A STUDY OF NANO BORON CARBIDE COMPOSITES WITH MECHANICAL PROPERTIES

M. Venkatesan
Research Scholar, Department Of Mechanical Engineering, Sri Satya Sai University of Technology & Medical Sciences, Sehore, M.P., India.

Prof. (Dr.) D. V. Patel
Research Guide, Department Of Mechanical Engineering, Sri Satya Sai University of Technology & Medical Sciences, Sehore, M.P., India.

Abstract: *The investigation additionally demonstrated that the ductility and effect energy of the Nano composites were superior to the miniature B4C molecule strengthened composites. Combination of boron carbide Nano particles by utilizing high energy ball processing and consequently characterization of the integrated Nano particles utilizing AFM, SEM and XRD. A metallic matrix, commonly comprising of light aluminum or magnesium alloys, can be significantly strengthened even by very low weight fractions (~1 wt%) of well-dispersed nanoparticles. This review discusses the recent advancements in the fabrication of metal matrix Nano composites starting with manufacturing routes and different nanoparticles, intricacies of the underlying physics, and the mechanisms of particle dispersion in a particle-metal composite system. Thereafter, the microstructural influences of the nanoparticles on the composite system are outlined and the theory of the strengthening mechanisms is also explained. Finally, microstructural, mechanical, and tribological properties of the selected MMNCs are discussed as well. Micro structural observation revealed uniform distribution of B4C particles in the matrix. The analysis disclosed hardness, ultimate tensile strength, yield strength and compression strength of composites increased due to increase in percentage of Nano boron carbide particles and percentage elongation of the composites decreased with increase in B4C particulates in base alloy matrix.*

Keywords: Nano Boron, Carbide Composites, Mechanical Properties, Nanoparticles, Micro Structural, Microstructural

Introduction

The interest for light weight MMC in auto and different applications has been filling fundamentally in the previous 10 years due to unprecedented properties of the MMC. A yearly utilization development pace of 5.9% is normal till 2013, and the complete utilization will increment from 4.4 million kilograms in 2008 to 5.9 million out of 2013. The expanding development of the MMC market requires refined and advanced innovations for large scale manufacturing of MMC easily and with high productivity. Significantly greater improvement

exercises in MMC, lacking cycle soundness and dependability and deficient monetary effectiveness actually challenges the MMC fabricating industry.

The expanding interest for light weight, modest, energy saving, solid and solid material in airplane, space, safeguard and auto applications has invigorated a consistently developing exertion to created composite material. These days, Metal Matrix Composites (MMCs) are under genuine thought to trade ordinary materials for an enormous number of underlying applications, for example, aeronautical/aviation, transportation, safeguard and sports businesses as a result of their boss properties. The fantastic mechanical properties and nearly ease make them as an alluring choice. In AMCs one of the constituent is aluminium amalgam, is named as matrix stage. The other constituent which is inserted in this aluminium combination matrix is fills in as reinforcement. The reinforcement is normally to be non-metallic and usually clay. The aluminium matrix is getting fortified when it is strengthened with the hard earthenware particles like SiC, Al_2O_3, and B_4C and so forth Aluminium composites are as yet the subjects of exceptional investigations, as their low thickness gives extra focal points in a few applications. These composites have begun to supplant solid metal and bronze to make wear obstruction parts. MMCs fortified with particles will in general offer upgrade of properties prepared by customary courses. A356/LM25 discovers applications in the food, compound, marine, electrical, numerous different ventures and in street transport vehicles where it is utilized for wheels, chamber squares and heads, and other motor and body castings.

Among various types of as of late created composites, molecule strengthened metal matrix composites and specifically aluminium base materials have just arisen as possibility for modern applications. Boron Carbide particulate fortified aluminium composites have a one of a kind blend of high explicit strength, high versatile modulus, great wear opposition and great thermal soundness than the relating non-strengthened matrix compound framework.

A restricted exploration work has been accounted for on AMCs strengthened with B_4C because of higher crude material expense and helpless wetting. B_4C is a strong material having fantastic compound and thermal soundness, high hardness and low thickness (2.52 g/cm3) and it is utilized for assembling projectile evidence vests, protective layer tank and so forth Consequently, B_4C fortified aluminium matrix composite has acquired fascination with ease projecting course.

To make the MMC materials, enormous quantities of creation methods are as of now utilized dependent on the sort of reinforcement. i.e., mix projecting procedure (or compo projecting),

fluid metal invasion, press projecting and splash co-statement. The microstructure is additionally a vital boundary which impacts the properties of the composite.

Broad investigations about the idea of materials with their structure property relationship, helps in creating composite materials with improved mechanical, physical and Degradation properties. Persistent progressions in the field of composite materials make us to comprehend that they are the advanced materials for expanded applications.

In the new year's, cast aluminium composites are broadly utilized in car and other designing applications as chamber blocks, cylinder, cylinder ring, brake plate and drum, because of light weight, erosion obstruction, high thermal conductivity, weakness strength and functionality. Anyway, the uses of aluminium compounds are restricted because of helpless wear and seizure opposition at room and raised temperatures. The interest for light weight, cheap and energy productive Aluminium Metal Matrix Composites (AMCs) has been expanding with multifunctional properties for autos, airplane and different applications. The AMCs is an alluring material because of its low thickness, high hardness, strength, solidness, great consumption opposition and high thermal conductivity. On-going examinations have utilized miniature measured particles to improve the mechanical properties of AMCs. Nonetheless, the helpless ductility and diminished crack strength have restricted the use of miniature estimated earthenware molecule strengthened AMCs. The utilization of nano-sized particles to improve the mechanical properties of the AMCs is appealing in light of the fact that it improves ductility, high temperature creep obstruction, weariness life, wear opposition and break sturdiness. The Nano molecule content expands the mechanical and wear obstruction of the aluminium metal matrix Nano composites (AMNCs). The manufacture of AMNCs by ultrasonic cavitation's-based hardening handling is appealing because of better matrix particle holding, simpler control of matrix structure, effortlessness, economical preparing, adaptability, immaterialness to mass creation and complex shape.

The AMNCs require not just great mechanical strength and high wear obstruction yet in addition self-grease properties. The fuse of two distinctive Nano particles into aluminium matrix has prompted the improvement of crossover Nano composites. Quite possibly the most much of the time utilized self-ointment materials is hexagonal boron nitride strong Nano oil. Accordingly, in this work, B_4C Nano molecule strengthened aluminium Nano composites and Al-B_4C-h-BN half breed Nano composites have been created by ultrasonic cavitation-based cementing handling. The job of the B_4C and h-BN nanoparticles content on the mechanical and

room and high temperature wear conduct of the aluminium composites have been contemplated. One of the upsides of the Al- B_4C-h-BN crossover Nano composites is that they are self-ointment materials containing h-BN strong Nano oil but then their solidarity is improved by the presence of the hard earthenware B_4C Nano particles.

(1) Particulate Composite

The reinforcement is of molecule nature. The state of the reinforcement could be circular, cubic, round and hollow (or) some sporadic shape. Yet, the particulate composite are all in all equiaxed structures. These particulates are not that much powerful in improving the Fracture Resistance. Yet, the improvement in the firmness is seen with particulates. Particulates adjust the mechanical, thermal, Degradation, Machining and electrical properties of the general composite.

The choice of reasonable particulate to a specific application is exceptionally fundamental. Care ought to be taken to dodge shrinkage (or) volumetric contortion when the composite are exposed to openness in different conditions. These sort of Particulate Composites comprise of a matrix wherein the reinforcement of scattered stage in made as particles. They can be further sub-partitioned in to two sorts of classes as follows:

a) Composites with arbitrary direction of particles and
b) Composites with favoured direction of particles. Two dimensional pieces or level platelets of particles are set down corresponding to one another in the scattered period of these sorts of composite materials.

(2) Fibrous Composites

The fibre has the angle Ratio (l/d) more noteworthy than 1. The measurements and direction of the sinewy reinforcement decide the general property of the composites. The break obstruction of the Matrix stage is significantly better with the expansion of stringy reinforcement stage, since the break development which is typical to the reinforcement is debilitate (or) the engendering of breaks gets halted as the sinewy demonstration transporter to the break spread. On the off chance that, of Brittle Matrix stages, the sinewy reinforcements are suggested the Man-made stringy are designed to suit a specific application. The common stringy properties contrast all around i.e., no consistently in appropriately all through the world. A post vault made of bamboos from various locales might not have the uniform properties. So the significance of Man-made sinewy fortified composites substitutes the shaft vault made of common bamboos. The stringy take the heap from the Matrix stage and ensure the Matrix stage

against climate and during dealing with and transportation. The exchange of burden from the Matrix to sinewy is considerably more basic than the heap move from Matrix to particulate.

(3) Laminate Composites

In these cover composites, fibre reinforcements were made into a few layers with various fibre directions and it is likewise called the multilayer composite. The wide arrangement of these composite materials is given in beneath Figure 1.

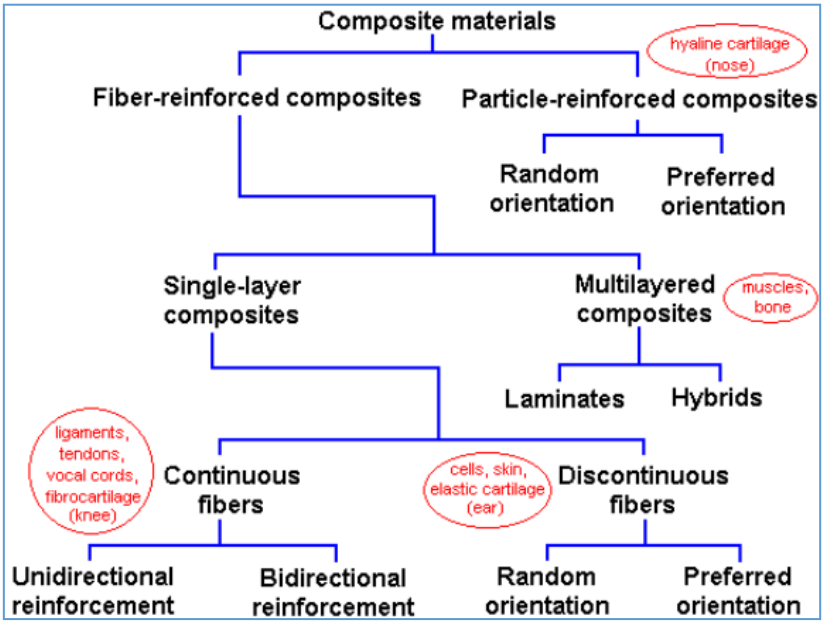

FIGURE 1: Broad classifications of composite materials

In particulate composites, the matrix is fortified by a scattered stage and the constituents are in a strengthening stage that is implanted in a matrix. The strengthening stages are by and large as particles, strands or drops. The significant part of the matrix material is that it will disseminate the pressure through to the reinforcement inside the matrix materials giving the last state of the composite materials.

The mechanical properties were improved by the reinforcement material and subsequently the reinforcement in the matrix would be adjusted in special ways. The volume portion of the reinforcement and the matrix decides the idea of the composite and that the reinforcement material chooses the mechanical nature in the composites. One significant condition during the legitimate utilization of matrix and the reinforcement is that both ought not respond with one another artificially so the physical and compound dormancy isn't upset during reinforcement.

Composite material finds various applications, for example, electrical, biomedical and aeronautic trade because of their higher explicit properties, for example, strength and firmness

when contrasted with that of metals and amalgams. The fundamental design of composite is appeared in Figure 2.

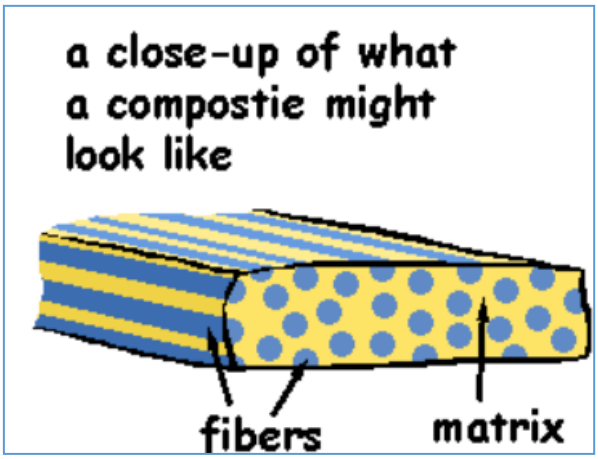

FIGURE 2: Basic structure of composites

Composites are generally made of two sections, a fibre and a matrix. The fibre can be glass, Kevlar, carbon fibre, or polyethylene. The matrix, which is the stuff that holds the strands, is normally a thermos like an epoxy tar. The fibre is implanted in the matrix to make the matrix more grounded. Fibre reinforced composites have two things going for them. They are solid and light. They're frequently more grounded than steel, however gauge significantly less. This implies that composites can be utilized to make cars lighter, so they utilize less fuel. Composites can likewise be utilized to copy normal materials, as in instruments where utilization of wood is normal. However, wood can be costly, for example, in a decent violin, or it tends to be erratic, as in a wood reed for a saxophone or clarinet. Composites made of straight strands encompassed by exceptional epoxy pitches can look and act a ton like wood; they may likewise last more and perform better.

TYPES OF COMPOSITES

There are different sorts of composite dependent on their matrix material. They are as per the following;

(i) Metal Matrix Composites

(ii) Polymer Matrix Composites

(iii) Ceramic Matrix Composites

1 Metal Matrix Composites

Metal matrix composite will be composite material comprising of at least two where custom-made properties are accomplished by methodical mix of various constituents. One is a metal and the other material can be diverse metal or different materials, for example, a fired and natural compound. Metal matrix composites strengthened with clay particulate offer critical favourable circumstances over unadulterated metals and amalgams. Because of the generally simple low thickness, better processibility with great dielectric and mechanical strength polymers were broadly utilized as matrix materials and because of the reinforcements, their weakness increments and the ductility of the Polymer Matrix Composites (PMCs) additionally increments because of these reinforcements.

The materials naturally visible examinations is the way in to the manufacture of better parts and that the materials ought to be homogeneously spread out all through the matrix through blending of the ceramics, metals and polymers. The composites have all these preferred characteristics over their parent compound and can be expanded further by understanding its fundamental physical and synthetic nature.

2 Polymer Matrix Composites

Polymer Matrix Composites (PMCs) have reinforcements (fibres, stubbles or particulates) embedded in a polymer pitch matrix (for instance Polyesters, vinyl esters, PEEK, PPS).

Epoxy (EP), Unsaturated Polyester (UP), or Nylon, Polyvinylchloride, thermoplastic Polycarbonate (PC), Polystyrene is generally used as matrix and dissipated stages are Kevlar fibres, carbon or steel are the key portions of Polymer Matrix Composites. These composites are used in a wide extent of usages from plane plans to office furniture. Among the PMC's Glass Fibre Reinforced Polymer (GFRP) composites find an improved extent of employments from vehicle bodies to compartments.

Epoxy based polymer matrix composites show high fortitude to weight extents which are used in aeronautics and space developments. Besides, a Carbon Fibre Reinforced Polymer (CFRP) composite finds application in games and brandishing sorts of stuff, plane essential parts pressure vessels, Rocket motor cassis. Auto undertakings are eat up extended proportions of PMCs attempting to diminish the greatness of the vehicle weight to improve the fuel efficiencies. Plastic materials-the two Thermoplastics and Thermosetting plastics are used as

Matrix material for polymer Matrix composites with Resin folios. The saps are picked dependent on Thermal electrical compound, Fatigue and Moisture resistance. The sap ought to have strength identical to that of reinforcement effectively in its use and it must with ascend to help conditions. Furthermore, the gum ought to have a fair wettability with the fibres, with the ultimate objective that it should invade into the strands and overhaul the properties of strands.

3 Ceramic Matrix Composites

Ceramic particles, for example, alumina (Al_2O_3) and Silicon Carbide (SiC) are liked for high temperature applications. The silicon Nitride (Si3N4) is utilized in the gas turbine edge by broad gadgets (GE). Since ceramics are fragile in nature, they are poor in strain and shear, however great in pressure. The Matrix is ceramic, with the end goal that the reinforcements ought to be show strands/stubbles. The silicon carbide (SiC) and Boron Nitride (B4N) strands are utilized as filaments/hairs.

In these Ceramic Matrix Composites, the essential matrix is a ceramic material while the installed filaments of other ceramic material are used as scattered or reinforcement stage.

ALUMINIUM MATRIX COMPOSITES

Aluminium is the most well-known matrix for the metal matrix composites because of their great physical and mechanical properties. The aluminium and their combinations are broadly utilized in vehicle businesses as parts of inward ignition motors, for example, chamber blocks, chamber heads and cylinders because of light weight, high solidarity to weight proportion, high thermal conductivity and great erosion obstruction, conceivable to fortify by precipitation (Dinesh Kumar Koli et al. 2015). Aluminium matrix strengthened with constant or spasmodic filaments, hairs, or particles in aluminium and their combinations and gives the necessary properties which are not feasible with solid aluminium compounds. Aluminium and their compounds fortified with ceramic particles are all around called as aluminium matrix composites (AMCs). Particulate fortified AMCs have gotten extensive consideration as a result of their high explicit warmth limit and thermal conductivity just as low thickness, minimal effort, high explicit strength, high solidness, weariness opposition, predominant dimensional stability and isentropic properties. The determination of reinforcement type, size and volume portion is significant to get the best mechanical properties with ease.

1 Aluminium Metal Matrix Nano Composites

Aluminium matrix Composites fortified with ceramic nanoparticulate offer huge execution points of interest over unadulterated aluminium metals and compounds. Aluminium metal matrix nanocomposites (AMNCs) tailor the best properties of the two segments, for example, ductility and durability of the aluminium matrix and high modulus and strength of the reinforcements. These remarkable properties of AMNCs empower them to be potential for various applications, for example, auto, aviation and military businesses. The size of ceramic reinforcement particulates in AMCs m. AMNCs with a fine and uniform dispersion can change from 10nm to 500 m are alluded as aluminium of ceramic particles in the scope of 10nm to 1 metal matrix nanocomposites (AMNCs). The expanding interest for lightweight and elite materials is probably going to build the requirement for AMNCs. The utilization of micron-sized ceramic particulate in aluminium MMC has been restricted in explicit applications, for example, aviation and auto businesses because of helpless ductility and diminished break strength. The ceramic nanoparticles are one of a kind nanostructured material with uncommon mechanical, thermal and electrical properties. SiC, TiC, WC, B_4C, TiB_2, ZrB_2, and Al_2O_3 are probably the most well-known sorts of nano-particles that have been utilized for nanocomposites.

REINFORCEMENTS

The one-of-a-kind properties and uses of strengthened composites involve a noticeable situation of all Fibre Reinforced Polymer (FRP) composite materials. It has helpful useful and dimensional properties that stretch out its applications to different spaces. In the current examination work, Carbon fortified composite material is utilized as work piece. In the new twenty years, cost of crude materials, ecological and legitimate groups has prepared to amalgamation fresher materials for light weight, proficient and savvy items. Generally utilized strands and saps were utilized in mix with glasses, filaments, carbon with many metal matrix composites to frame required light weight and high strength materials.

Reinforcement expands the strength, firmness and the temperature obstruction limit and brings down the thickness of AMNCs. To accomplish these properties the choice relies upon the sort of reinforcement, size, shape, its strategy for creation and substance similarity with the matrix. The accompanying angles should be thought of while choosing the reinforcement material.

- Low thickness
- Mechanical similarity
- Chemical similarity
- Thermal stability
- High Young's modulus
- High pressure and tensile strength
- Good measure capacity
- Economic effectiveness.

FABRICATION OF ALUMINIUM METAL MATRIX NANOCOMPOSITES

The strategy for arrangement of AMNCs has a significant job to achieve an unmistakable interface, deformity free microstructure and homogeneous appropriation of ceramic nanoparticles. The significant detriment of AMNCs generally lies in the moderately significant expense of creation and of the reinforcement materials. The practical handling of nanocomposites is fundamental to grow for their applications. The determination of the handling course relies upon numerous variables including type and level of reinforcement stacking, straightforwardness and practical and the level of microstructural trustworthiness liked.

The manufacture strategies for metal matrix nano composites are appeared in Figure 1.3. The preparing courses for AMNCs could be isolated into ex-situ strategies and in-situ techniques. At the point when the reinforcement is remotely added to the matrix, ex-situ metal matrix nano composite materials are made. In situ incorporating of metal matrix composites includes the creation of reinforcements inside the matrix during the manufacture cycle. The reinforcements created in-situ are generally fine and consistently conveyed, nonetheless, they are not financially savvy and have less chance than ex-situ reinforcements for complex responses included. Ex-situ techniques are typically monetarily productive however the particles will in general agglomerate because of the helpless wet capacity between the matrix and reinforcement. Ex-situ fabricating strategies can be additionally assembled into strong state, fluid state and semi-strong preparing.

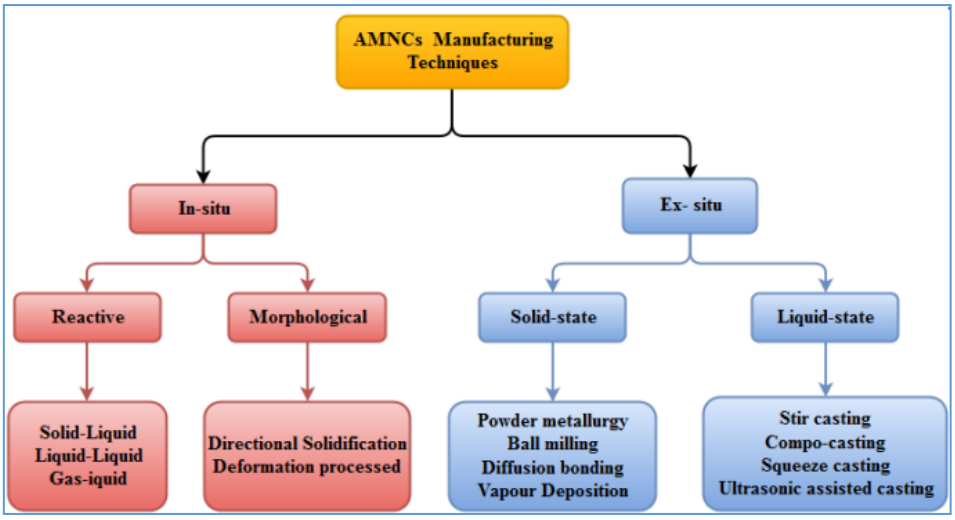

FIGURE 3: Manufacturing methods for aluminium metal matrix nano composites

MECHANICAL PROPERTIES OF THE ALUMINIUM METAL MATRIX NANOCOMPOSITES

1. Tensile Strength and Hardness

The tensile strength is a major mechanical property to give essential plan data on the strength of aluminium matrix composite materials and direct how the material will respond to the power applied in pressure. Tensile tests are utilized to discover the modulus of versatility, flexible cutoff, lengthening, corresponding breaking point, tensile strength, and yield point and yield strength. The tensile strength of aluminium matrix composite material relies upon determination of the reinforcement molecule and a productive holding among matrix and reinforcement. Besides, the reinforcement molecule size is one of the significant variables to improve the tensile strength, hardness and ductility of the composites. The ductility of aluminium matrix composite is a proportion of the degree to which a material will twist before disappointment. The measure of ductility is significant factor for aluminium composites while framing tasks are finished. The customary proportion of ductility of the composite is the designing resist crack and the decrease of territory at break. Aluminium matrix nanocomposites are required to display high tensile strength and crack sturdiness contrasted with their miniature estimated reinforcement particles. The increment in tensile strength and hardness of the aluminium matrix nanocomposites is because of a blend of following elements.

- Lobby Petch relationship
- Orowan reinforcing system
- Thermal befuddle fortifying instrument
- Burden bearing component

2. Impact Toughness

Impact toughness is the capacity of a material to twist plastically and to retain energy in the process without break when stress is applied quickly. It is utilized as quality control strategy to look at the overall toughness of designing materials. The effect toughness of the aluminium composite is dictated by the energy retained in the material before crack. The effect energy esteem is acquired by the noticing down the stature at which the pendulum is delivered and the tallness to which the pendulum swings after it has strike the example. The energy assimilated in material is equivalent to the distinction in possible energy of the pendulum toward the beginning and end of the test. The material with high strength and high ductility will have more toughness than a material with low strength and high ductility.

APPLICATION OF ALUMINIUM METAL MATRIX NANOCOMPOSITES

There is a gigantic requirement for utilization of AMCs because of the unrivaled properties and serious level of multi utilitarian property that they offer. It is seen that by utilizing nano measured ceramic particulates as reinforcement just as hybridization of reinforcement one can tailor and give magnificent properties to AMNCs when contrasted with Al based combination and micron estimated ceramic particulates strengthened AMCs. Different multifunctional properties could be accomplished through fitting choice of ceramic reinforcements in aluminium based nano and mixture composites. AMNCs give serious degree of explicit strength and firmness for underlying applications. Notwithstanding astounding explicit strength and solidness, primary prerequisites applications are high burden bearing strength, high dimensional stability, great effect and disintegration obstruction, protection from consuming and high temperature applications. High thermal conductivity, coefficient of thermal development, high temperature dimensional stability are significant properties for thermal applications like warmth exchangers, car motor segments, sub parts in aviation framework and auto applications, and substrates for PC processor chips. Numerous exactness applications require magnificent protection from twisting that happens because of the blend of mechanical and thermal loads, for example, hard plate drive, space transport fundamental edge,

hubble space telescope radio wire, telescope reception apparatus and fast assembling parts. Wear obstruction is a significant necessity for AMNCs for some applications, for example, cylinder and chamber bore in motor, particularly stopping mechanism segments in car.

The Research today is shining on high strength and Lightweight materials. Aluminum, Magnesium and Titanium goes under this classification. The Monolithic Metals are subbed to by the Metal – Matrix composites, with the end goal that the composite can be custom fitted to suit the specific application, The Al-SiC composites have been created by Duralcan USA, Alcan Aluminium Corporation.

The Timet for Mc Donnell Douglas airplane is made of high temperature, creep-safe Titanium Matrix composite. The Titanium, Silicon carbide discovers application in turbine motor shafts, which is manufactured by hot isostatic-squeezing method.

CERMTEC AG (Germany) built up the uncommon norm. Composite AlSi9CU3, with aluminium as Matrix material. The expense of aluminium is lesser when contrasted with Magnesium and Titanium. However the aluminium based combinations and composite delivered incredibly victories particularly in Automobile and Aerospace applications. The handling property of aluminium amalgams and composite a lot easier than Magnesium and Titanium. The securities estimates must we taken while which projecting Magnesium; else there might be possibility of blast. Titanium is inclined to oxidation in the event that it isn't projected in an idle/vacuum climate. Titanium based materials is utilized in blower advanced of Aeroengine, because of its great killjoy obstruction property. The responding segments in the engines are for the most part made of magnesium. The gudgen pins, cylinders and spring covers are likewise made of Mg-based combinations. The aluminium Sic composites discovers application in rocket direction framework, that supplant certain beryllium based segments, since the beryllium is harmful in nature. The aluminium – Lithium composites are the course of fascination as a result of their great wettability attributes.

CONCLUSION

The examinations on the assessment of microstructure on strengthened aluminium metal matrix composites, causes us to survey the degree of reinforcement of composites on the aluminium grids. The fundamental characteristics expected in the microstructure is the molecule matrix interface, less porosity, uniform molecule circulation and the mechanical properties which depends on the reinforcements of matrix, wettability, amount of and state of strengthening stage

and consequently examinations of microstructure is one of the apparatuses to evaluate the nature of the readied Al-MMCs. Functionality of the composites is its capacity to be moulded to the ideal mathematical design through plastic distortion.

In powder B–10C and B–18C combinations, it was seen the reduction on force of B tops in the wake of milling for 2 h, proposing that the nanometre particle sizes were accomplished and additionally the carbon iotas were part of the way disintegrated into the B grid to begin the formation of supersaturated solid solutions with its significant diffraction point close to the 17.63◦. In the wake of milling for 6 h, comparable construction with significant diffraction points close to the 27.92◦ was shaped in B–10C and B–18C powders. As of now, it is obscure its glasslike structure. In addition, the force of these obscure pinnacles was expanded continuously until ball milling for 90 h. High-energy ball milling delivered fine B–10C and B–18C powder particles less than 1 m with adjusted morphology in the wake of milling for 90 h.

A lot of B_4C was framed in powder B–C blends after warmth treatment at 1200 ◦C for 4 h, however the obscure pinnacles recently shaped during ball milling were additionally found. In addition, its general force was distinctive in warmth treated B–10C and B–18C powders. The accompanying speculations could be utilized to clarify the presence of these obscure pinnacles: (i) to be the B_4C stage with various design from $B_{13}C_2$, (ii) to be a metastable phase partially decomposed during heat treatment under inadequate conditions to obtain equilibrium structures, or (iii) to be another stable phase.AA6061/nano-B_4C_p MMNCs are effectively evolved by ultrasonic cavitation-helped casting course (normal particle size 50 nm). Aftereffects of the optical microscopy demonstrate that the Nano composites show refined matrix grains contrasted with that of unreinforced alloys. The uniform distribution and great dispersion of B_4C_p in the Al matrix is acquired; this can be confirmed by the HRFESEM and TEM pictures. The SEM crack examinations demonstrate that the kind of break saw in the composite microstructure is weak in nature.

REFERENCES

1) Alalkawi, H.J.M.; Aziz, G.A.; Aljawad, H.A. Preparation of new aluminum matrix composite reinforced with hybrid nano reinforcements Fe2O3 and Al_2O_3 via (P/M) route. Int. J. Mech. Eng. Technol. 2019, 10, 2046–2058

2) T H Manjunatha, Dr. Yadavalli Basavaraj,(2018), Investigations on mechanical behavior of Al7075 - nano B4 C composites, IOP Conf. Ser.: Mater. Sci. Eng. 376 012091.

3) Ahmadi, M.; Siadati, M.H. Synthesis, mechanical properties and wear behavior of hybrid Al/(TiO2 + CuO) nanocomposites. J. Alloys Compd. 2018, 769, 713–724.

4) Sekar, K.; Jayachandra, G.; Aravindan, S. Mechanical and Welding Properties of A6082-SiC-ZrO2 Hybrid Composite Fabricated by Stir and Squeeze Casting. Mater. Today Proc. 2018, 5, 20268–20277.

5) Kumar, V.; Sharma, V. Effects of SiC, Al_2O_3 , and ZrO2 particles on the LBMed characteristics of Al/SiC, Al/Al_2O_3, and Al/ZrO2 MMCs prepared by stir casting process. Part. Sci. Technol. 2018, 37, 770–780.

6) Ahmadi, M.; Siadati, M.H. Synthesis, mechanical properties and wear behavior of hybrid Al/(TiO2 + CuO) nanocomposites. J. Alloys Compd. 2018, 769, 713–724

7) Dileep, B.P.; Ravikumar, V.; Vital, H.R. Mechanical and Corrosion Behavior of Al-Ni-Sic Metal Matrix Composites by Powder Metallurgy. Mater. Today Proc. 2018, 5, 12257–12264.

8) Penchal Reddy, M.; Manakari, V.; Parande, G.; Ubaid, F.; Shakoor, R.A.; Mohamed, A.M.A.; Gupta, M. Enhancing compressive, tensile, thermal and damping response of pure Al using BN nanoparticles. J. Alloys Compd. 2018, 762, 398–408.

9) Ubaid, F.; Matli, P.R.; Shakoor, R.A.; Parande, G.; Manakari, V.; Amer Mohamed, A.M.; Gupta, M. Using B_4C nanoparticles to enhance thermal and mechanical response of aluminum. Materials (Basel) 2017, 10, 621.

10) Ghasali, E.; Fazili, A.; Alizadeh, M.; Shirvanimoghaddam, K.; Ebadzadeh, T. Evaluation of microstructure and mechanical properties of Al-TiC metal matrix composite prepared by conventional, microwave and spark plasma sintering methods. Materials (Basel) 2017, 10, 1255.

11) Karwowska, E. Antibacterial potential of nanocomposite-based materials—A short review. Nanotechnol. Rev. 2017, 6, 243–254.

12) Arif, S.; Alam, M.T.; Ansari, A.H.; Siddiqui, M.A.; Mohsin, M. Investigation of Mechanical and Morphology of Al-SiC composites processed by PM Route. IOP Conf. Ser. Mater. Sci. Eng. 2017, 225

13) Liu, G.; Wang, Q.; Liu, T.; Ye, B.; Jiang, H.; Ding, W. Effect of T6 heat treatment on microstructure and mechanical property of 6101/A356 bimetal fabricated by squeeze casting. Mater. Sci. Eng. A 2017, 696, 208–215.

14) Kannan, C.; Ramanujam, R. Comparative study on the mechanical and microstructural characterisation of AA 7075 nano and hybrid nanocomposites produced by stir and squeeze casting. J. Adv. Res. 2017, 8, 309–319.