CHARACTERIZATION OF B4C REINFORCED ALUMINIUM HYBRID NANO COMPOSITES

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ABSTRACT

Aluminium is a material which has an exclusive advantage of light weight and high thermal conductivity which can be improved by reinforcing aluminium with various composites (viz) zinc, Magnesium and Copper which are the major constituents of Al7075 series. The Al7075 alloy is primarily used in Marine, Automotive and Aerospace areas and also as frames for such transport applications due to their improved strength, stiffness and wear resistance properties. At the same time, Al7075 alloy has lesser corrosion resistance than other Aluminium alloys.

The present work focuses on the study of change in the properties of Aluminium Al7075 reinforced with various weight percentage of boron carbide (B_4C) particles by conventional stir casting route. The percentage of B_4C reinforcement is varied as 3wt. %, 6wt. % and 9wt. %. The Wear test and mechanical properties of the fabricated aluminium metal matrix composites are investigated. Optical Micrographs showed uniform distribution of B_4C in the Aluminium matrix. The mechanical properties such as ultimate tensile strength and hardness have improved at the cost of reduction in ductility with increase in weight percentage of boron carbide particulates in the aluminium metal matrix.

Keywords: Aluminium metal matrixs, Reinforcement,AI7075, wear test, Conventional stir casting, percentage of reinforcement.

INTRODUCTION

Composites exist in nature. A piece of wood is a composite, with long cellulose fibres held together by a substance called lignin. Composite materials are formed by combining two or more materials that have quite different properties and they do not dissolve or blend into each other. The different materials in the composite work together to give the composite unique properties.

Following the industrial revolution, synthetic resins started to take a solid form by using polymerisation. In the 1900s this new-found knowledge about chemicals led to the creation of various plastics such as polyester, phenolic and vinyl. Synthetics then started to be developed, Bakelite was created by the chemist Leo Baekeland. The 1930s was an incredibly important time for the advancement of composites. Glass fibre was introduced by Owens Corning who also started the first fibre reinforced polymer (FRP) industry. The resins engineered during this era are still used to this day and in 1936, unsaturated polyester resins were patented. The first carbon fibre was patented in 1961 and then became commercially available. Then, in the mid-1990s, composites were starting to become increasingly common in manufacturing and construction due to their relatively cheap cost compared to materials that had been used previously.

A composite material is basically composed of three phases:

matrix phase which is also called as continuous phase,

filler/reinforcement phase which is

surrounded by matrix material,

Interface phase with different structures and properties from matrix and filler/reinforcement phase.

The performance and properties of composite materials is directly affected by interaction and composition of these three phases.

Weight saving is one of the main reasons for using composite materials rather than conventional materials for components. While composites are lighter they can also be stronger than other materials, for example, reinforced carbon-fibre can be up to five times stronger than 1020 grade steel and only one fifth of the weight, making it perfect for structural purposes.

Another advantage of using a composite over a conventional type of material is the thermal and chemical resistance as well as the electrical insulation properties. Unlike conventional materials, composites can have multiple properties not often found in a single material.

Composite materials are generally used for buildings, bridges, and structures such as boat hulls, swimming pool panels, racing car bodies, shower stalls, bath tubs, storage tanks, imitation granite, cultured marble sinks and counter parts.

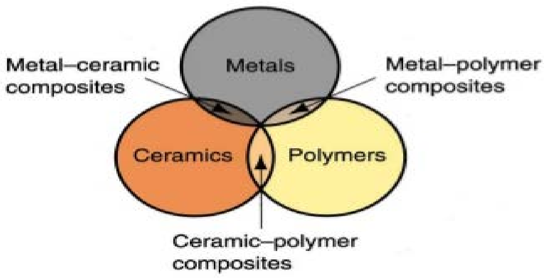

Figure: 1.1 Composite

TYPES OF COMPOSITES

There are three main types of composite matrix materials:

Ceramic matrix composite: Ceramic spread out in a ceramic matrix. These are better than normal ceramics as they are thermal shock and fracture resistant

Metal matrix composite: A metal spread throughout a matrix

Polymer matrix composite: Composites based on macromolecular substances (reinforced polymers)

Some common composite materials include:

Reinforced concrete: Concrete strengthened by a material with high tensile strength such as steel reinforcing bars

Glass fibre reinforced concrete: Concrete which is poured into a glass fibre structure with high zirconia content

Translucent concrete: Concrete which encases optic fibres

Engineered wood: Manufactured wood combined with other cheap materials. One example would be particle board. A speciality material like veneer can also be found in this composite

Plywood: Engineered wood by gluing many thin layers of wood together at different angles

Engineered bamboo: Strips of bamboo fibre glued together to make a board. This is a useful composite due to the fact it has higher compressive, tensile and flexural strength than wood

Parquetry: A square of many wood pieces put together often out of hardwood. It is sold as a decorative piece

Wood-plastic composite: Either wood fibre or flour cast in plastic

Cement-bonded wood fibre: Mineralized wood pieces cast in cement. This composite has insulating and acoustic properties

Fibreglass: Glass fibre combined with a plastic which is relatively inexpensive and flexible

Carbon Fibre reinforced polymer: Carbon fibre set in plastic which has a high strength-to-weight ratio

Sandwich panel: A variety of composites that are layered on top of each other

Composite honeycomb: A selection of composites in many hexagons to form a honeycomb shape.

Papier-mache: Paper bound with an adhesive. These are found in crafts

Plastic coated paper: Paper coated with plastic to improve durability. An example of where this is used is in playing cards

Syntactic foams: Light materials created by filling metals, ceramics or plastics with micro balloons. These balloons are made using either glass, carbon or plastic.

CERAMIC MATRIX COMPOSITES

Ceramic matrix composites (CMCs) are a subgroup of composite materials. They consist of ceramic fibers embedded in a ceramic matrix, thus forming a ceramic fiber reinforced ceramic (CFRC) material. The matrix and fibers can consist of any ceramic material. CMC materials were designed to overcome the major disadvantages such as low fracture toughness, brittleness, and limited thermal shock resistance, faced by the traditional technical ceramics.

Literature Review

S. Nallusamy, S. Saravanan worked on "Experimental analysis on reinforced aluminium metal matrix with boron carbide, graphite and fly ash chemical composites". This study shows that the percentage of B4C, Gr and fly ash has a direct relation with hardness and increase in addition of B4C, Gr and fly ash restricts the deformation of the matrix material and improve the hardness. From the experimental results, it was found that B4C at 3wt%/Gr at 5wt%/ fly ash at 8wt% composite specimen has shown better results than other two composition specimens and may suggest for automobile industries.

Zeeshan Ali,M D Umar published a research paper on "Characterization of aluminium-7075 reinforced with boron carbide (B4C) synthesized by stir casting". The paper is the result of investigations made on microstructure and mechanical behavior of Al7075 and Al7075-4% B4C. The analysis disclosed hardness, ultimate tensile strength, and yield strength of composites increased due to addition of reinforcements.

P. Sri Ram Murthy published a research paper on "Evaluation of Mechanical Properties of Aluminum Alloy-Alumina-Boron Carbide Metal Matrix Composites". This paper attempts to review the different combination and configuration of reinforcing materials used in processing of hybrid aluminum matrix composites and how it effects the mechanical, corrosion and wear performance of the materials. Finally it proposes that the fabrication of hybrid metal matrix composites results in advancement of mechanical properties such as low density, mechanical compatibility, high elastic modulus, low thermal expansion, high compression and tensile strength etc.

T. Vignesh, T. Shanmugam worked onAnalysis of aluminium Al7075 composites reinforced with Boron Carbide (B4C). This research article shows that the Aluminium MMC containing SiC (upto 8%), B4C

(upto 8%), and Al2O3 (upto 4%) has been found to have better hardness, lowest wear rate than Aluminium metal and other Aluminium Composites irrespective of the increase in load for atime period of 360 seconds.SEM images of the metal matrix composites containing various reinforcements at various weight percentages are obtained and it is observed that the B4C, SiC, & Al2O3 particles are homogeneously dispersed through the metal matrix of the aluminium composites. From this it can be inferred that the properties of the composites are improved due to the equivalent dispersion of reinforcement particles in the base alloy.

Mohammed Imranpublished an article on "Characterization of Al-7075 metal matrix composites: a review". Appreciable improvements in mechanical properties were observed by addition of various wt. % of ceramics particles reinforcing in aluminum alloys. Addition of silicon carbide, alumina, barium chloride, etc. reinforced particles in aluminum increases the tensile strength, hardness, yield strength, compressive strength, flexural strength, whereas ductility is decreased. Addition of graphite as reinforcement in aluminum alloy improves the tensile strength, ductility and elastic modulus whereas hardness is decreased. Also tribological behavior of such AMMCs shows decreased coefficient of friction with increase in wt. % of Gr particles. The extensive review found that the addition of industrial waste organic reinforcement materials fly ash, rice husk ash and coconut shell ash which significantly improves the physical and mechanical properties of AMMCs.

SUDHAKAR, MADHUSUDHAN REDDY, K. SRINIVASA RAOworked onBallistic behavior of boron carbide reinforced AA7075 aluminium alloy using friction stir processing – An experimental study and analytical approach. In this work an attempt also has been made to validate the analytical results with the experimental findings. Increase in ballistic efficiency may be attributed to the frictional characteristics of armor surface and projectile, which favors the damage to the surface of the projectile tip by abrasive action of harder (B4C) particles on the target and leads to the macro-deformation and breaking of the projectile tip. Analytic approach to estimate the penetration depth has been done for the first time and the results obtained are closer to the experimental finding. Variation in the findings may be accounted to the assumptions of considering the isotropic nature of target, and the shear strength is obtained on hardness data.

Mohit Kumar Sahu, Raj Kumar Sahu workedIn this study, Al 7075/B4C/Fly-Ash hybrid aluminium matrix composites (HAMCs) with constant weight fraction of fly-ash (2 wt.%) and different weight fractions of boron carbide (2,4,6 and 8wt.%) have been successfully synthesized by stir casting technique. The internal structure and incorporation of fly ash and boron carbide of casted composites were observed using optical micrographs and found the homogeneous distribution of reinforcement particles. The coefficient of variations of micro-hardness values was calculated at seven local points of hardness specimen and found very low value of the coefficient of variation (less than 3%), which confirms uniform hardness values as well as uniform dispersionof reinforcements throughout the composite.

Balasubramani Subramaniam worked on a research paper“Investigation on mechanical properties of aluminium 7075 - boron carbide - coconut shell fly ash reinforced hybrid metal matrix composites”. This research work reports the fabrication and evaluation of the mechanical properties of hybrid aluminium matrix composites (HAMC). Aluminium 7075 (Al7075) alloy was reinforced with particles of boron carbide (B4C) and coconut shell fly ash (CSFA). Al7075 matrix composites were fabricated by stir casting method. The samples of Al7075 HAMC were fabricated with different weight percentages of (0, 3, 6, 9 and 12wt.%) B4C and 3wt.% of CSFA. The mechanical properties discussed in this work are hardness, tensile strength, and impact strength. Hardness of the composites increased 33% by reinforcements of 12wt. % B4C and 3wt. % CSFA in aluminium 7075 alloy. The tensile strength of the composites increased 66% by the addition of 9wt. % B4C and 3wt.% CSFA in aluminium 7075 alloy. Further addition of reinforcements decreased the tensile strength of the composites. Elongation of the composites decreased while increasing B4C and CSFA reinforcements in the matrix.

Nishant Verma,S.C.Vettivelpublished a research paper “Characterization and experimental analysis of boron carbide and rice husk ash reinforced AA7075 aluminium alloy hybrid composite”. This paper investigates the mechanical behavior of AA 7075-B4C-Rice Husk Ash (RHA) hybrid composite. The samples AA 7075 and 5 wt. % of B4C along with 3, 5 wt. % of RHA are prepared by using the Stir Casting technique. The Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) analysis are used to characterize the prepared AA7075 hybrid composite. The mechanical behaviors hardness tensile and compression are tested using their ASM standards. The fractured samples are studied using SEM. The data obtained from various test are quantitative. The hardness is higher for AA 7075-5 B4C-5RHA. The highest hardness is 121 HV at 5 wt. % of B4C and 5 wt. % of RHA. The highest tensile strength is 260MPa at 5 wt. % of B4C. The highest compression strength is 563MPa at 5 wt. % of B4C and 5 wt. % of RHA in hybrid composite. The obtained data are analyzed on Design Expert version V.10 using two levels factorial design. The regression equations obtained from the software is validated using diagnosis plots and the optimized values of reinforcements are obtained using the desirability analysis.

C. Kannan, R. Ramanujamworked on a Comparative study on the mechanical and microstructural characterisation of AA 7075 nano and hybrid nanocomposites produced by stir and squeeze casting In this research work, a comparative evaluation on the mechanical and microstructural characteristics of aluminium based single and hybrid reinforced nanocomposites was carried out. The manufacture of a single reinforced nano composite was conducted with the distribution of 2 wt.% nano alumina particles (avg. particle size 30–50 nm) in the molten aluminium alloy of grade AA 7075; while the hybrid reinforced nanocomposites were produced with of 4 wt.% silicon carbide (avg. particle size 5–10 µm) and 2 wt.%, 4 wt.% nano alumina particles. Three numbers of single reinforced nanocomposites were manufactured through stir casting with reinforcements preheated to different temperatures viz. 400 °C, 500 °C, and 600 °C. The stir cast procedure was extended to fabricate two hybrid reinforced nanocomposites with reinforcements preheated to 500 °C prior to their inclusion. A single reinforced nano composite was also developed by squeeze casting with a pressure of 101MPa. Mechanical and physical properties such as density, hardness, ultimate tensile strength, and impact strength were evaluated on all the developed composites. The microstructural observation was carried out using optical and scanning electron microscopy. On comparison with base alloy, an improvement of 63.7% and 81.1% in brinell hardness was observed for single and hybrid reinforced nanocomposites respectively. About 16% higher ultimate tensile strength was noticed with the squeeze cast single reinforced nano composite over the stir cast.

METAL MATRIX COMPOSITES

Metal matrix composites (MMCs) are composite materials that contain at least two constituent parts – a metal and another material or a different metal. The metal matrix is reinforced with the other material to improve strength and wear. Where three or more constituent parts are present, it is called a hybrid composite. In structural applications, the matrix is usually composed of a lighter metal such as magnesium, titanium, or aluminum. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common.

Typical MMC's manufacturing is basically divided into three types: solid, liquid, and vapor. Continuous carbon, silicon carbide, or ceramic fibers are some of the materials that can be embedded in a metallic matrix material.

Composition

MMCs are made by dispersing a reinforcing material into a metal matrix. The reinforcement surface can be coated to prevent a chemical reaction with the matrix. For example, carbon fibers are commonly used in aluminium matrix to synthesize composites showing low density and high strength. However, carbon reacts with aluminium to generate a brittle and water-soluble compound Al_4C_3 on the surface of the fibre. To prevent this reaction, the carbon fibres are coated with nickel or titanium boride.

Matrix

The matrix is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. 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 matrices are common.

Reinforcement

The reinforcement material is embedded into a 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 can be either continuous, or discontinuous. Discontinuous MMCs can be isotropic, and can be worked with standard metalworking techniques, such as extrusion, forging, or rolling. In addition, they may be machined using conventional techniques, but commonly would need the use of isualized line diamond tooling (PCD).

Continuous reinforcement uses monofilament wires or fibers such as carbon fiber or silicon carbide. Because the fibers are embedded into the matrix in a certain direction, the result is an anisotropic structure in which the alignment of the material affects its strength. One of the first MMCs used boron filament as reinforcement. Discontinuous reinforcement uses “whiskers”, short fibers, or particles. The most common reinforcing materials in this category are alumina and silicon carbide.

Residual stress

MMCs are fabricated at elevated temperatures, which is an essential condition for diffusion bonding of the fiber/matrix interface. Later on, when they are cooled down to the ambient temperature, residual stresses (RS) are generated in the composite due to the mismatch between the coefficients of the metal matrix and fiber. The manufacturing RS significantly influence the mechanical behavior of the MMCs in all loading conditions. In some cases, thermal RS are high enough to initiate plastic deformation within the matrix during the manufacturing process.

ALUMINIUM METAL MATRIX COMPOSITES

Aluminium alloy-based metal matrix composites (AMMCs) have been by now established themselves as a suitable wear resistant material especially for sliding wear applications. Different ceramic materials that are generally used to reinforce aluminum alloys in MMCs are SiC, TiC, ZrC, TiB2, ZrB2, AlN, Si3N4, Al2O3, B4C, SiO2, Al4Mo, Al3Ti and Al3Zr. The combined effect of reinforcements on Aluminium Metal Matrix composites with individual and multiple particulate reinforcements like Hybrid Metal matrix composites are finding increased applications in aerospace, automobile, space, underwater, and transportation applications. This is mainly due to improved mechanical properties like strength, stiffness, abrasion, impact resistance and wear resistance.

SILICON CARBIDE REINFORCED AMC

With the increase in reinforcement ratio, tensile strength, hardness and density of Al MMC material increased, but impact toughness decreased. 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. The modulus, strength and the ductility of the two composite microstructures decreased with an increase in temperature. The degradation in cyclic fatigue life was more pronounced for the under-aged microstructure than the peak-aged microstructure Also, for a given ageing condition, increasing the load ratio resulted in higher fatigue strength.

Polymethylsiloxane (PMS) was used as a binder. A polymer content of 1.25 wt. % conferred sufficient stability to the preforms to enable composite processing. It is thus shown that the PMS- derived binder confers the desired strength to the Sic preforms without impairing the mechanical properties of the resulting Al/Sic composites. In the performance of stir casting Al2O3 and Sic reinforced metal matrix composite material, the result showed that the composite materials exhibit improved physical and mechanical properties, such as low coefficient of thermal expansion as low as 4.6x10 -6 / C, high ultimate tensile strength up to 23.68%, high impact strength and hardness. The composite materials can be applied as potential lightweight materials in automobile components. Experimentally it is found that with addition of Al- SiC reinforcement particles, the composite exhibited lower wear rate compared toAl-Al2O3 composites. The study of Effects of Particle Clustering on the flow behaviour of SiC particle reinforced Al MMCs. The results revealed that during the tensile deformation, the particle clustering has greater effects on the mechanical response of the matrix than the elastic response and also the plastic deformation is affected very much. ALUMINIUM OXIDE REINFORCED AMC

In the Investigation of the effect of Al2O3 in Aluminium for volume fractions varying from 5-30% and found that the increase in volume fraction of Al2O3 decreased the fracture toughness of the MMC. This is due to decrease in inter-particle spacing between nucleated micro voids. The high cycle fatigue behaviour of 6061 Al-Mg-Si alloy reinforced Al2O3 microspheres with the varying volume fraction ranging between 5% and 30%. They found that the fatigue strength of the powder metallurgy processed composite was higher than that of the unreinforced alloy and liquid metallurgy processed composite. In the fabrication of the Al2O3 particle reinforced 2024 Al alloy composites by vortex method and studied the mechanical properties and found the optimum conditions of the production process with a pouring temperature of 700 C, preheated mold temperature of 550 C, stirring speed of 900 rev/min, particle addition rate of 5 g/ min, stirring time of min and with a applied pressure of 6Mpa. The wettability and the bonding between Al alloy/Al2O3 particles were improved by applied pressure but porosity will be decreased by this pressure. In the orthogonal cutting tests to study the effect of cutting parameters and particulate properties on the micro-hardness variations on the machined Al2O3 particulate reinforced AMC. They found that the micro hardness is higher near the machined surface layer. Micro-hardness variations were higher for low volume fraction and coarse particles.

STIR CASTING

Stir casting is an economical process for the fabrication of aluminum matrix composites. There are many parameters in this process, which affect the final microstructure and mechanical properties of the composites.

In this process, the matrix material is heated to above its liquids temperature so that the metal is totally melted .The melt is then cooled down to a temperature between the liquids and solidus points and kept in a semi solid state. At this stage, the preheated particles are added and mixed. The two-step mixing process has been used in the fabrication of aluminium. Among all the well-established metal matrix composite fabrication methods, stir casting is the most economical. For that reason, stir casting is currently the, most popular commercial method of producing aluminium based composites.

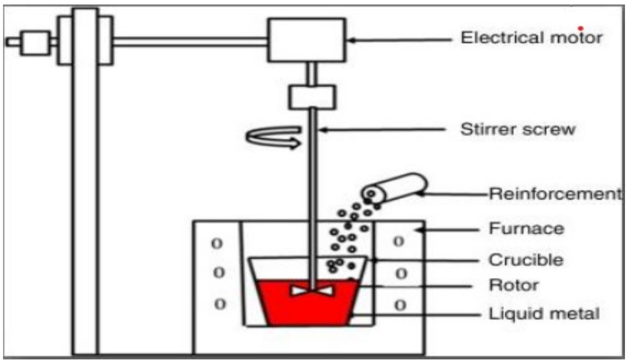

Fig 1.2

MATERIAL SELECTION AND PREPARATION

MATERIALS USED IN PREPARATION OF COMPOSITE

Base metal: Aluminium 7075

Reinforcement: Boron Carbide

Properties of Al 7075

PROPERTIES	Al7075
Density (g/cm3)	2.8
Tensile strength (Mpa)	572
Compressive strength (Mpa)	572
Melting point (°c)	635
Thermal conductivity (W/mK)	130
Young’s Modulus (Gpa)	72

COMPOSITION OF ALUMINIUM 7075

Composition of base metal

COMPOSITION	WEIGHT (%)
Zn	6.886
Cu	1.561
Mg	1.605
Si	0.035

Fe	**0.830**
Cr	**0.092**
Ti	**0.049**
Mn	**0.023**
Li	**0.041**
Al	**Remaining**

PROPERTIES OF BORON CARBIDE

The Chemical formula of Boron carbide is B4C and it falls under third hard material category. First and second are diamond followed by cubic boron nitride.

Properties of B4C

PROPERTIES	**B4C**
Density (g/cm3)	**2.52**
Melting point (°c)	**2445**
Thermal conductivity (W/mK)	**30 – 42**
Young's Modulus (Gpa)	**450 - 470**
Fracture Toughness (MPa. m-1/2)	**2.9 - 3.7**
Hardness (kg.mm-2)	**2900 - 3580**

SPECIMEN COMPOSITION

The specimens were prepared with various weight percentages of Boron Carbide (3%, 6% & 9%). Boron carbide is known as a robust material having high hardness, high cross section for absorption of neutrons (i.e. good shielding properties against neutrons), stability to ionizing radiation and most chemicals. Therefore, the weight Percentage of Boron Carbide is varied. Generally, the reinforcement weight percentage in metal matrix composite such as Aluminium is kept below 10% and rarely more than 10%. Hence the weight percentage of Boron Carbide reinforcement is varied as 3%, 6%, 9%.

Test matrix (Weight Percentage)

S. No	**Al 7075**	**B4C**
1.	**95%**	**3%**
2.	**92%**	**6%**
3.	**89%**	**9%**

SPECIMEN GEOMETRY

4.5.1 IMPACT STRENGTH

The mechanical and physical testing of composite materials can be done by various tests. Chapry impact test provide an easier alternative .The standard charpy impact test specimen is of dimensions 55mm*10mm*10mm .In Charpy test the composite material in the form of a beam, with or without a notch at its mid-length supported by the pendulum. As pendulum swings it impacts and breaks the specimen from which the amount of energy required for fracture can be determined

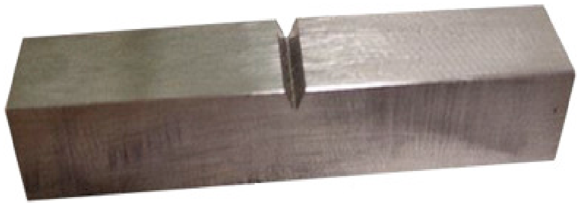

Fig 4.1 Impact strength specimen

WEAR TEST

A Pin-on-disc testing machine was used to investigate the dry sliding wear conducted wear behaviour of AL7075 MMC composite specimens.The mode of wear in the as-received Al 7075 and surface composite layer is both adhesive and abrasive.The rate of wear increased with increasing sliding distance in as-received Al mainly because of increased coefficient of friction

CORROSION TEST

Corrosion test was conducted by immersing the specimen in 3.5% Nacl solution for duration of 24 hrs. The corrosion test reveals that corrosion rate decreases with increase in b4c particulates at different exposure time.

Preparation of Aluminium - B4C Metal Matrix composite by Stir casting method

The Aluminium 7075 rod was cut into small pieces and made ready for the casting. The stir casting was used in this processes the stir casting is the simplest and the most cost-effective method of liquid state fabrication. The furnace used in this process was Electrical heating Furnace. The furnace temperature was raised to 650oC. Then the Aluminium pieces of 1.2kg was placed in the furnace and kept undisturbed for 30 minutes. Reinforcement particles with required weight percentage were preheated at 350◦C temperature for about 5 minutes in order to remove moisture or any other gases present within reinforcement. After 30 minutes, the Al 7075 became liquid form, then the reinforcements were added to the Al7075. Then, the mixture was stirred using a mechanical stirrer at a speed of 600 rpm for 10 minutes. Then the casting was poured in the cylindrical die and left for 30 minutes to cool. The cast product was machined to the dimensions required for Tensile strength, Micro-hardness and Microstructure testing and as per the ASTM standard.

Synthesizing of composite

shows the synthesizing of the metal matrix composite by stir casting

composite cast product shows the composite cast product.

IMPACT STRENGTH TEST:

Impact toughness indicates toughness of a material using the value of impact energy absorbed by the material during fracturing under impact.Material impact toughness can be measured by various types of test such Charpy impact test, which gives an indication of the toughness of material at a specified temperature.

CHARPY IMPACT TEST:

The Charpy test is similar to Izod test. In Charpy test the composite material in the form of a beam, with or without a notch at its mid-length supported by the pendulum. As pendulum swings it impacts and breaks the specimen from which the amount of energy required for fracture can be determined.The energy absorbed by the specimen is determined precisely by measuring the decrease in motion of the pendulum.The important factors that affects the toughness of a material include low temperature, high strain rates(by impact or pressurization), and stress concentrators such as notches, cracks and voids.

WEAR TEST:

Aluminum based lightweight materials have a significant attraction in various industries, such asaircraft, automobile, and armor, for improving fuel efficiency and reducing CO2emissions throughweight reduction of interior parts and body components . However, it is hard to apply Al alloysdirectly in harsh working environment parts, such as engine blocks, powertrains, and braking systems,due to their relatively low strength and modulus and poor wear properties at elevated temperatures.Ceramic particulate reinforced Al matrix composites (AMCs) provide a high strength to weightratio, superior physical properties, thermal stability, good wear resistance, and other mechanicalproperties . Moreover, the specific structural characteristics of AMCs affect the mechanicalproperties of composites . Among the various ceramic materials, B4C particulate is known as apromising reinforcement due to its high hardness, low density, and excellent thermal and chemicalstability. A high-volume fraction (>40%) of B4C reinforced AMC possesses a higher hardness and compressive strength than that of AMCs with a lower volume fraction (<30%).

The mode of wear in the as-received Al 7075 and surface composite layer is both adhesive and abrasive.The rate of wear increased with increasing sliding distance in as-received Al mainly because of increased coefficient of friction.

Al7075 alloy as a matrix and B4C powder as reinforcements were used to fabricate AMCs through the liquid press processing. The B4C particles with a 5 and 40μm size were mixed together at a 1:1 weight ratio.After mixing, an Al7075 plate and the mixed B4C particles were inserted into the steel mold,and then the temperature was elevated up to 800◦C under a low vacuum atmosphere. After the Alalloys melted, the mold was pressed in the mechanical press, and then, the pressing pressure wasmaintained until the temperature decreased under the solidus of Al7075. After the mold had cooleddown completely, the composite was extracted and processed into specimens.

Wear tests were conducted by using pin on disc apparatus to evaluate the tribological behaviour of the composite and to determine the optimum content of B4C for its minimum wear rate.The wear mass loss was found to decrease with increasing sliding distance. The mechanical properties of the composites and base alloy were tested. The mechanical properties decrease with increasing B4C content as compared to base alloy. The presence of wt.% in the composites can exhibit superior wear property as compared to base alloy

The test results showed increasing hardness of composites compared with the base alloy because of the presence of the increased ceramic phase. The wear resistance of the composites increased with increasing content of B4C particles, and the wear rate was significantly less for the composite material compared to the matrix alloy. A mechanically mixed layer containing oxygen and iron was observed on the surface, and this acted as an effective insulation layer preventing metal to metal contact. The coefficient of friction decreased with increased B4C content and reached its minimum at 10 vol% B4C.

CORROSION TEST:

Corrosion resistance is the parameter that describes the deterioration of intrinsic properties of a material caused by reaction with surrounding environments.The corrosion test of aluminum hybrid composites has been performed as per ASTM B117 salt spray test method. It has been found that aluminum alloys possess high affinity to oxygen and it has been treated as most reactive materials. Owing to its inert and protective characteristics it forms aluminum oxide on the surface of the metal .This is due to the fact that the presence of copper in these materials has superior castability and enhanced mechanical properties compared with others. It is also noted that this phases perform as reduction in oxygen reaction and intensify the oxidation of alloys of aluminum. Due to that the pH has been increased. This leads to disintegration of aluminum alloy matrix throughout surroundings of preferential cathode. This can be overcome by adding suitable.

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SALT SPRAY CHAMBER:

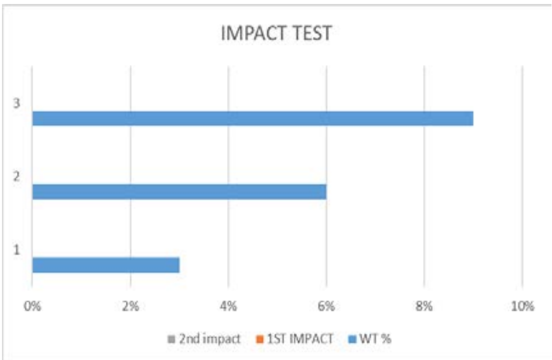
The corrosion tests was carried out in 5 % NaCl mixed with 95% of distilled water The specimen of size 20mm X20mmX 6mm were cut as per ASTM B117M standard and it was polished by 1200 grit size emery sheets. Then the specimen is polished smoothly in the polishing machine using diamond paste. The cut samples were degreased with acetone and then rinsed in distilled water before it gets immersed in the solution. The specimen is then tied in a nylon wire and immersed in the salt spray chamber and it should be closed. The salt water is sprayed continuously for 48hrs and the fog developed inside the chamber. The NaCl reacts with aluminium metal and the white rust forms on the surface. The results were evaluated by weight loss and the corrosion rate was measured by immersing the specimen in an interval of 2 days.

RESULTS AND DISCUSSION

IMPACT TEST:

The toughness value of the alloy and the composites is shown in Fig. 6.1 It is observed that thereis a decrease in toughness due to an increase in the volume fraction of reinforcements.The impact strength in composite materials has slightly reduced due to the presence ofreinforced particles which exhibit brittle nature and act as stress concentration areas. The heterogeneous dispersion of reinforced particles in the matrix results in the formation of clusters which also decreases the matrix-reinforcement bonding and reduces the impact strength of the composites

WT%	3%	6%	9%
1ST IMPACT	2.5J	1.1J	1.2J
2ND IMPCT	3J	1.2J	1.5J



IMPACT TEST RESULT GRAPH

COROSSION TEST:

Salt spray testing is popular because it is relatively inexpensive, quick, well standardized, and reasonably repeatable. Although there may be a weak correlation between the duration in salt spray test and the expected life of a coating in certain coatings such as hot-dip galvanized steel, this test has gained worldwide popularity due to low cost and quick results.

TABLE 6.2 CORROSION TEST RESULTS

SALT SPRAY TEST:

WT%	CORROSION IN Mm/Yr	CORROSION IN Mils/Yr
3%	0.00060709	0.286546268
6%	0.000374491	0.0.1767598
9%	0.000541605	0.255637703

FIG.6.2 SPRAY TEST CHAMBER

The details of the tests, inferences observed and the conclusions arrived are given below. Details of testing parameters:

Humidity : 98% as measured by hygrometer during the test.

Temperature of the test : 33 to 35 Degrees centigrade.

(Continuously indicated).

Pressure of Air for atomizing : 2 to 3 bar continuously by pressure regulator.

Composition of the salt solution : For 1 liter of solution.

5% of Sodium chloride

1% of Magnesium chloride

De-ionized water 94%

PH of the solution : Maintained at 7.5 by addition of buffer solution.

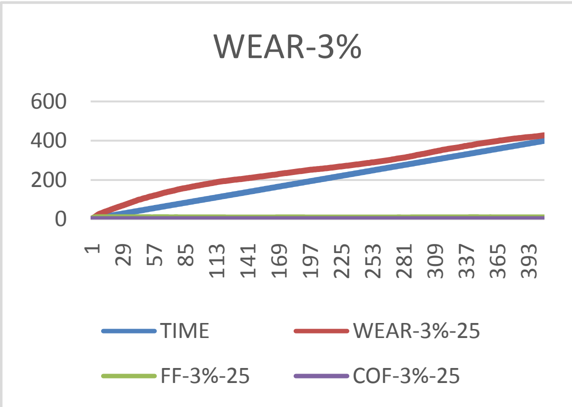
Measurement of pH : Measured once in 8 hours.

Type of loading of specimens : Tied with plastic wire and hung in the hangers.

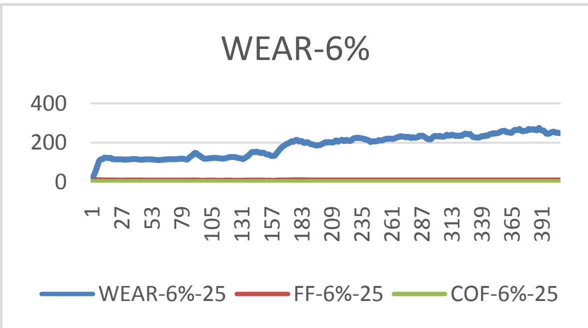
WEAR TEST:A pin-on-disc wear testing machine was usedto investigate the dry sliding wear conducted wear behaviour of the Al 7075 MMC composite specimens

WEAR TESTING MACHINE

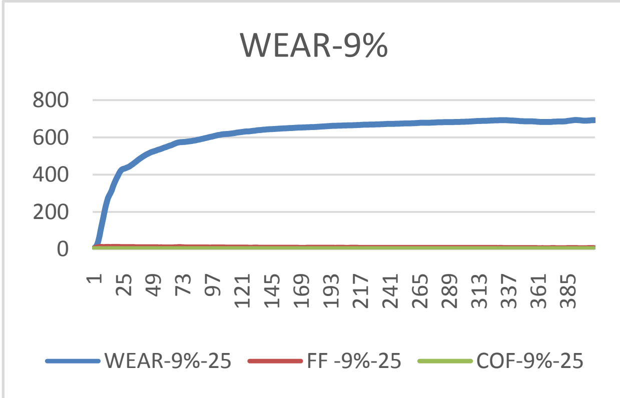
GRAPHICAL REPRESENTATION OF WEAR TEST REULTS:



Representation of wear in 3%B4C reinforced alloy.

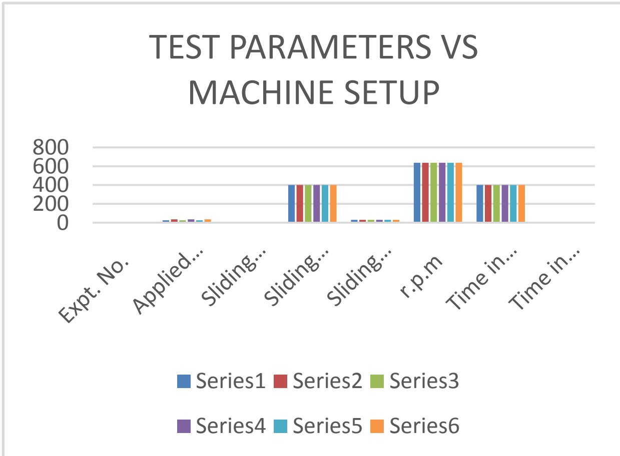


Representation of wear in 6% B4C reinforced alloy.



Representation of wear in 9% B4C reinforced alloy.

TEST PARAMETRS VS MACHINE SETUP.



WEAR TEST RESULTS

% of B4C	Samples	Initial weight g	Final weight g	Wear loss in %	Mean Wear Loss
3%	**1**	**4.153**	**4.147**	**0.144473874**	**0.33539314**
	2	**4.027**	**4.005**	**0.546312391**	
6%	**3**	**4.094**	**4.081**	**0.31753786**	**0.52818258**
	4	**4.217**	**4.185**	**0.758833294**	
9%	**5**	**4.149**	**4.047**	**2.458423717**	**1.65650393**
	6	**4.136**	**4.099**	**0.894584139**	

CONCLUSION

Aluiminium 7075 metal matrix composite with Boron Carbide reinforcements were synthesized using stir casting method. Boron Carbide weight percentage was varied as 3%, 6%, and 9%. Specimens were machined out of the cast product and were tested for Tensile strength and Micro-hardness. Optical micrographs were taken and studied for the distribution of Boron Carbide. From the test results, it is observed that Tensile strength of the composite increases gradually with increase in percentage of B4C. Boron Carbide being a harder particle than Aluminium by nature has resulted in the high tensile strength when the reinforcement of Silicon nitride was increased. The Micro-hardness of composite is increasing with the increase of boron carbide content, which can be recognized to the fact that the boron carbide possess higher hardness and its presence in the aluminium matrix improves the hardness.

Further, from the optical micrograph, it is found that Boron Carbide has been uniformly distributed in the Aluminium matrix and with increase in the percentage of Boron Carbide the uniformity in distribution as well as the density of distribution increased. Further, the micro structure revealed a good interfacial bonding between Aluminium and reinforcement particles. Also, Boron Carbide acts as a better load bearer when compared with Monolithic Aluminium 7075 Alloy

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