a review about the said hybrid composites to investigate thermal properties for engineering applications have been discussed based on its technological relevance, applications and research prospect.

Keywords: *Aluminium matrix composites, matrix, thermophysical, expansivity, reinforcements, Graphite and applications*

1. Introduction

The intense development of metal matrix composites has been a major transformation in the technology of materials. The demand for a material comprising high strength and high toughness and competent enough to operate effectively under undesirable conditions, have led to the strengthening of new generation materials. These are highly developed materials generally consisting of reinforcements in the form of fibres which may be continuous or discontinuous and particulates or whiskers and are the main contenders for the applications pertaining to high temperature [Introduction to Composites (2002), Karl Ulrich Kainer, Basics of Metal Matrix Composites, D. Hull and T.W. Clyne, L.A. Looney (1992), William D. Callister, Materials Science and Engineering].

In the present scenario, metal matrix composites have evoked an intense curiosity for potential applications in aerospace and automotive industries owing to their superior strength-to-weight ratio and high temperature resistance. The widespread use of particulate metal matrix composites for engineering applications are hindered by the high cost of producing components. Although numerous technical challenges exist with casting technology, yet it has been used to surmount this problem. Achieving the distribution of reinforcement based on homogeneity within the matrix is one such attribute, which influences the properties and quality of composite material [William D. Callister, Materials Science and Engineering].

The development of Aluminium Matrix Composites (AMCs) has been a major transformation in the technology of materials. Aluminium matrix composites have evoked an intense curiosity for potential applications in aerospace and automotive industries

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owing to their high strength-to-weight ratio and desirable thermal properties. One of the major advantages of Aluminium-Silicon Carbide-Graphite hybrid composites is that, they have dual characteristics of self lubricating effect of the reinforcement of Graphite and improved strength of the Silicon Carbide ceramic phase. Persistent efforts are being made by the researchers to fabricate Aluminium-Silicon Carbide-Graphite composites and investigate thermal characteristics. Many experimental investigations have been carried out pertaining to thermal characterization of Aluminium Silicon Carbide composites but, limited work has been accomplished on Aluminium-Silicon Carbide-Graphite hybrid composites. It has been established that, the inclusion of Graphite reinforcement with Aluminium Silicon Carbide composites will enhance self lubricating properties. It is required to establish the data pertaining to the evaluation of thermal properties of hybrid composites in order to transform the material from design to manufacturing stage.

Among the various matrix materials, Aluminium and its alloys are predominantly used for research. The main focus of research is on Aluminium because of its distinctive combination of good corrosion resistance, low density and excellent mechanical properties. Aluminium alloys find extensive applications in automotive and aerospace industries because of their high strength-to-weight ratio, high stiffness, low thermal expansivity and high thermal conductivity. In automobiles, Aluminium is used chiefly in the fabrication of cylinder liners, piston, connecting rod, drive shafts and brake rotors. However, Aluminium exhibits poor tribological properties leading to seizure under critical conditions. Therefore, a strong prospective to develop advanced materials with greater resistance to wear and improved tribological properties led to the development of Aluminium Matrix Composites (AMCs).

Aluminium matrix composites belong to the family of materials whose mechanical, tribological, thermal and electrical properties can be effectively customized. Most of the commercial work on MMCs have been accentuated on Aluminium as the matrix material. The combination of light weight, environmental resistance and mechanical properties have made Aluminium alloys exceedingly admirable and beneficial and these properties support Aluminium to be used as a matrix metal. The melting point of Aluminium is high enough to assure many application requirements, yet low enough to render composite processing reasonably expedient. Also, Aluminium can accommodate a variety of reinforcing agents. Although much of early work on Aluminium matrix composites are well emphasized on continuous fibre types, most of the research work is focused on Discontinuously Reinforced Aluminium Matrix Composites (DRAMCs) because of their greater ease of manufacture, low production cost and comparatively superior isotropic properties. The specific mass of most of the AMCs is about one third that of Steel and the specific strength and stiffness of these materials are relatively high. These properties are imperative for automotive and aerospace applications because of the potential for large reductions in weight up to 25%. Moreover, the retention on high temperature strength is also a prevailing characteristic, making them appropriate candidate materials for the use in aeronautical and automotive engineering, military engineering, space science and aircraft engine applications [Introduction to Composites (2002), Karl Ulrich Kainer, Basics of Metal Matrix Composites, D. Hull and T.W. Clyne , L.A. Looney (1992), William D. Callister, Materials Science and Engineering].

High quality AMCs are accessible in large quantities with major producers scaling up production and promising lower prices. The rapid growth of new materials have met many challenges and are being documented in automotive industries such as improving fuel economy, enhancing performance and profitability, minimizing vehicular pollution and emissions, maintaining safety and quality. Persistent efforts have been made to develop new manufacturing techniques and processes by the use of Aluminium alloy materials for automotive engine components and other sophisticated applications. The applications of AMCs are being progressively more advantageous in both structural and functional parts of air and land vehicles. These materials have a dominating role in the comprehension of thermodynamic aspects of internal combustion engines depending on the factors viz., high thermal resistance and structural strength [N.R. Habbu (2000), Jayashree P.K et al. (2013), Dinesh Kumar and Jasmeet Singh (2014), Ashish Srivastava et al. (2014), Daljeet Singh et al. (2012)].

In recent years, greater emphasis has been given to Graphite particle matrix composites, which reveal approving mechanical and tribological properties. Several studies have been focused on the applications of Aluminium Graphite composites. These composites are extensively used in a large number of automotive components viz., cylinder liners, pistons and various types of brakes, air diffusers and bushings. Aluminium Graphite composites have been developed for tribological applications because of their antifriction properties, wear resistance and antiseizure characteristics.

In the present scenario, researchers and scientists are exploring on metal matrix composite materials and have led to phenomenal technological advancements. They have carried out exhaustive research work on mechanical and tribological behaviour of composite materials because of their estimable properties. Composites are used not only for their structural properties, but also for electrical, thermal, tribological and environmental applications. Aluminium Silicon Carbide composites are regarded as the most encouraging and appreciative composites because of their superior mechanical and thermal properties. Aluminium reinforced Silicon Carbide particulate composites are finding extensive engineering applications predominantly in industries. The major advantages of Silicon Carbide as reinforcement are improved stiffness, strength, thermal conductivity, wear resistance, fatigue resistance, low cost, low density and low thermal expansivity. Besides these exceptional properties, they are comparatively easier to fabricate and have shown greater potential to be inexpensive. A sequence of Aluminium alloy based composites are available with a wide range of values for the coefficient of thermal expansion, depending on the proportion of Silicon Carbide. Aluminium Silicon Carbide particulate composites are one of the materials that find wide range of applications in automobile and aerospace engineering [S.C. Tjong et al. (1998), P.K. Rohatgi et al. (1997), Qiang Zhang et al. (2003), Johnston C and Young R (2000), Zweben C (1999)].

The experimental studies are predominantly emphasized on Aluminium matrix composites reinforced with high proportion of particulates of Silicon Carbide which are generally above 10%. Many problems have been encountered while machining of AMCs with high volume proportion of ceramic Silicon Carbide. Ceramic phases cause rapid wear of cutting tools, which are by and large abrasive in nature. Thus, it is essential to include only a low volume proportion of reinforcements with the alloys of Aluminium to allow machining of composite materials efficiently.

Presently, research has been carried out by the use of two or more reinforcements to fabricate Aluminium matrix composites. Such composites have been referred to as hybrid metal matrix composites. Aluminium matrix composites combined with Silicon Carbide and Graphite reinforcements are prominent among them. These hybrid composite materials are generally used in structural, aerospace and automotive industries. Hybrid MMCs have greater technological relevance for automotive components viz., piston rods, piston pins, braking systems, cylinder liners, frames, valve spring caps, disk brake caliper, brake disks, disk pads and shaft. One of the major advantages of Aluminium-Silicon Carbide-Graphite hybrid composites is that, they have dual characteristics of self lubricating effect of the reinforcement of Graphite and improved strength of the Silicon Carbide ceramic phase. These AMCs possess enhanced properties of friction and excellent wear resistance due to the combined effect of the strength of Silicon Carbide that influences on the matrix and self lubrication property of Graphite.

The thermophysical properties of these composite materials can be particularly determined and exhibit exceptional mechanical properties. These composites can be fabricated with ease. Aluminium matrix composites reinforced with the particulates of Silicon Carbide possess high yield strength, low coefficient of thermal expansion or thermal expansivity, high moduli of elasticity and excellent wear resistance by maintaining volume proportion up to 20%. Aluminium hybrid composites can be customized to exhibit low coefficient of thermal expansion or thermal expansivity and high thermal conductivity that are constructive for the applications pertaining to thermal management equipment and electronic packaging. However, it is necessary to evaluate different percentage compositions of reinforcements with matrix Aluminium to confirm thermal stability and to determine specific heat capacity, thermal conductivity and coefficient of thermal expansion. It is expected that, Aluminium-Silicon Carbide-Graphite hybrid composites can be used as load bearing material for the above mentioned applications [.Saraswati R and Polese F.J. (1998), Eslamian M, Rak J and Ashgriz N (2008)].

Aluminium matrix composites are more promising materials and data pertaining to the salient thermal properties have to be established. This aspect has generated enormous interest in research pertaining to the area of composite materials. The characterization of thermal properties viz., specific heat capacity, thermal conductivity, thermal stresses and thermal expansivity have been advantageous for aerospace and automotive applications, space science, military engineering, heat sinks, electronic packaging and thermal management equipment. Hence, emphasis needs to be given for carrying out research on thermal characterization of composite materials. This research work intends to enhance the comprehension of the thermal aspects of Aluminium matrix composites.

2. Literature Review

The objective of this section is to furnish a review of the past research efforts related to the thermal characterization of composite materials. In this literature review, casting techniques, microstructural characterization, mechanical, tribological and thermal behaviour of composite materials, use of various thermal analyzers and computational thermal analysis have been discussed. In the literature review, importance has been given for the determination of thermal properties viz., coefficient of thermal expansion or thermal expansivity, thermal conductivity, specific heat capacity or thermal capacity. Computational thermal analyses of composite materials based on finite element approach have also been accentuated. The challenges in research and the definite directions relating to this research work have been identified through a detailed literature review. The important papers concerning with the thermal characterization of composite materials have been discussed in this section.

Kang and Rohatgi in their research have described the investigation on the phenomenon of one-dimensional heat transfer by transient thermal analysis of Aluminium alloy and Copper metal matrix composites comprising Aluminium oxide and the particulates of Silicon Carbide and Graphite. The distribution of particles have been evaluated by constantly varying the volume proportions based on centrifugal casting. A specific technique on finite difference has been adopted. This investigative study has depicted that, the presence of particulates of Silicon Carbide and Graphite increases the solidification time of the casting.

Zhang et al. have examined the influence of particulates of Silicon Carbide and Graphite on the behaviour of resultant damping on Al 6061 metal matrix composites to develop a reliable damping material. The microstructural analyses have been accomplished by means of precision instruments viz., Scanning Electron Microscope, Optical Microscope and Image Analyzer. In this research paper, it has been conclusively emphasized that, the capacity of damping of Al 6061 has been significantly enhanced by the addition of either Silicon Carbide or Graphite particulates through the technique of spray deposition processing.

Ted and Tsao have investigated the tribological behaviour of Aluminium-Silicon Carbide-Graphite hybrid composites by varying the weight proportions of Graphite by employing Semi Solid Powder Densification (SSPD). It has been reported that, the phenomenon of seizure which occurred on a monolithic Aluminium alloy did not transpire with the hybrid metal matrix composites. The quantity of the proportion of Graphite discharged on the wear surface has been increased and resulted in the reduction of the coefficient of friction.

Cooper and Chyung in their experimental study have presented that, Silicon Carbide continuous fibre-reinforced glass and glass-ceramic matrix composites exhibited high strength and fracture toughness. The extraordinary mechanical behaviour of these materials have been reliably associated with the formation of Graphite between the fibres and the matrix material. The results have been interpreted upon a potential mechanism for the behaviour of high temperature embrittlement for these materials when they undergo rupture in an aerobic environment.

Yongzhong has analyzed the function of the particulates of Silicon Carbide, Graphite and Copper hybrid composites and have been fabricated by using powder metallurgy. The analysis of microstructure has been carried out, where it has been demonstrated that, a uniform layer of Graphite microcrystals on the top of worn surface benefitted to diminish the plastic deformation in subsurface region and alleviate adhesion wear. It has been reported that, the particulates of Graphite has been an effective addition agent for Copper matrix composite applied in high temperature condition of sliding wear.

Daljeet et al. have carried out a comprehensive experimental investigation on mechanical behaviour of Aluminium by adding Silicon Carbide and Alumina as major reinforcements. They have focused research on the study of change in the behaviour of Aluminium by adding percentage reinforcements of Silicon Carbide and Alumina fabricated by stir casting technique. The tensile, hardness and impact tests have been accomplished by the use of these samples. It has been inferred that, as the weight fraction of the reinforcement increases, the mechanical properties viz., hardness, yield strength and ultimate strength tend to increase.

Dunia has carried out investigations on Aluminium Silicon Carbide and Aluminium Graphite particulate composites. Experiments have been conducted by varying percentage reinforcements of Silicon Carbide, Graphite and Alumina in 5%, 10%, 15%, 20%, 25% and 30%, while percentage reinforcement of Graphite 2%, 4%, 6%, 8% and 10% and other properties have been maintained as constants. It has been observed that, up to 25% percentage reinforcement of Silicon Carbide, the hardness increases and tends to reduce with further addition of Silicon Carbide, whereas at 4% percentage reinforcement of Graphite, maximum hardness has been obtained.

Haydar et al. have worked extensively on the effect of Graphite on mechanical and machining properties of Aluminium based hybrid composite. The work has been aimed at investigating the Aluminium hybrid metal matrix composites mixed with Silicon Carbide and Graphite as the reinforcements. This investigation includes hardness, compressive strength, cutting force, surface roughness and microstructural analysis. The results have demonstrated the improvements in microhardness and compressive strength by reinforcing 6% Silicon Carbide and Graphite based on weight proportions. The results of machining have revealed that, adding Silicon Carbide as reinforcement with matrix Aluminium led to surface roughness and the cutting force has been increased with the base matrix.

Abdalla et al. have described the method of determining the values of volume fraction of filament wound glass and carbon fibre reinforced composites. In their research work, they have presented the results from a sequence of tests based on the physical properties of composite materials. The volume proportions of glass and carbon fibres have been estimated to be 0.476 and 0.540.

Zhang et al. have examined the effect of volume proportion on the flow behaviour of Aluminium and Silicon Carbide composites by considering the spatial resolution of delaminated particles. The effect of volume proportion based on the distribution of particulates and its relation concerning with the behaviour of tensile deformation have been examined for particle reinforced Aluminium and Silicon Carbide metal matrix composites. A mathematical model has been developed to comprehend the behaviour of the composites. The effects of particle clustering on the accumulation of damage and the behaviour of deformation have been explored in the particle reinforced metal matrix composites. The clustering tendency of the Al-10 percentage volume of Silicon Carbide has been determined by the Normalized 2-Dimensional Local Number Density (LND2D) of the particle. It has been found that, the uniform material exhibiting a spatial distribution close to the random distribution has higher flow stress magnitude and larger elongation value. The particle/matrix delamination is trouble-free to transpire preferentially at the particles of larger size in the more clustered regions in the stage of tensile deformation.

Davis and Artz in their thesis have elucidated that, the thermal conductivity of metal matrix composites have been regarded as the prospective thermal property, which are applicable for electronic packaging and thermal management. It has been computed by the use of an effective medium theory and techniques based on finite element analysis approach. It is evident that, the particulates of Silicon Carbide in Aluminium should have radii in excess of 10 μm to attain the inclusive benefit of the ceramic phase based on the behaviour of thermal conductivity. The assessment of the effective medium theory has resulted in the computations of finite element for axisymmetric unit cell models and computational simulations have been carried out to validate the authenticity of the theory.

Cem et al. have examined the behaviour of thermal expansion and thermal conductivity of Aluminium Silicon-Silicon Carbide-Graphite hybrid metal matrix composites. They have emphasized that, Aluminium Silicon based hybrid composites reinforced with the particulates of Silicon Carbide and Graphite have been fabricated by liquid phase particle mixing and squeeze casting. Results have clearly illustrated that, an improvement is seen in the dimensional stability of the composite with an increase in the proportion of Graphite, further no substantial variation have been observed in the behaviour of thermal conductivity and thermal expansion of Silicon Carbide reinforced composites for the particle sizes of 45 μm and 53 μm.

Molina et al. have investigated the behaviour of thermal conductivity of Aluminium Silicon Carbide composites based on high volume proportion of the particles of Silicon Carbide. It has been investigated by comparing data for composites fabricated by infiltrating liquid Aluminium into preforms made either from a single particle size or by mixing and packing particles of Silicon Carbide of two different average sizes 170 μm and 16 μm. For composites based on powders with a monomodal size distribution, the thermal conductivity tends to increase progressively from 151 W/m K for particles of mean diameter 8 μm to 216 W/m K for 170 μm particles. For the bimodal particle mixtures, the thermal conductivity tends to increase with increasing volume proportion of coarse particles and reaches an approximately 220 W/m K for mixtures with 40 or more percentage volume of coarse particles. It has been depicted that, data can be accounted for by the Differential Effective Medium (DEM) scheme taking into account a finite interfacial thermal resistance.

It is evident from the literature review that, Aluminium matrix composites have been given greater emphasis. Literature review reveals that, many experimental investigations have been carried out on mechanical, tribological and thermal characterization. But, the research work on the thermal aspects of Aluminium-Silicon Carbide-Graphite hybrid composites is found to be limited. Many experimental investigations have been carried out pertaining to thermal characterization of Aluminium Silicon Carbide composites but, limited work has been accomplished on Aluminium-Silicon Carbide-Graphite hybrid composites. It has been established that, the inclusion of Graphite as reinforcement with Aluminium Silicon Carbide composites will enhance self lubricating properties. It is required to establish the data pertaining to the evaluation of thermal properties of hybrid composites in order to transform the material from design to manufacturing stage.

It has been reported in the literature that, experimental investigation on the thermal characteristics of Aluminium Silicon Carbide composites with the percentage reinforcements at lower and higher weight proportions have been accomplished. But, research on thermal characterization of Al 6061 with equal proportions of Silicon Carbide (SiC) and Graphite (Gr) reinforcements pertaining to low and high percentage reinforcements have been deficient. Hence it is pertinent to investigate the thermal properties of Aluminium-Silicon Carbide-Graphite hybrid composites by maintaining equal percentage reinforcements at lower weight proportions and smaller particle sizes. Casting techniques viz., stir casting, gravity die casting, centrifugal casting and squeeze casting have been extensively used.

Thermal analysis is also often used as a term for the study of heat transfer to determine specific heat capacity and thermal conductivity. It is essential to carryout thermal analysis of hybrid composites based on experimental investigation. Thermal properties such as specific heat capacity, thermal diffusivity, thermal conductivity and coefficient of thermal expansion will be determined. Finite element method is regarded as an efficient technique for the prediction and computation of the properties based on mechanical and thermal behaviour of composite materials. An important application of metal matrix composites in the topic of engineering design necessitates an elaborate categorization of mechanical and thermal properties. The properties based on thermal expansion of composite materials play a significant role in computing the thermal properties viz., thermal displacement, thermal strain and thermal stresses in components or structures of metal matrix composites. Analogously, the properties based on the thermal conductivity behaviour of composite materials play a dominating role for the computation of thermal gradient, thermal flux and rate of heat flow.

3. Technological relevance and research prospect

The composite material which is of light weight and can be produced at a low cost, fascinate the researchers from all perspective. Metal matrix composites normally possess properties such as high strength, ductility and high stiffness. MMCs exhibit better thermal properties viz., low thermal expansivity, specific heat or thermal capacity and thermal conductivity at higher magnitudes, which are best suited for electronic packaging, automobile engineering, heat sinks and thermal management applications. Among modern composite materials, Particle Reinforced Aluminium Matrix Composites (PRAMCs) are finding augmented applications due to their distinctive mechanical properties and good wear resistance. Usually, Silicon Carbide added to Aluminium possesses significant properties viz., high electrical and thermal conductivity, good wear resistance and low coefficient of thermal expansion or thermal expansivity. These properties are preferred for structural applications concerning with aerospace and automobile applications. A good combination of high strength and ductility of Aluminium based metal matrix composites have shown phenomenal growth towards industrial applications. The simplicity, suppleness and applicability of Aluminium to large scale production have extensively benefitted engineering applications in terms of production, capacity and cost efficiency. Aluminium alloy based MMCs offer researchers to comprehend the research benefits that exhibit good strength at high temperatures, good structural rigidity, dimensional stability, light weight, and low thermal expansivity or coefficient of thermal expansion.

Aluminium alloys reinforced with ceramic particles viz., Silicon Carbide, Aluminium Oxide, Boron Carbide and Graphite have been reported to possess wear resistance and strength. For hybrid composites, the use of Silicon Carbide and Graphite reinforcements help to increase the wear resistance, but the wear resistance increases with the increase in the proportion of Silicon Carbide. Boron Carbide is a non-metallic reinforcement that possesses hardness, wear resistance and melting point with high magnitudes. Hence reinforcing Aluminium composites with the particulates of Boron Carbide confirms high specific strength, modulus of elasticity, good wear resistance and thermal stability. Ceramic particles viz., Aluminium Oxide, Silicon Carbide and Boron Carbide are most extensively used to reinforce Aluminium. Aluminium Boron Carbide composites find its applications in structural neutron absorber, armour plate materials and a substrate material for computer hard disks.

Composite materials having one or more reinforcement are referred to as hybrid composites. Hybrid composites which comprise two or more particulates provide excellent strength, wear resistance and approving material properties and find expansive engineering applications. One of the major advantages of Aluminium-Silicon Carbide-Graphite hybrid metal matrix composites is that, they have dual characteristics of self lubricating effect of the reinforcement of Graphite and improved strength of Silicon Carbide ceramic phase. In recent times, continued efforts have been accomplished by the researchers to fabricate Aluminium-Silicon Carbide-Graphite hybrid metal matrix composites and examine their performance characteristics based on thermal characterization.

Composite materials comprising reinforcements which are discontinuous and metal matrix composites of particulate nature, find applications commercially, since they can be fabricated convincingly by the techniques of conventional processing. A variety of methods have been developed for the fabrication of Aluminium matrix composites. A cost-effective method of fabricating AMCs involves the incorporation of the particles into liquid metal and casting. The straightforward, inexpensive and the most dependable method of achieving liquid state fabrication is stir casting. Liquid state fabrication of metal matrix composites involves with the inclusion of reinforcements into a matrix metal in molten state, followed by the process of solidification. In this research work, stir casting has been employed for the fabrication of Aluminium matrix composites.

The manufacturing of Aluminium based casting composite by stir casting is one of the most inexpensive methods of processing metal matrix composites. The technique of stir casting is predominantly used for the manufacturing particulate reinforced metal matrix composites. Stir casting has been extensively used among the different processing techniques available. This technique usually involves prolonged contact of reinforcement, which can cause significant reaction in the interface. Stir casting is essentially used for manufacturing of particulate reinforced metal matrix composites. Among all well established metal matrix composite fabrication methods, stir casting is most economical. At present, this casting technique is the most acclaimed and commercial method of fabricating Aluminium based composites. The major merits of this technique are simplicity, suppleness and applicability for large quantity production. It has been fascinating because, it allows a conventional metal processing route to be employed, and therefore minimizes the final cost of the product.

4. Applications

AMCs have found extensive applications in many areas pertaining to daily life. Often it is not realized that the application makes use of composite materials. These materials have been produced from the conventional production and processing of metals. Materials like cast iron with Graphite or Steel with high proportion of carbide belong to the cluster of composite materials. In the present circumstances, Aluminium matrix composites are imperative for military and aerospace applications. The most essential commercial application of AMCs is Diesel engine piston made by Toyota. It has been estimated that 3, 00,000 such pistons are manufactured and sold in Japan annually.

Other industrial applications include cutting tools and circuit breaker contacts. AMCs with high specific stiffness and strength could be used in robots, high speed machinery and high speed rotating shafts for ships and land vehicles. The two significant thermal properties viz., thermal expansivity and thermal conductivity are applicable for lasers, precision machinery, thermal management equipment and electronic packaging.

In some prominent applications, AMCs will offer unsurpassed combinations of properties that cannot be originated in other materials. Electronic packaging for aircraft entails low thermal expansivity, low density and high thermal conductivity. Certain AMCs can gratify these prerequisites, replacing Beryllium, which is inadequate and presents stern toxicity problems. The high magnitude of heat transfer coefficient is greatly desirable for space-based radiators, where this property will be supported by Graphite fibre reinforced Copper, Aluminium and Titanium. The higher transverse strength of AMCs is pertinent for space applications viz., space shuttle orbiter struts which are fabricated by Boron fibre added to Aluminium.

In aerospace applications, thermophysical and thermomechanical properties viz., thermal conductivity, thermal expansivity, high stiffness and strength are the principal drivers. The cost factor and performance are the driving potential for the development of materials. The reduction in the weight of a component is a remarkable driving potential for any application in the field of aerospace engineering. In automotive engineering, the fabrication of Diesel crown pistons is an imperative application of metal matrix composites. The usefulness of carbon fibre and alumina particles in an Aluminium matrix for cylinder liners is yet another application in automobile engineering. Application area like traffic engineering is cost oriented and conservative and the industry will be reluctant to pay additional or miscellaneous costs for the use of composite materials.

In the present era, the technology of advanced composites have been progressed to an extent where emerging military aircraft systems have copious composite components in production. For next-generation aircraft, high intensity production should utilize composites which are more competitive with metals. To assure these anticipated production requirements on a cost competitive basis, aircraft manufacturers have been investigating needs and installing modern equipment required for a meticulous conversion to extensive use of novel materials. The advanced composite aircraft technology will effectively deal with the sophisticated structures and engross in innovative manufacturing methods to fabricate composite assemblies.

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