A LITERATURE REVIEW ON ALUMINIUM-7075 METAL MATRIX COMPOSITES

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Abstract - *In this review paper, the individual and multiple impact of Aluminium and reinforcement metal matrix composites are discussed. The aluminum MMC's has received extensive concentration for basic and also for practical reasons. The individual and multiple reinforcements with Aluminium 7075 metal matrix composite has gained tremendous applications in Space, Defense, Aerospace, Automobile, Marine, etc., This is mainly due to high strength and less weight properties. The addition of reinforcements in Aluminum 7075 improves specific strength, tensile, wear and fatigue properties. Many researchers gone through different experiments with adding different reinforcement materials and results in different property.*

Key Words: Aluminium Alloy, Reinforcement, Strength, Wear, Experiments, Property.

1. INTRODUCTION

Traditional monolithic metals or products have disadvantages over achievable combinations of strength, stiffness, and density. To minimize these problems and to get the significantly increasing engineering demands of recent technology, metal matrix composites are gaining great importance.

The combining of two or more materials in which one is matrix and another is filler materials results in Metal Matrix Composite. The best mechanical properties which are not achieved by traditional materials are provided by Aluminum Metal Matrix Composite. Metal Matrix Composites have been substantially utilized in marine, Aerospace and automobile industries, due to their good mechanical properties such as fracture toughness, elastic modulus, hardness, tensile strength at room and elevated temperatures, tribological properties like wear resistance combined with significant weight savings than base alloy materials.

Zinc is the foremost alloying element used in aluminum 7075. It is solid, with quality similar to numerous steels, and has great exhaustion quality and normal machinability, yet has less protection from corrosion than numerous other Al composites. Aluminum Alloy 7075 offers best quality of the basic screw machine components. The perfect pressure erosion obstruction of the T173 and T7351 tempers makes Aluminium 7075 an intelligent option for 2024, 2014 and 2017 in huge numbers of the critical applications. The T6 and T651 tempers have reasonable machinability. Metal matrix 7075 is extensively used by the air ship and weapons manufacturing industry because of actuality of its extraordinary quality.

The reinforcements being used are whiskers, fibers, and particulates. Mainly particulate-reinforced composites are best quality for their flammability with a price advantage. Further, they are ingrained with wear and heat resistant properties. For MMCs SiC, Al_2O_3, Gr, B_4C, etc., is excessively applied particulate reinforcements.

Table -1: Mechanical Properties of Aluminum 7075

Density	2.81g/cm^3
Hardness(Brinell)	150
Ultimate tensile stress	572Mpa
Tensile yield stress	503Mpa
Young's modulus	71.7Gpa
Machinability	70%
Shear strength	331Mpa
Melting point	635^{0}C

Table-2: Composition of Aluminum-7075

Al	Zn	Cr	Ti	Mn	Si	Fe	Cu	Mg
88.85%	5.5%	0.15%	0.2%	0.3%	0.4%	0.5%	1.6%	2.5%

2. LITERATURE REVIEW

[1] R.Kartigeyan et.al.[2012], has effectively developed Al 7075 alloy and Short Basalt Fibre composite through liquid metallurgy technique. The increase in short basalt fibre maximizes the ultimate tensile strength, yield strength and Hardness. The composite containing 6% wt of short basalt fibre signifies higher hardness value of 97.1 Mpa when compare to base matrix hardness 92Mpa. The Al-7075/short basalt fibre reinforced 6 vol % maximizes the ultimate tensile strength by 65.51%. The distribution of reinforcements in metal matrix is genuinely uniform.

From the above research paper I concluded that, under tension loading without affecting the tensile ductility, values of tensile strength increases. Experimental values of short basalt fiber gives the best result for the Al-MMC's

[2] Pradeep P et.al.[2017], has fabricated Al 7075 and Titanium DI Boride (Tib2) via the sir casting technique. The quantity fraction of TiB2 prompted are 4%, 6% and 8% . They evaluated the microstructure, wear, hardness properties. At 8% wt of TiB_2 notices the maximum hardness of 126 VHN and strengthens the base matrix. Explicit wear rate diminishes as the sliding rate increments up to rotation speed (1.6 m/s) and weight, in light of work solidifying of the material surface. Minimal effect of the wear rate got from the 8 Wt. % of TiB2 fortified composite. The speed and the sliding distance are in most extreme with the insignificant weight. The micro image indicates the Aluminium debris are unvaryingly dispersed within the highest volume fraction of particulate matrix of 8Wt. %.

From the above research paper I presumed that wear and abrasive area properties of MMCs having aluminum as base material exceptionally relies upon the particulate utilized for filler, its size and weight division of particles. If the particulates added for reinforced well to the lattice, the wear obstruction increments with expanding volume division of support materials.

[3] Arunkumar D T et.al. [2018], successfully fabricated the Al-7075 composites with mica and kaolinite reinforcements using stir casting technique. They used equal volume fractions of mica and kaolinite are [(2+2)%, (4+4)%, (6+6)%,(8+8)] and conducted a wear test for various time intervals at constant load. The wear loss in composites with 8% volume of mica and kaolinite are observed to decrease at a slower rate. The SEM microstructure of the composite indicates a homogeneous reinforcement distribution into matrices and no evidence of agglomerate.

From the above research paper I concluded that the presence of mica and kolonite in the matrix decreased wear loss by increasing wear resistance.

[4] Rajesh Kumar Bhushan et.al.[2013], contemplated Fabrication of Al7075 combination interfaced with SiC particulates. The analysis includes preparation of specimens utilizing fluid vortex cast technique for the combinations Al7075 included with SiCp of various work sizes(20-40). The composites of different volume divisions of filler materials (10% and 15%) were examines by EPMA, XRD, SEM, EMPA and DTA investigation. Oxidation of SiC has constrained the synthetic reactions at interfaces. Improvement of wetting operation connecting the base material and Si particles was seen because of very much mixed combinations and filler material. SEM micro pictures demonstrate that the dispersion of filler particles is uniform. The XRD chart sees no rise of Al4C3. EPMA investigation shows that Aluminum as the fundamental compound and the particles contained the alloying component of Zinc, Magnesium, copper.

From the above research paper I inferred that Alloying of Al metal with 2.52 wt.% Mg and its detachment at the interfaces has been seen to be amazing in restricting the course of action of the Al4C3at the interfaces during example planning. There are no opposing engineered reactions; in this way, these composites are sensible for car, airplane and protection applications.

[5] Madhuri Deshpande et.al.[2016], successfully prepared Pitch based carbon fiber added to Al matrix composites from Powder Metallurgy (PM) technique. Weight % of carbon fibre are (5-50)% uncoated (UnCf) and coated milled pitch based carbon fibers (NiCf) and AA7075 as matrix with different volume contents of carbon fibers. Uncoated and Ni-coated carbon fibers were reinforced with AA7075 Aluminium alloy powder and subsequently hot pressed and they studied on density and hardness strength. A highest of 11% reduction in density is noticed for 50Vol% Cf Composite compared to as cast Al7075. It indicated that the composites developed with uncoated carbon fiber shows minimum values of hardness as compared with Pure Al7075 hot pressed specimen. Whereas the Ni coated carbon fiber composites show the increase in hardness up to 20Vol%. It is observed from the microstructures that carbon fibers are homogeneously distributed in the Aluminium matrix for all wt % compositions.

From the above research paper I concluded that the electroless nickel coating on the fiber surface improves the interfacial bonding which results in increased hardness of the composite. Double action hot pressing experiences improved density and density gradient is not indicated in composite.

[6] Manoj Singla et.al.[2009], successfully conducted Experiments by changing various wt% of SiC (5%-30% at intervals of 5%) They conducted tests on hardness and impact strength. Uniform dispersion of SiC particles in the Al matrix represents raising trend in the specimen preparation through liquid vortex process. The results of study propose that with increament in the particle of SiC, the expansion in hardness, impact strength and standardized strain have been observed. The supreme results for hardness 45.5BHN and maximum impact strength36.6N-m have been obtained for 320 grit size SiC particles at 25% weight fraction.

From the above research paper I reasoned that Homogenous mixture of SiC particles in the Al alloy demonstrates an expanding pattern in the examples represented by dosent applying mixing process, with manual directing and with 2-Stage stirring for liquid vortex method separately.

[7] Jamaluddin Hindi et.al. [2016], successfully prepared Al 7075 Reinforced with Gray Cast Iron of different wt% 2%,4% and 6% and 2 wt% of Fly Ash are prepared employing stir casting method. It was seen that tensile strength raises with the expansion in wt% of GCI. The

maximum tensile strength 275Mpa got at 6% GCI. Hardness increments generously with increment in wt% of GCI in the composite. Wear rate diminishes from 410μm with an expansion in wtt% of GCI.

From the above research paper I reasoned that. As the wt% of GCI increments in the grid, the support material increases and the inter molecule space minimizes. There is no sign of hole formation in the matrix.

[8] Mohan Kumar S et.al.[2014], finished examinations on an Al 7075-T6 and it's Electroless Nickel covering of 10 – 20 μm in thickness. Plane strain crack mechanics, confirmation was followed in this examination. Uncoated Al 7075-T6 composite exhibits a yield nature of 560 MPa, and again EN covering on mix of 10μm and the 20μm yield nature of amplifies to the 569 MPa and 603 MPa. The uncoated Aluminum essential load is 4.44 KN and K1c esteem is 22.28 mpa√m. Further for 10microns and 20microns secured aluminum compound has an essential load of 6.67 kN and 7.41 kN which separates to KIC estimations of 34.48 MPa√m and 37.67 MPa √m exclusively.

From the above research paper I concluded that The EN covering encounters improving delamination and crack at the most high load, because of the ductile material, plastic deformation occurs. The split development is shaky because of solid attachment between EN covering and Aluminum alloy.

[9] Gururaj Aski, Dr. R.V.Kurahatti [2017], developed to study the behavior of LM13 reinforced with ZrSiO4 in 2, 4 and 6 weight%. The tests included tensile test, impact test, microstructure analysis, SEM analysis and hardness test. Increase in volume fraction of ZrSiO4 results in increase intensile strength. LM13 with 6 wt% ZrSiO4 exhibited highest ultimate strength 128.75N/mm2. Hghest hardness of 76 HRB found at composite of 6% wt of ZrSiO4, LM13 with 6 wt% of ZrSiO4 exhibited higher impact strength0.10N-m/mm2compared to other specimens.. From SEM images, it was observed that distribution of ZrSiO4 was homogeneous. This homogeneous mixture was observed in 6wt% ZrSiO4-LM13.

From the above research paper From the microstructure analysis, it was inferred that tensile strength values of the composites were inversely proportional to the grain size.

[10] Shivannah, V. S. Ramamurthy [2012], prepared A356-ZrSio4 (Zirconium Silicate) metal matrix Composites by liqid vortex method. The amount of volume fraction $ZrSio_4$ is varied from 0 to 7.5%. The solid composites were machined and also the specimens were prepared for hardness yet as for wear behavior were ready as per ASTM standards. It is noticed that the hardness of A356-ZrSio4 increment with maximum content of the ZrSio4 reinforcement. Wear increases as the % of Zirconium silicate increases. Wear rate minimizes as sliding distance increases. The microstructure of the solid composite shows uniform particle distribution with less priority.

From the above research paper I concluded that the hardness of the filler matrix found to be higher than the main matrix this is mainly due to the influence of zirconium silicate.

[11] R.S. Raveendra et.al. [2016], Liquid metallurgy course utilizing vortex strategy is utilized to plan Al6061 MMCs material. The microstructural examinations show the unvarying mixture of the reinforcement particles in the matrix. 6% weight dimension of α-Al2O3 shows highest Hardness of 64 BHN nano-ceramic production. A definitive elasticity of the MMCs is established higher 139mpa at 6% wt of Al_2O_3. The compression strength maximises with increases in α-Al2O3 production. After the investigations it should be noticed that raise in trend of mechanical properties by Al-6061 and Al_2O_3.

From the above research paper I assumed that Al2O3 nanoceramic particles demonstrates an better holding with Al-6061 MMC and furthermore with each other which helps in more load when assessed with Al-6061 base matrix. The hard filler particles restrict bending, stress while growing the properties of the composite.

[12] Miss. Laxmi, Mr. Sunil Kumar [2017],investigated on the mechanical properties of SiC reinforced with Aluminum 6061 metal matrix composites created by liquid vortex technique. The distinctive weight % is 10%, 15%, 20% of SiC. The test outcomes demonstrate that with the improves in rate from 10% to 15%, hardness of the composites is improved. To further increment of sic particles up to 20%, result as an declination of hardness. Out of every one of these specimens, the hardness is more for 15% SiC with Al example (64BHN). Scanning Electron Microscopy pictures of the considerable number of specimen, exposed to tensile strength is inspected.

From the above research paper I concluded that with the increase in the composition of SiC, an increase in hardness has been observed.

[13] Z. Hasan et.al.[2011], composites have been fabricated by applying a Liquid Metallurgy procedure using 2124 Al combination as the base material with 10 and 20 % SiC particulates by weight. The Effect of Load and Disk Surface on the Wear Volume and impact of Load and Disk Surface on Weight Loss has been considered. The weight declination of the materials is displayed for weight 20 N, 30 N and 50 N. The wear volume in every one of the circumstances is the base for the Al-20% SiC composite. With expanding load there is a reliable increment in the wear volume. For a given burden and separation ventured to every part of the, weight reduction is observed to limit in the Al-20% SiC composite.

From the above research paper I reasoned that the wear rate is observed to be maximise with load in every one of the materials considered. The expansion in wear rate of the aluminum base alloy is progressively significant because of cutting and wrinkle activity by generous rough particles.

[14] GOPAL KRISHNA U B et al.[2013], By liquid casting technique, aluminum metal matrix was strengthen with boron carbide particulates of 37, 44, 63, 105, 250μ sizes separately. The mechanical and microstructure properties of the manufactured AMCs was examined. In view of the outcomes acquired from tensile strength of the alloy composites of various sizes, 105μ size B4C was picked and changed the wt% of B4C with 6,8,10 and 12wt%. The miniaturized scale vicker's hardness of AMCs was observed to be most extreme for the molecule size of 250μ and discovered greatest for 12 wt% if there should be an occurrence of changing wt% of the fortification of 105μ size. The tensile stress of AMCs was observed to be most extreme for the molecule size of 105μ and discovered greatest for 8 wt% . The Optical micrographic study and XRD investigation uncovered the nearness of B4C particles in the composite with homogeneous scattering.

From the above research paper I reasoned that the presence of such hard surface zone of particles offers more protection from plastic twisting which prompts increment in the hardness of composites. The expansion of B4C particles in the lattice prompts more solidarity to framework compound by offering more protection from elastic loads.

[15] Shivaraja H B, B S Praveen Kumar [2012], Al 356 MMC's reinforced with Zirconium Silicate and Silicon Carbide particles has been successfully joined with the stir casting technique. A tensile stress and the yield quality of the composite are more greater within the sight of ZrSiO4 and SiC. The outcome demonstrates the higher hardness with the expansion in the particle volume fractions in wt%. The outcome shows that there is a significant increment in the toughness strength in the presence of silicon carbide and zirconium silicate particles in the MMC'S. The Hybrid composite 2% SiC and 6% ZrSiO4 particles has demonstrated high strength for crack. Microstructure uncovers a sensibly uniform appropriation of SiC and ZrSiO4 particles in the cast composite.

From the above research paper I inferred that the presence of hard grain particles in the composite could deter the development of disturbance since these particles are greater than the matrix wherein they are fixed. The distortion and toughness properties of the composite uncover the significance of particle sizes. It is settled that enormous particles are inconvenient to break sturdiness because of their tendency towards crack.

[16]Z. KONOPKA et.al. [2006], A356 aluminum combination with short carbon fiber with two distinctive volume fraction 7.5% and 12.5% manufactured by stir casting strategy. The toughness strength of Al-Si-carbon composites slowly expanded as a component of the weight fiber division. The greatest estimation of K1c was 8.4 MPa $m^{1/2}$ for composite with fiber contact 12.5% and length of fiber 7 mm.

From the above research paper I presumed that . Crack durability testing did utilizing KIc parameter should be taken on examples with bigger thickness, which ensures plain strain state in tested specimens.

[17] Ajay Kumar et.al. [2016] the conducted experiments on the Al356 base MMCs having distribution of Graphite, Boron Carbide, and varying fractions of fly ash. The tensile strength of composite materials increased predominantly by 60- 70% (Al356+5%Graphite+5%B4C +15% Fly Ash) compared to the as cast Al-356 alloy,. The hardness of the composite material also raised with increase in wt% of fly ash content in the composite. From the microstructure studies, it is observed that genuinely even dispersion of reinforcements in the composite material.

From the above research paper I presumed that uniform appropriation of fly ash particles in the grid without any voids appears to have added to the improved properties of the composite.

[18] Niranjan K.N et.al.[2017] their work was on the investigation of hybrid composites i.e, aluminium alloy 6061 as a base material and reinforced material as sic(6%) and graphite (3%,6%&9%). They calculated mechanical properties of tensile, compressive and hardness tests. They have increased the percentage of reinforcement (graphite), then the hardness will be decreased and tensile, compressive strength will be increases with the influence of sic particles.

From the above research paper I concluded that the, parameters of reinforcement material influences greatly the mechanical properties increases increased the percentage of reinforcement (graphite), then the hardness will be decreased and tensile, compressive strength will be increases with the influence of sic particles.

[19] Avinash Patil et.al. [2017] contemplated on break sturdiness and weariness development on aluminum compound A384. The Plain strain break durability of Al-compound A384 is resolved. Tests were completed on a widespread testing machine (Axial Fatigue Testing Machine). It is seen that the moderate crack strength esteem around 22.91 MPa is acquired for Al-combination A384. The weakness pre breaking burden is acquired for Al-amalgam A384 material is 1.97 KN which is required to create sharp split close to the break tip. The most extreme load (Pmax) acquired before complete break of the metal is around 2.67 KN. For Al-compound A384 the break load (PQ) is acquired is about 2.068 KN. The temporary crack durability of Al-compound A384 was seen around 18.53 MPa. Explanatory calculation like provisional fracture durability and fracture

durability for Al-alloy A384, were calculated is 18.44 MPa and 23.78 MPa separately.

From the above research paper I concluded that the fracture toughness can be determined by an analytical method and compared with the experimental results which shows almost similar results.

[20] Tadeusz Szymczak, Zbigniew.L.Kowalewski[2013] Effctively created 4420 casting, aluminum combination reinforced with different wt% of the Saffil fibres, i.e. 10% ,15%, 20%.The basic results of stress concentration factor 44200 aluminum combination, come to the following levels: 12.201, 12.121, and 11.866 [MPam1/2], separately. The basic value of the stress concentrated factor of the composite was three times littler than that of the 40H steel accomplished. Impact of the Al_2O_3 saffil fibers substance inside the the run from 10% to 20% on the basic stress intensity factor was irrelevant little.

From the above research paper I concluded that the break strength of the composites examined is not high enough to be used especially for the very responsible elements of engineering constructions.

[21] Joel Hemanth et.al. [2000] has prepared the aluminium chilled in different block thickness and added the Glass particulate composite consists dispersoid (size 20-50μm) with wt% of 3-12. Different materials for chill block(25mm) is used are Cu, steel, CI, SiC. The various for mechanical properties like PSFM strength, tensile strength was conducted . Ultimate tensile strength increased at 9% of weight ie., 138mpa for Cu chil block. Fracture toughness of 15mpa mpa√m at 9% of weight for Cu chil block.

[22] Syed Ahamed et.al. [2014] successfully fabricated the Al-Si (LM-13) /kalonite/graphite carbon hybrid matrix material composites through liqud vortex method. Particle size of Kalonite/Graphite carbons is between 50-100μm.The different percentage of colonies are 3%, 6%, 9%, 12% and graphite carbon is kept constant to 2.5%. Nickel coating on graphite carbon particles through the electrolysis process was given. Different Chill thickness ranges from (10-25mm). The tensile, hardness, fracture toughness and microstructure tests were conducted. The increased hardness, ultimate tensile strength and fracture toughness are identified for 9% out of coolant in 25mm chill thickness IE.,82.8 BHN, 175.837Mpa(UTS) and 11.7mpa√m respectively. The microstructure of the models containing 9 weight% and 12 weight% dispersoids cast utilizing copper chill of 25 mm thick shows that kaolinite particles were delaminated from the matrix due to damage in a brittle manner as an effect of too much chilling, stress intensities and crack propagation.

From the above two research paper[21],[22] I concluded that the chilling process plays important role in manufacturing process. The chilling process is incorporated to minimize the micro shrinkages in composites

[23] Ajit Bhandakkar et.al. [2014] fabricated aluminum 2024 and silicon carbide and fly ash as reinforcement material particle size of 25-45 μm in 5%, and 10% by weight. As the % of filler material increases, the ultimate stress, yield stress, and % of elongation also increases. The stress intensity KIC obtained for AA2024-fly ash composite is 18 MPa√m and 21 MPa√m for unreinforced and remolded base alloy. Homogeneous mixture of reinforcement alloy has been observed by thr micro structural analysis .

From the above research paper I assumed that fracture strength decreases with maximum reinforcement materials the combination of SiC and fly ash is not good enough to get expected results.

[24] Boopathiraam C et.al.[2019]prepared the specimen by using aluminium7075 reinforced with Boron carbide and Titanium carbide both has equal volume %(5,10,15) through liquid vortex technique. The micro hardness test was conducted in Vickers scale which shows higher for 15vol% of composite ie.,46.10 VHN. Maximum ultimate tensile strength obtained is 220.41mpa at 15 vol% . microstructure analysis shows uniform dispersion of filler particles in matrix.

From the above research paper I assumed that hardness and tensile strength increases with maximum content of hybrid particles and it also shows the brittle fracture. The microstructure investigation shows great bonding between hybrid reinforcement and matrix material

3. CONCLUSIONS

This review paper includes many investigations on mechanical and tribological properties of various aluminum material series and different filler particles added to base matrix. This enhances our knowledge on composite materials and increases the interest in advanced materials used in aircraft, vehicles and the materials required for our daily use.

The tensile test provides various applications and determines the various mechanical characteristics such as yield strength, tensile strength, with different category of ductile and brittle materials. Many researches have shown that tensile strength increases with increases in reinforcement materials when compare with base matrix. Different reinforcements like SiC, B_4C, Al_2O_3, Graphite, Carbon fiber, Grey cast iron etc. are added to aluminum base alloy, results in increase in tensile strength upto 278Mpa when compare to base matrix 167mpa. The tensile strength increases up to 60-70% from the Aluminium base material.

Fracture mechanics plays a crucial role in determining the various properties like fracture toughness, crack propagation, crack initiation, impact loading etc. Some researchers highlight the importance of fracture toughness in selecting engineering materials. Stress intencity factor K1c increases with increases in reinforcement materials like SiC, carbon fiber, kolonoite, etc these reinforcements shows increase in 30% . But some reinforcements like saffil fibres and fly ash shows same or less results than As cast materials.

The hardness of the composites was checked on taking everything into account, it is found that as the support substance expanded in the framework material, the hardness of the composites additionally expanded. Further, the tests directed to decide the equivalent demonstrated the (Vickers and Brinell's hardness) expanded hardness with expanded support substance when contrasted and the base lattice.. It is obvious that the structures and properties of the fortifications control the mechanical properties of the composites.

The main objective of wear test is to provide the information on sliding distance, friction behavior, heat treatment, lubrication, load, speed etc, the significant effect of these factors influences the tribological properties. As the hard ceramic particles are added, that increases the wear resistence of aluminum metal metal matrix composite. The stats in this survey paper states that adding the reinforcement material results in decrease of wear rate up to 50% when compared to base matrix.

All the research papers conclude that, the reinforcement materials greatly affect the mechanical, physical and tribological properties of various aluminum series materials. This motivates other research scholars to investigate different mechanical properties by reinforcing the new materials to aluminum and hope to get best results of mechanical and tribological properties.

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