A REVIEW PAPER ON STUDY OF ALUMINIUM (AL-6061) METAL MATRIX COMPOSITE

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Abstract- Metal Matrix Composites (MMCs) are developed to satisfy the demand for lighter materials with high specific strength, stiffness and wear resistance. Aluminum matrix composites (AMCs) area unit rising as advance engineering materials because of their strength, malleability and toughness. Their ability to be created by standard strategies adds to the advantage. The metallic element matrix is often reinforced by reinforcing with onerous ceramic particles like SiC, Al_2O_3 and B_4C etc. Even handed choice of the variables is important to optimize the properties of composites. The form and size of reinforcement particles and matrix composition need to be fastidiously chosen. In the present review study, an effort is made to get known with the enhancement of the mechanical properties like tensile strength, hardness, wear and corrosion resistance of AMCs by reinforcing 6061Al matrix with hard ceramic particles. There are various routes, which can be used for reinforcement of 6061Al matrix, like Stir casting, Compo-casting, Squeeze casting, Spray casting, etc. Stir casting route is most widely used for production of MMCs. The microstructure and mechanical properties of the fabricated AMCs are analyzed. The optical microstructure images reveal the homogeneous dispersion of reinforced particles in the matrix. The reinforcement dispersion was conjointly been known with X-Ray Diffraction (XRD). The mechanical properties were found to extend with the production of ALMMC.

Keyword: - Aluminum metal matrix composite (Al MMCs), Boron carbide, stir casting

1. INTRODUCTION: -

A material in which a continuous metallic phase (the matrix) is combined with another phase (The reinforcement) to strengthen the metal and increase high-temperature stability is Metal matrix composite (MMCs). Standard monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. To beat these shortcomings and to satisfy the ever-increasing demand of contemporary technology, composites are most promising materials of recent interest.

Metal matrix composites (MMCs) possess considerably improved properties as well as high specific strength; specific modulus, damping capability and smart wear resistance compared to unreinforced alloys. MMCs area unit finding increasing use in automotive applications and this has increased concern regarding their corrosion resistance.

Generally, MMCs show a lot of higher corrosion rates than the matrix materials because of galvanic corrosion between the matrix and also the reinforcements. Metal matrix composites (MMCs) are light-weight structural materials employed in a little variety of craft, helicopters and space vehicle. MMCs materials contains arduous reinforcing particles embedded inside a metal matrix part. The matrix of MMCs is sometimes a low-density metal alloy (e.g., aluminum, Mg or titanium). The metal alloys employed in craft structures, such as 2024 Al, 7075 Al and Ti–6Al–4 V, area unit well-liked matrix materials for several MMCs. Nickel superalloys could also be used because the matrix innovate MMCs for high-temperature applications. The metal matrix part is reinforced victimization ceramic or metal chemical compound within the style of continuous fibers, whiskers or particles. chemical element (or borsic, a Sic-coated boron), carbon and chemical element carbide (Sic) area unit usually used as continuous fiber reinforcement, and these area unit distributed through the matrix part. carbide, aluminum oxide (Al2O3) and chemical element inorganic compound (B4C) area unit popular particle reinforcements.

The maximum volume content of reinforcement in MMCs is usually below 30%, that is under the fiber content of region carbon–epoxy composites (55–65% by volume). Reinforcement contents on top of concerning 30% aren't typically used thanks to the issue in process, forming and machining of the MMC thanks to high hardness and low malleability. 6061Al is kind of a preferred selection as a matrix material to arrange MMCs thanks to its higher formability characteristics. Among totally different styles of the recently developed composites, particle strengthened metal matrix composites and especially aluminum base materials have already emerged as candidates for industrial applications 6061Al is extensively utilized in various engineering applications together with transport and construction wherever superior mechanical properties like enduringness, hardness, etc. It has sensible mechanical properties, exhibits sensible weldability, and is extremely usually extruded (second in quality solely to 6063). it's one amongst the foremost common alloys of aluminum for general-purpose use.

Table 1: Chemical Composition of Al6061 by wt%

Elements	Si	Fe	Cu	Mn	C	Pb	Zn	Ti	Sn	Mg	Cr	Al
%	0.4	0.7	0.2	0.1	0.05	0.2	0.1	0.15	0.001	0.8	0.2	left

The density of 6061 aluminum alloy is 2.7 g/cm^3 (0.0975 lb/in^3). 6061 aluminum alloy is heat treatable, simply shaped, weld-able, and is sweet at resisting corrosion.
Boron Carbide particulate bolstered aluminum composites possess a singular combination of high coefficient of elasticity, sensible wear resistance and sensible thermal stability than the corresponding non-reinforced matrix alloy system. A restricted analysis work has been reported on AMCs reinforced with B_4Cdue to higher stuff price 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's used for producing bullet proof vests, armor tank, etc. Hence, B_4C bolstered aluminum matrix composite has gained additional attraction with affordable casting route.

2. LITERATURE REVIEW: -

The analysis efforts and directions associated with the current work are known through literature survey. The analysis papers analyzed the varied properties of composite materials are mentioned in this section.

Gopal Krishna et. Al. [1] Studied the effect of percentage reinforcement of B_4Con the tensile property of Aluminum metal matrix composites. By using stir casting technique, the A6061 was fabricated by wt% (6,8,10,12) and also B_4Cwere fabricated by the same procedure. The fabricated AMCs was evaluated the mechanical properties and microstructure with the help of X-Ray Diffraction (XRD) and also hardness and tensile strength. In X-Ray Diffraction and optical photomicrographs, it was observed that B_4Cparticles are dispersed uniformly in the aluminum matrix for wt % of reinforcement. The XRD evaluate the confirmation of presence of B_4Creinforcement within the matrix. In evaluation of mechanical properties, the micro Vicker's hardness of AMCs was found to be maximum (121.31 VHN) for wt% of 12% and in the tensile strength of AMCs was found to be maximum (176.37 MPa) for the wt% of 8 wt%.

Mohd Adnan et. Al. [2] had compared the mechanical properties of aluminum Boron carbide at micron and Nanometer size grain particles. The powder metallurgy process was used to fabricate Boron carbide and aluminum. The boron carbide having grain size 50-micron and 50 mm with wt% 3%, 6%,9%,12%& 15% with aluminum having grain size 50-micron was prepared by sintering method. After preparation hardness test & Tensile was carried out with the help of "Rockwell hardness tester" & "Universal Testing Machine". The result was found to be that by increasing the weight percentage of boron carbide from 3% to 15% the tensile and hardness value are increased. Likewise, after estimation of hardness and ultimate tensile strength with grain size of both aluminum and boron carbide in nanometer is consistently higher once contrasted with hardness and ultimate tensile strength with grain size of each aluminum and boron carbide in metric linear unit having same weight and extent of aluminum and boron carbide in two cases.

B Manjunatha et. Al. [3] investigated the effect of amount of boron carbide on wear loss of A6061 matrix composite. Taguchi technique was used to determine wear loss of Al MMCs and also hardness and tensile strength was evaluated. The liquid science technique was used to prepared the composite material. It is possible to disperse B_4Cparticulates in Al 6061 matrix and prepare the composites by stir casting technique. The composites exhibited increasing hardness, wear resistance and tensile strength with increasing amount of reinforcement. The factors that in the main influence the wear mass loss of the composites is found to be speed, load time and quantity of reinforcement, in decreasing order of influence. The best contribution for the wear loss is found to be from the speed of testing, whereas very cheap is from reinforcement content. On the opposite hand, applied load and time of application were of intermediate contributions. The optimum conditions for every issue are reinforcement content of 8 % (A3), load of 2 kg (B2), speed of 80 RPM (C1) and time of 30 min (D1). Response Surface plots showing the influence of Load-Reinforcement content, Speed Reinforcement content, Time- Reinforcement content, Speed-Load, Time-Load and Time-speed on wear mass loss at optimum combination determined from Taguchi analysis unconcealed blue regions were generated at the (i) second level of applied load and third level of reinforcement content indicating this region representational process low wear mass loss,

(ii) initial level of speed and third level of Reinforcement content, (iii) initial level time and third level of Reinforcement content, (iv) initial level of speed and second level of load, (v) first level of time and second level of load and (vi) first level of time and first level of speed respectively. Scanning microscopy study of the worn-out surfaces of the composites showed developed wear tracks supported that wear mechanism can be studied besides dispersion within the Al 6061 matrix and fracture of those particles. This steered that the wear mechanism is powerfully settled by the presence of B_4C particles within the matrix and fractured surface of carbide particles.

Gopal Krishna et. Al. [4] investigated and the effect of boron carbide Reinforcement of Aluminum matrix composite. By stir casting route, aluminum 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 reinforcement dispersion has also been identified with X-ray diffraction (XRD). The Al-B_4C composites were produced by stir cast route with different particle size (Viz 37µ, 44µ, 63µ, 105µ, 250µ) of reinforcement and the microstructure, mechanical properties are evaluated. Production of
Al-B_4C composites was completed successfully. The Optical micrographic study and XRD analysis revealed the presence of B_4Cparticles in the composite with homogeneous dispersion. The micro Vickers's hardness of AMCs was found to be maximum for the particle size of 250µ and found maximum for 12 wt% in case of varying wt% of the reinforcement of 105µ size. The tensile strength of AMCs was found to be maximum for the particle size of 105µ and found maximum for 8 wt% in case of varying wt% of the reinforcement of 105µ size.

Rajesh GL et. Al. [5] investigated the mechanical property of B4C and particulate reinforced Al6061 metal matrix composite. The Al6061 was fabricated by stir casting method and to overcome the incorporation of B4C in aluminum matrix preheated titanium fluoride flux with ratio of 0.15Ti/B4C was added. After that it was subjected to micro structural characterization by using Scanning electron Microscopy EDX analysis. They concluded by using EDX analysis that B4C is present in Al6061 matrix and it is uniformly distributed. At the end they come to know that as the reinforcement B4C increases by wt% the hardness also get increases. The improvement of 17% and 38.4% in ultimate tensile strength was achieved over Al6061 alloy after addition of 7 and 9wt% of B4C. Compressive strength was achieved over Al6061 alloy after addition of 7wt% and 9wt% of B4C particles is 330N/mm^2 and 355 N/mm^2

Sridhar Raja et. Al. [6] studied the corrosion behavior of boron carbide reinforced with aluminum metal matrix composite. The stir casting process was used to fabricate Al356 alloy and boron carbide was added by wt% of 3%, 6%, 9%, 12% accordingly. The corrosion test was carried out by salt spray test and with SEM (Scanning electron microscopy) image of corroded structure was observed. They concluded that the weight loss increases with the increase in reinforcement. By salt spray test the carbon particle in the boron carbide reacts with the NaCl solution and forms rust surrounding the particle. It's because of the presence of small amount of iron present in the aluminum matrix alloy. Since boron carbide is highly resistance to corrosion, the corrosion rate is more when compared to another reinforcing particle. They observed that the composite has good corrosion resistance in sodium chloride medium.

K. Rajkumar et. Al. [7] studied the microwave Heat Treatment on Aluminum 6061 alloy and boron carbide composite. They fabricated the Aluminum metal matrix composite by two steps stir casting. After fabrication of AlB4C it was subjected to heat treatment process. They carried this process by testing sample composite in both conventional as well as in microwave oven separately. The hardness test was carried out with the help of using Rockwell Hardness Machine and also impact strength of composite was done by Izod test. The machining was done on the heat-treated and non-heat treated AlB4C (5%, 10%, and 15%). At the end the result was comparable mechanical properties were obtained in both conventional & microwave heat treatment processes. Time consumption was very less in microwave heat treatment and it is a cleaner energy process. The non-heat-treated composite material of Al-B4C is less hard than the heat treated one. The hardness of the composite is increased while adding the B4C reinforcement to the Aluminum matrix. At high cutting speed, machining will minimize chip tool contact length & build-up edge formation, which reduces the cutting force. As such, cutting force is high when machining with a higher depth of cut and increased feed rate. Microwave heat treated composites exhibited finer microstructure in machining compared with non-heat-treated composite material. Surface roughness is reduced in heat treated samples when compared with non-heat-treated material.

Ch Hima Giresh et. Al. [8] investigated the mechanical property of Al6061 Hybrid metal matrix composite. As usual as stir casting method was carried as a result of it is easy and most economical technique of fabricating particulate strengthened composite. During this investigation they used the three-ceramic was used particularly SiC, Al_2O_3 and Fly ash for reinforcing the hybrid MMCs. After reinforcing them various test were carried out such as tensile test, Hardness test, Impact test, wear test. The AHMMC prepared with equal amounts of SiC, Al2O3, and fly ash (each of 5 wt %) possesses a tensile strength of 117 MPa, a yield strength of 79 MPa, and a hardness of 53 BHN. They confined that the mechanical properties with the simultaneous increase of weight percentage of SiC and Al2O3 in equal amounts in two steps (7.5% each and 10% each) and without any change in fly ash content. They concluded that when the SiC and Al_2O_3 content of each increased from 5% to 7.5%, the tensile strength of the composite increased by 8.2%, the yield strength increased by 36.48%, and the hardness increased by 20%. The increase of SiC and Al_2O_3content from 5% to 10% leads to an increase of tensile strength and yield strength of the composite by 10.4% and 25%, respectively. However, the hardness of the composite decreased by 16%. On comparison with the base metal Al6061, the planned composite exhibits an honest improvement in tensile strength, yield strength, and hardness. However, no important amendment is discovered in impact strength.

CONCLUSION: -

This literature review predicted that are as follows:

- The addition of reinforcement in Aluminum metal matrix increases the mechanical and physical properties such as hardness strength, tensile strength, stiffness, weight, fatigue life and resistance to corrosion as compared to standard materials.

- The specific wear rate was reduced as the weight percentage of reinforcement increased.

- When the percentage of reinforcement were increased by wt% the hardness and tensile strength were recorded as 121.31 VHN for wt% of 12% and in the tensile strength of AMCs was found to be maximum 176.37 MPa for the wt% of 8 wt%.

- ALMMC is more stable and lighter weight product for various industries (i.e., automotive, aerospace, and defense)

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