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Research Article

A Review Paper on Stir Casting of Reinforced Aluminium Metal Matrix Composite (MMC)

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Abstract

This paper deals about the importance of composites as engineering materials which is reflected by the fact that most of the materials which are available in the market are composites. These composites replaced cast iron and bronze alloys due to their poor wear and seizure resistance. Due to the wide choice of materials, today's engineers are posed with a big challenge for the right selection of a material and the right selection of a manufacturing process for an application. There are more than 50,000 materials available to engineers for the design and manufacturing of products for various applications. In the present study, based on literature review, the effect of Boron Carbide particle reinforcements are finding increased applications in aerospace, automobile, space, underwater and transportation applications. This is mainly due to improved mechanical and tribological properties like strong, stiff abrasion and impact resistant and it is not easily corroded. In a review of different researchers have been made to consolidate some of the aspects of mechanical and wear behaviour of Aluminium Metal Matrix Composites reinforced with Boron Carbide particles.

***Keywords**: Aluminium alloy, Metal matrix Composites, Boron Carbide, Stir casting.*

Introduction

Aluminium is widely used as a structural substantial especially in the aerospace industry because of its light weight properties however the low strength and low melting point of aluminium were always a problem. The metal matrix composites (MMCs), like all other composites consist of at least two chemically and physically well-defined phases, suitably distributed to provide properties not obtainable with either of the individual phases. For many researches the term MMCs is often equated with the term light metal matrix composites. Substantial progress in the development of light metal matrix composites has been achieved in recent decades, so that they could be introduced into the most important applications. Aluminium matrix composites (AMCs) are the effective material in the industrial world. Due to its excellent mechanical properties, it is widely used in aerospace, automobiles, marine etc. (rohatgi. P. K., Ray.S., Louis. Y. 1993). The aluminium matrix is getting strengthened when it is reinforced with the hard ceramic particles like SiC, Al_2O_3,and B_4C etc. Aluminium alloys are still the subjects of intense studies, as their low density gives additional advantages in several applications. These alloys have started to replace cast iron and bronze to manufacture habiliment resistance parts. MMCs reinforced with particles tend to offer enhancement of properties processed by conventional routes. 6061Al is widely used in many engineering applications including transport and construction where superior mechanical properties such as tensile strength, hardness etc., are essentially required (Chan. K. C. long. J. 2000). 6061Al is rather a popular choice as a matrix material to prepare MMCs owing to its better form-ability characteristics. Among contrary kinds of the recently developed composites, particle reinforced metal matrix composites and in particular aluminium base materials have already emerged element candidates for industrial applications. Boron Carbide particulate reinforced aluminium composites possess a unique combination of high specific strength, high elastic modulus, good wear resistance and good thermal stability than the corresponding non-reinforced matrix alloy system.

A limited research work has been reported on AMCs reinforced with B_4C due to higher raw material cost and poor wetting. B_4C is a robust material having excellent chemical and thermal stability, high hardness (HV = 30 GPa), and low density (2.52 g/cm3) and it is used for manufacturing bullet proof vests, armour tank etc. Hence, B_4C reinforced aluminium matrix composite has gained more attraction with low cost casting route (Chaska. N., Shen. Y. L. 2001, Kasaan. J. S. 2010).

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Metal Matrix Composite (MMC)

Metal matrix composites, at present though bring forth a wide interest in research brotherhood, are not as widely in use as their plastic counterparts. High strength, fracture toughness and stiffness are content by metal matrices than those offered by their polymer counterparts. They can withstand elevated temperature in corrosive environment than polymer composites. Most metals and alloys could be used as matrices and they require reinforcement materials which need to be stable over a range of temperature and non-reactive too. However the guiding aspect for the choice depends essentially on the matrix material. Light metals form the matrix for temperature application and the reinforcements in addition to the aforementioned reasons are characterized by high moduli (Sherry. R., Raghuvir. B. P., Rainbow. S. S, Natalie. R. 2009).

Most metals and alloys make good matrices. However, practically, the choices for low temperature applications are not many. Only light metals are answering, with their low density proving an advantage. Titanium, Aluminium and magnesium are the popular matrix metals currently in vogue, which are particularly useful for aircraft applications. If metallic matrix materials have to offer high strength, they require high modulus reinforcements. The strength-to-weight ratios of resulting composites can be higher than most alloys.

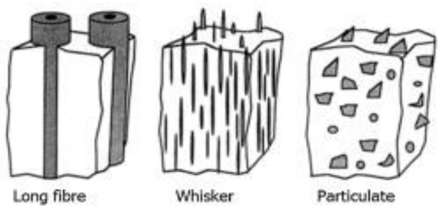
The melting point, physical and mechanical properties of the composite at various temperatures determine the service temperature of composites. Most metals, ceramics and compounds can be used with matrices of low melting point alloys. The choice of reinforcements becomes more stunted with increase in the melting temperature of matrix materials (Chang.C.,Yang. G. J., Ling. C. and Chou. C. 2010)

Properties of MMC

Some important properties of MMC's are given as following:

1) High Toughness and impact properties.
2) High electrical and thermal conductivities.
3) Excellent antifriction anti abrasion, damping.
4) Excellent machine ability properties.
5) Reduced wear, anti-sizing.
6) Lighter in weight.
7) Good strength and Specific stiffness.
8) High Strength.
9) Low Density.

Forms of MMC



Advantages of MMC

1) Higher strength and stiffness.
2) Higher service temperatures.
3) Higher electrical conductivity (grounding, space charging).
4) Higher thermal conductivity.
5) Better transverse properties.
6) Improved joining characteristics.

Aluminium Metal Matrix Composites (AMMC)

MMC (Metal matrix composites) are metals reinforced with other metal, ceramic or organic com- pounds. They are made by dispel the reinforcements in the metal matrix. Reinforcements are usually done to amend the properties of the base metal like strength, stiffness, conductivity, etc. Aluminium and its alloys have attracted most attention as base metal in metal matrix composites. Aluminium MMCs are widely used in aircraft, aerospace, auto- mobiles and various other field the reinforcements should be stable in the given working temperature and non-reactive too. The most commonly used reinforcements are Silicon Carbide (SiC) and Aluminium Oxide. SiC reinforcement increases the tensile strength, hardness, density and wear resistance of Al and its alloys. The particle statistical distribution plays a very vital role in the properties of the Al MMC and is improved by intensifier shearing. Al_2O_3 reinforcement has good compressive strength and wear resistance. Boron Carbide is one of hardest known elements. It has high elastic modulus and fracture toughness. The addition of Boron Carbide in Al matrix increases the hardness, but does not improve the wear resistance significantly. Fibers are the important class of reinforcements, as they satisfy the desired conditions and transfer strength to the matrix constituent influencing and enhancing their properties as desired. Zircon is usually used as a hybrid reinforcement. It increases the wear resistance significantly. In the last decade, the use of fly ash reinforcements has been increased due to their low cost and availability as waste by-product in thermal power plants. It increases the electromagnetic shielding effect of the ALMMC (Klancnik.G.G, Medved.J., Mrvar.P 2010). Based on the stated potential benefits of MMC this paper examines the various factors like:

1) Effect of Various Reinforcement.
2) Mechanical Behaviour Like Strength, Wear, Fatigue Behaviour, Etc.
3) Processing Methodology and Its Effects.
4) Application of the Specialty AMC.

Aluminium

Aluminium is a stuff element with symbol Al and atomic number 13. It is a silvery-white, soft, nonmagnetic, ductile metal in the boron group of the Earth's crust; it is the third most abundant element after oxygen and silicon and the most abundant metal in the crust, though it is less common in the mantle below. The chief ore of aluminium is bauxite. Aluminium metal is so chemically reactive that native specimens are infrequent and limited to extreme reducing environments. Instead, it is found combined in over 270 different minerals. Aluminium and its alloys are vital to the aerospace industry and important in transportation and building industries, such as building facades and window frames. The oxides and sulfates are the most useful compounds of aluminium. Despite its prevalence in the environment, no known form of life uses aluminium salts metabolically, but aluminium is well tolerated by plants and animals. Because of these salts' abundance, the potential for a biological role for them is of continuing interest, and studies continue. Aluminium metal was unknown to ancient people. The only possibility of an occurrence of the metal was recorded by Roman historian Pliny the Elder; however, this claim has been disputed. The history of aluminium has been shaped by usage of alum. First written record of alum, made by Greek historian Herodotus, dates back to the 5th century BCE. The ancients are known to have used alum as dyeing mordants and for city defense. After the Crusades, alum, a good indispensable in European fabric industry, was a subject of international commerce; it was imported to Europe from the eastern Mediterranean until the mid-15th century.

Boron Carbide

Boron carbide (chemical formula approximately B4C) is an extremely hard boron–carbon ceramic, and covalent material used in tank-armor, bulletproof vests, Engine sabotage powders,(Rohatgi . P. K., Ray. S. Louis. Y. 1993)as well as numerous industrial applications. With a Vickers Hardness of >30 GPa, it is one of the hardest known materials, behind cubic boron nitride and diamond.

Boron carbide was discovered in 19th century as a by-product of reactions involving metal borides, however, its chemical formula was unknown. It was not until the 1930s that the chemical composition was estimated as B_4C. There remained, however, controversy as to whether or not the material had this exact 4:1 stoichiometry, as in practice the material is always slightly carbon-deficient with regard to this formula, and X-ray crystallography shows that its structure is highly complex, with a mixture of C-B-C chains. These features argued against a very simple exact B_4C empirical formula.[4] Because of the B12 structural unit, the chemical formula of "ideal" boron carbide is often written not as B4C, but as B12C3, and the carbon deficiency of boron carbide described in terms of a combination of the B12C3 and B12CBC units. The ability of boron carbide to absorb neutrons without forming long-lived radiosonde makes it attractive as an absorbent for neutron radiation arising in nuclear power plants and from anti-personnel neutron bombs. Nuclear applications of boron carbide include shielding, control rod and shut down pellets. Within control rods, boron carbide is often powdered, to increase its surface area.

Boron carbide is used in refractory applications due to its high melting point and thermal stability; it is used as abrasive powders and coatings due to its extreme abrasion resistance; it excels in ballistic performance due to its high hardness and low density; and it is commonly used in nuclear applications as neutron radiation absorbent. In addition, boron carbide is a high temperature semiconductor that can potentially be used for novel electronic applications. This paper provides a comprehensive review of the recent advances in understanding of structural and chemical variations in boron carbide and their influence on electronic, optical, vibrational, mechanical, and ballistic properties. Structural instability of boron carbide under high stresses associated with external loading and the nature of the resulting disordered phase are also discussed.

Reinforcement of aluminium with boron carbide

Particulate reinforced aluminum matrix composites (PRAMC) have received considerable attention because of their high specific strength, high specific modulus, low CTE (coefficient of thermal expansion) value and good wear resistance. The PRAMCs were usually produced by powder metallurgy and casting route. Powder metallurgy techniques have advantage over casting method by eliminating the segregation typical of casting (KertiI, Tipton F 2008). So blending the mixture to achieve the homogeneous distribution of reinforcement into base alloy became a key step of powder metallurgy process. Mechanical alloying/ milling became an active way to improve reinforcement distribution throughout the matrix. Some research works show that reinforcements such as SiC particles can be successfully incorporated into aluminum matrix using MA technique. The property of composites was improved by the uniform distribution of reinforcement and the refinement of sub-grain size.
Boron Carbide (B_4C) has many attractive properties, such as low specific gravity, high hardness value, high elastic modulus value and neutron absorption, which help B_4C to be widely used as cermet's and armor materials. As a promising reinforcement of PRAMC, B4C received little attentions over its counterparts such as SiC and Al_2O_3. From limited information of B_4C reinforced aluminum matrix composites, there are several researches works mainly focused on the wet-ability and chemical reaction between aluminum and boron carbide. Hu et al. analyzed the micro-structure and interface of B_4C/Al composites fabricated by Boralyn process, but the data of mechanical property about the composites are not reported yet.

This paper aims to analyze the micro-structure evolution of B_4C p/Al composites during mechanical alloying and the micro-structure, mechanical property of the composites prepared by MA–hot extrusion technique. We explore a method to produce the B_4C particulate reinforced aluminium matrix composites by combining the MA and hot extrusion technique.

The aluminium matrix is getting strengthened when it is reinforced with the hard-ceramic particles like SiC, and B_4C etc. Aluminium alloys are still the subjects of intense studies, as their low density gives additional advantages in several applications. These alloys have started to replace cast iron and bronze to manufacture wear resistance parts (K. Kalaiselvan, N. Miriam, Siva Paramswaran2011)MMCs reinforced with particles tend to offer enhancement of properties processed by conventional routes. 6061Al is widely used in numerous engineering applications including transport and construction where superior mechanical properties such as tensile strength, hardness etc., are essentially required.

6061Al is quite a popular choice as a matrix material to prepare MMCs owing to its better form-ability characteristics. Among different kinds of the recently developed composites, particle reinforced metal matrix composites and in particular aluminium base materials have already emerged as candidates for industrial applications. Boron Carbide particulate reinforced aluminium composites possess a unique combination of high specific strength, high elastic modulus, good wear resistance and good thermal stability than the corresponding non-reinforced matrix alloy system.

Properties

1. Good Electrical Conductivity
2. High Strength
3. Hardness
4. Heat Resistant
5. Corrosion Resistant
6. Fabrication Methods

Fabrication methods

Fabrication methods are an important part of the design process for all structural materials, including MMCs. Considerable work is under way in this critical area. Significant improvements in existing processes and development of new ones appear likely.

Current methods can be divided into two major categories, primary and secondary. Primary fabrication methods are used to create the MMC from its constituents. The resulting material may be in a form that is close to the desired final configuration, or it may require considerable additional processing, called secondary fabrication, such as forming, rolling, metallurgical bonding, and machining. The processes used depend on the type of reinforcement and matrix.

A deprecative consideration is reactions that can occur between reinforcements and matrices during primary and secondary processing at the high temperatures required to melt and form metals. These impose limitations on the kinds of constituents that can be combined by the various processes. Sometimes, barrier coatings can be successfully applied to reinforcements, allowing them to be combined with matrices that otherwise would be too reactive. For example, the application of a coating such as boron carbide permits the use of boron fibers to reinforce titanium (Price.D.M.,1995). Potential reactions between matrices and reinforcements, even coated ones, is also an important criterion in evaluating the temperatures and corresponding lengths of time to which MMCs may be subjected in service.

Mono layer tapes are also produced by spraying metal plasma on coll i-mated fibers, followed by hot pressing. Structural shapes can be fabricated by creep and super-plastic forming of laminates in a die. An alternate process is to place fibers and unbounded foils in a die and hot press the assembly.

The boron/aluminium struts used on the space shuttle are fabricated from mono-layer foils wrapped around a mandrel and hot ecstatically pressed to diffusion bond the foil layers together and, at the same time, to diffusion bond the composite laminate to titanium end fittings.

Fabrication of MMC

1) **S.Dinakaran and T,V Moothy *et.al*.** Aluminium matrix composites (AMCs) play a pivotal role as advanced engineering materials due to their distinct mechanical properties like lightweight, strength, wear resistance, toughness, stiffens…etc. the focus of the work is on fabricating the aluminium (AA6061) matrix composites reinforced with the varied propositions of the percentage of the weight of B4C particle of size at 220µm such as 3%, 6% and 9% by means of the stir casting method. The enhancement in the wettability of B4C particles in the matrix by adding K2TiF6 flux into the molten metal, has been significant. Besides, the microstructure and mechanical properties of the fabricated AMCs have also been analyzed. Uniform distribution of the presence of the B4C particle in the matrix has been confirmed using the Scanning Electron Microscope (SEM) images. It has been found that the tensile strength and hardness of the fabricated AMCs increases phenomenally with the increased content of the B4C particle.
2) **T Albert and T Praven Tamil Selvan *et.al*.** A composite material is the combination of two or more materials, which are having different phases and the properties superior to the base material. Aluminum matrix composite (AMCs) are emerging as advance engineering materials due to their strength, ductility and toughness. The aluminium matrix can strengthened by reinforcing with hard ceramic particles like SiC, Al2o3 , B4C etc. In this paper, an effort is made to enhance the mechanical

properties like strength and hardness of aluminium matrix composite by reinforcing aluminium matrix with boron carbide particles. By powder metallurgy route, aluminium matrix has been reinforced with boron carbide particulate of 400µ sizes. The aluminium metal powder is blended with boron carbide in weight ratio of 5%wt and 10%wt. The microstructure and mechanical properties of the fabricated aluminium matrix composite has analyzed. The properties of pure aluminium formed by powder metallurgy has been compared with the properties of aluminium boron carbide formed by powder metallurgy. Based on the result obtained by the optical microstructure image reveal the homogeneous dispersion of boron carbide particles in the matrix. The reinforcement dispersion has also been identified with X-ray diffraction (XRD). The strength and hardness was found to increase with increase in wt% of there enforcement.

3) **Cun-Zhu Nie *et.al*.** Boron carbide particulates reinforced 2024 Aluminum matrix composites were fabricated by mechanical alloying–hot extrusion technology successfully. The morphology and microstructure of B_4C_p/2024Al composite were investigated by optical microscopy (OM), scanning electron microscopy (SEM) and transmission electron microscopy (TEM). A clean interface of B_4C between aluminum was obtained in this experiment, and matrix alloy revealed the typical microstructure of high energy milling with average grain size about 300 nm. Nanosized oxide and carbide formed after the composites subjected to high energy milling and hot consolidation process. The yield strength and Young's modulus values were improved significantly over the monolithic 2024 alloy

4) **Gopal Krishna u b*et.al*.** Aluminum matrix composites (AMCs) are emerging as advance engineering materials due to their strength, ductility and toughness. The aluminium matrix can be strengthened by reinforcing with hard ceramic particles like SiC, Al_2O_3, B_4C etc. In the present study, an effort is made to enhance the mechanical properties like tensile strength and hardness of AMCs by reinforcing 6061Al matrix with B_4C particles. By stir casting route, aluminium matrix was reinforced with boron carbide particulates of 37, 44, 63, 105, 250µ sizes respectively. The microstructure and mechanical properties of the fabricated AMCs was analyzed. Based on the results obtained from tensile strength test of the metal matrix composites of different particle sizes, 105µ size B_4C was chosen and varied the wt% of B_4C with 6,8,10 and 12wt%. The optical microstructure images reveal the homogeneous dispersion of B_4C particles in the matrix. The reinforcement dispersion has also been identified with X-ray diffraction (XRD). The tensile strength and hardness was found to increase with the increase in the particle size and also with the increase in wt% of the reinforcement.

5) **V Prasanna Swami *et.al*.** A composite material is a combination of two or more chemically distinct and insoluble phases; its properties and structural performance are superior to those of the constituents acting independently. Metals and ceramics, as well, can be embedded with particles or fibers, to improve their properties; these combinations are known as Metal-Matrix composites. Aluminum alloy constitutes a very important engineering material widely employed in the aircraft and aerospace industry for the manufacturing of different parts and components. It is due to its high strength to density ratio that it a sought after metal matrix composite. Various processing techniques for the fabrication of Aluminium matrix composites, testing of their mechanical properties are available.

6) **Kenneth kanayoAlename *et.al*.** Aluminium hybrid composites are a new generation of metal matrix composites that have the potentials of satisfying the recent demands of advanced engineering applications. These demands are met due to improved mechanical properties, amenability to conventional processing technique and possibility of reducing production cost of aluminium hybrid composites. The performance of these materials is mostly dependent on selecting the right combination of reinforcing materials since some of the processing parameters are associated with the reinforcing particulates. A few combinations of reinforcing particulates have been conceptualized in the design of aluminium hybrid composites. This paper attempts to review the different combination of reinforcing materials used in the processing of hybrid aluminium matrix composites and how it affects the mechanical, corrosion and wear performance of the materials. The major techniques for fabricating these materials are briefly discussed and research areas for further improvement on aluminium hybrid composites are suggested.

7) **T Miller *et.al*.** The importance of composites as engineering materials is reflected by the fact that out of over 1600 engineering materials available in the market today more than 200 are composites. These composites initially replaced Cast Iron and Bronze alloys but owing to their poor wear and seizure resistance, they were subjected to many experiments and the wear behavior of these composites were explored to a maximum extent and were reported by number of research scholars for the past 25 years. In the present study, based on the literature review, the effect of Silicon carbide on Stir cast Aluminium Metal Matrix Composites is discussed. Aluminium Metal Matrix Composites with Silicon carbide particle reinforcements are finding increased applications in aerospace, automobile, space, underwater, and

transportation applications. This is mainly due to improved mechanical and tribological properties like strong, stiff, abrasion and impact resistant, and is not easily corroded. In the present scenario, a review of different researchers have been made to consolidate some of the aspects of mechanical and wear behavior of Aluminium Metal Matrix Composites reinforced with Silicon carbide particles in both untreated and precipitation hardened condition.

8) **Vengatesh.D and Chandramohan*et.al*.** For the last few years there has been a rapid increase in the utilisation of aluminium alloys, particularly in the automobile industries, due to low weight, density, coefficient of thermal expansion, and high strength, wear resistance. Among the materials of tribological importance, Aluminium metal matrix composites have received extensive attention for practical as well as fundamental reasons. Aluminium alloys and aluminium-based metal matrix composites have found applications in the manufacture of various automotive engine components. Compound work pieces are developed to combine favorable properties of different materials. Many composite materials are used in home and industrial production. Weight reducing in rapid moving parts of automobile engines such as Crankshaft, connect rod. to a reduction of the weight and wear reduction purpose. For this review paper discussed with recent composite technology and performance behavior and also we discussed MMC. the material mixed with nonmetal and analyzed in this mechanical properties and fabrication technique.
9) **L.K. Reddy *et.al*.** Polymer-matrix composites (PMCs) have been used for a variety of structural memberships for chemical plants and airplanes, since they have outstanding performances, such as lightweight and good fatigue properties. To hold the long-term durability and to estimate the residual life of the composites under some hostile environments, it is an important issue to clarify the facture and/or the failure mechanism in each service conditions. Degradation of components made from polymeric materials occurs in a wide variety of environments and service conditions, and very often limits the service lifetime. Degradation occurs as the result of environment-dependent chemical or physical attack, often caused by a combination of degradation agents, and may involve several chemical and mechanical mechanisms. The main concern of this review will be to examine the causes of degradation of polymeric components from the completion of fabrication to ultimate failure.
10) **Gorge Kennedy *et.al*.** Aerospace is a material intensive industry. Inadequacy of a single or a group of materials to fulfill all the stringent requirements of aerospace industry along with the dual demand of economy and performance have led the researchers to look for new material. Composite is the answer. Although aircraft utilizes numerous elements in their construction, the most important of these is aluminium because of its low density, good cast ability, high strength, corrosion resistant and good fatigue strength. However, its usage is constrained due to its limited strength and hardness. To overcome this, aluminium is combined with various other elements. An example of this includes a family of materials known as aluminum metal matrix composites (Al-MMCs). Of all criteria of material selection for aerospace application, the most important is strength to weight ratio i.e. high specific modulus (E/ρ). Because of its high specific modulus, good mechanical and thermal properties aluminium based metal matrix composites are natural choice for aerospace applications
11) **Rama Rao *et al.*** examined that aluminium alloy-boron carbide composites were fabricated by liquid metallurgy techniques with different particulate weight fraction (2.5, 5 and 7.5%). Phase identification was carried out on boron carbide by x-ray diffraction studies microstructure analysis was done with SEM a composites were characterized by hardness and compression tests. The results shows increase the amount of the boron carbide. The density of the composites decreased where as the hardness is increased. Whereas the compressive strength of the composites was increased with increase in the weight percentage of the boron carbide in the composites.
12) **Ravichandran *et al*.** Synthesized and studied the forming behavior of aluminium-based hybrid powder metallurgic composites. Aluminium-based metal matrix composites were synthesized from Al-TiO2-Gr powder mixtures using the powder metallurgy technique and their forming characteristics were studied during cold upsetting.
13) **Karunamoorthy *et al*.** Analysed that A 2D microstructure-based FEA models were developed to study the mechanical behaviour of MMC. The model has taken into account the randomness and clustering effects. The particle clustering effects on stress-strain response and the failure behaviour were studied from the model. The optimization of properties was carried out from analysis of microstructure of MMC since the properties depend on particles arrangement in microstructure. In order to model the microstructure for finite element analysis (FEA), the micro-structures image converted into vector form from the raster than it conversion push to IGES step and mesh in FEA model in ANSYS 7. The failure such as particle interface de-cohesion and fracture the predicted for particle clustered and non-clustered micro structures. They analyzed that failure mechanisms and effects of particles arrangement.

14) **Sozhamanna *et.al*.** analysed that the methodology of microstructure based elastic-plastic finite element analysis of PRMMC. This model is used to predict the failure of two dimensional microstructure models under tensile loading conditions. Hence analyses were carried out on the microstructure of random and clustered particles to determine its effect on strength and failure mechanisms. The FEA models were generated in ANSYS using SEM images. The percentage of major failures and stress-strain responses were predicted numerically for each microstructure. Here the mixture material Al alloy,
15) **Rohatgi *et.al*.** Analysed that A356-fly ash cenosphere composites can be synthesized using gas pressure infiltration technique over a wide range of reinforcement volume fraction from 20 to 65%. The densities of Al356-fly ash cenosphere composites, made under various experimental conditions, are in the range of 1250-2180 kg/m3 corresponding to the volume fraction of cenosphere in the range 20-65%. The density of composites increased for the same cenosphere volume fraction with increasing size of particles, applied pressure and melt temperature. This appears to be related to a decrease in voids present near particles by and enhancement of the melt flow in a bed of cenosphere. The compressive strength Plateau stress and modulus of the composites increased with the composite density.
16) **Venkat prasat *et.al*.** Investigated that tribological behaviour of aluminium alloy reinforced with alumina and graphite this is fabricated by stir casting process. The wear and frictional properties of the hybrid metal matrix composites was studied by performing dry sliding wear test using a pin – on- test wear test. Experiments were conducted based on the plan of experiments generated through taguchi's technique. AL27 orthogonal array was selected for analysis of the data. Investigation to find the influence of wear rate sliding speed applied load sliding distance, as well as the coefficient of friction. The results show that sliding distance has the highest influence followed by load and sliding speed. Finally, confirmation test were carried out to verify the experimental results and scanning electrons microscopic studies were done on the wear surfaces. The incorporation of graphite as primary reinforcement increases the wear resistance of composites by forming a protective layer between pin counter face and the inclusion of alumina as a secondary reinforcement also has a significant effect on the wear behaviour. The regression equation generated for the present model was used to predict the wear rate and coefficient of friction of HMMC for intermediate conditions with reasonable accuracy.
17) **Sedat Ozden *et.al*.** Investigated the impact behaviour of Al and SiC particle reinforced with AMC under different temperature conditions. The impact behaviour of composites was affected by clustering of particles, particle cracking and weak matrix-reinforcement bonding. The effects of the test temperature on the impact behaviour of all materials were not very significant.
18) **Mahendra boopathi. M *et.al*.** Experimented to Development of hybrid metal matrix composites has become an important area of research interest in materials science. In view of this, the present study was aimed at evaluating the physical properties of aluminium 2024 in the presence of fly ash, silicon carbide and its combinations. Consequently aluminium MMC combination the strength of the reinforcement with the toughness of the matrix to achieve a combination of desirable properties not available in any single conventional material. stir casting method was used for the fabrication of aluminium MMC. Structural characterization was carried out on MMC by x-ray diffraction studies and optical microscopy was used for the micro structural studies.
19) **Bienias *et.al*.** Experimented that microstructure characteristics of aluminium matrix Ak12 composites containing of fly ash particles, obtained by gravity and squeeze costing techniques, pitting corrosion behaviour and corrosion kinetics are presented and discussed. It was found that one in the comparison with squeeze casting, gravity casting technology is advantageous forobtaining higher structural homogeneity with minimum possible porosity levels, good interfacial bonding and quite a uniform distribution of reinforcement, second one the fly ash particles lead to an enhanced potting corrosion of the Ak12/9%flyash (75-100 μm fraction) Composite in comparison with unreinforced matrix (Ak12 alloy), and third one the presence of nobler second phase of fly ash particles, cast defects like pores, and higher silicon content formed as a result of reaction between aluminium and silica in Ak12 alloy and aluminium fly ash composite determine the pitting corrosion behaviour and the properties of oxide film forming on the corroding surface. Anilkumar et al [10]. Investigation that mechanical properties of fly ash reinforced aluminium alloy (Al 6061) composites fabricated by stir casting. They are three sets of composites with fly ash particle sizes of 75-100, 45-50 and 4-25 μm were used. Each set had three types of composite samples with the reinforcement weight fractions of 10 15 and 20%. The mechanical properties studied were the compressive strength, tensile strength, ductility and hardness. Unreinforced Al6061 samples also tested the mechanical properties. It was found that the compressive strength, tensile strength and hardness of the aluminium alloy composites decreased with the increase in particle size of reinforced fly ash. Increase in the weight fractions of the fly ash particles the ultimate tensile strength, compressive strength, hardness and decreases the ductility of the composite. The SEM

of the samples indicated uniform distribution of the fly ash particles in the matrix without any voids. Research efforts put in place to resolve these problems are mostly channelled towards selecting the right choice of reinforcing materials. This is an indication that the reinforcing materials play significant role in determining the overall performance of the composites.

Stir Casting

It was Introduced by S. Ray in 1968.Conventional stir casting process has been employed for producing discontinuous particle reinforced metal matrix composites for decades. The major problem of this process is to obtain sufficient wetting of particle by liquid metal and to get a homogenous dispersion of the ceramic particles. Stir casting technique is a liquid state fabrication of metal matrix composite in which the reinforcement particles are added to the molten metal matrix by means of mechanical stirring. In this process, reinforcements are usually in the form of powder, which is homogeneously mixed in the molten metal with the help of mechanical stirring. (Hashim J., Looney L and Hashmi M. S. J. 1999). Mechanical stirring while the molten metal and the reinforcement are in the furnace is the key to this process. The resultant mixture is then used to make desired shape by either moulding or casting.

Crucible Melting of Aluminium

In this maneuver the desired quantity of the 6061 aluminium rod according to weight and by volume of our mould is taken and put inside the preheated furnace by help of graphite crucible. In our case a batch of 500g of 6061Al was melted to 750°C in a graphite crucible using Coal fired furnace.

Conclusion

The literature survey shows that variety of work has been done to modify properties of Aluminium Metal Matrix Composite reinforced with particulate Boron Carbide. Also characterization of the produced MMCs presented in the survey clearly shows the advantage of modified properties of these composites and that's why newer and newer applications of these materials will come to fore in the future.

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