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Experimental Investigation on Stir Casted Aluminium Composites for Corrosion Behaviour and Mechanical Properties - A Review

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ABSTRACT: In the past few years, the global need for low cost, high performance and good quality materials has caused a shift in research from monolithic to composite materials. In case of aluminium matrix composite due their high strength to weight ratio, low cost and high wear resistance are widely manufactured and used in structural applications along with aerospace and automobile industry. Also, a simple and cost-effective method for manufacturing of the composites is very essential for expanding their application. Reinforcements like magnesium oxide, silicon carbide, graphite, fly ash etc can easily be incorporated in the melt using cheap and widely available stir casting method. This paper presents a review on the mechanical and tribological properties of stir cast aluminium matrix composites

KEYWORDS: Aluminium, Reinforcement, Friction Stir Casting, Mechanical Properties, Tribological Properties.

I. INTRODUCTION

Today, the demand for producing metal matrix composites for use in high performance applications has greatly expanded. [1]. Among these composites, aluminum alloy matrix composites attract much attention due to their lightness, high thermal conductivity, moderate casting temperature, etc. [2,3]. Various kinds of ceramic materials, e.g. Sic, Al₂O₃, MgO and B₄C. are extensively used to reinforce aluminum alloy matrices. Superior properties of these materials such as refractoriness, high hardness, high compressive strength, wear resistance, etc. make them suitable for use as reinforcement in matrix of composites [4-11]. Nonetheless, limited wettability with molten metals and density variations increases their tendency to agglomerate, lowering mechanical characteristics. Numerous attempts were made to overcome the identified weakness. [12-14].

Al-alloy powders may be used to produce such kinds of composites with improved properties. In this way, subsequent and appropriate sintering procedure needs to be performed [11]. Stir casting, an alternative and relatively simple method, can be utilized successfully to manufacture metal matrix composites. This approach would reduce agglomeration, sedimentation, and flotation of reinforcement during casting. However, exact optimization of reinforcement content, casting temperature, stirring velocity, and other parameters should be considered. [14-17]. Therefore, optimum particle size, amount of reinforcement and processing parameters, should be determined for each technique and matrix.[18]

Aluminium alloys have gained popularity as structural materials in recent years due to their favourable properties, which include a high strength-to-weight ratio, ease of fabrication, a high degree of workability, considerable ductility, excellent thermal conductivity, high corrosion resistance, and an appealing appearance in their natural finish. As a result, the building industry consumes 25% of total global aluminium production. Aluminium alloys are a versatile structural material due to their ease of extrusion, allowing the manufacture of complicated cross-sectional shapes suited for structures that cannot be constructed using more conventional structural materials, such as concrete or steel. Their high corrosion resistance makes them ideal for marine applications that do not require surface protection and have low maintenance costs. Their great durability allows for structures that can maintain their inherent properties even in large temperature variations. [19]

Aluminium-based composites are increasingly being employed in the transportation, aerospace, marine, automotive, and mineral processing industries due to their superior strength, stiffness, and wear resistance. They provide a wide range of mechanical qualities based on the chemical composition of the aluminium matrix. [20]

II. METHODOLOGY

2.1. Material:

Al-Li alloy 2195 (AA2195) has been used as a material for the lightweight fuel tank in space shuttle because higher specific strength has been shown than that of AA2219 under ambient pressure. AA2195 also showed higher performance even at cryogenic atmosphere. The advantages of AA2195 are produced by an addition of lithium of 1e4 wt.%. The lithium has been known as the lightest metal with low density of 0.534 g/cm³. This density is only 20% of density for AA2195 (2.7 g/cm³). This metal could be dissolved into Al by 1 wt.% and 4 wt.% at room temperature and 600 C, respectively. By an addition of lithium of 1 wt.%, density of the alloy can be reduced up to 3% while elastic modulus can be enhanced up to 6%. For instance, tensile strength of AA2219-T8 was known to be 455 MPa whereas that of AA2195-T8 was reported as 565 MPa. AA2195 has been attractive after a success in production of fuel tank for space shuttle in USA. However, fabrication of AA2195 was difficult due to an explosive reaction and low melting temperature of lithium. Fundamental researches on relation between mechanical properties and microstructures of AA2195, varied by heat treatment, have been conducted to understand its precipitation behavior, leading to strengthening [21].

A transverse slice from an industrial AA2195 cast ingot fabricated by the Dubuc Works of Rio Tinto Alcan using the direct chill (DC) casting technology was used in this study. The ingot with a chemical composition of Al-4.04Cu-1.05Li-0.28 Mg-0.3Ag-0.13Zr (wt.%), had a measured cross section of 295 1372 mm² and a length of several meters. Rectangular samples with dimensions of 150*20*18 mm³ were cut from the middle of the ingot for microstructural analysis and tensile testing. The as-cast and heat-treated samples were polished and etched for metallographic observation using optical and scanning electron microscopes. [22]

2.2. Aluminum Alloy Fabricated with Nano Sized MgO

Aluminum alloy (A356.1) and nano sized MgO were used for fabrication of composites. Chemical composition of A356.1 and some characteristics of MgO powder, respectively. The samples were prepared using a resistance furnace, equipped with a stirring system. After smelting of aluminum ingots, 3g Keryolit was added to the molten metal and stirring was carried out at constant rate of 420rpm for 14min. The stirring rate was adapted, according to the results of literature. Nano-powder MgO (1.5, 2.5 and 5 vol%) was wrapped in aluminum foils thence added to the molten metal during stirring. The casting was performed at 800, 850 and 950 °C. Steel mold was used for casting of specimens. Finally, specimens fabricated in nine various conditions were prepared for subsequent microstructural and mechanical analyses. [23]

2.3 Aluminium Alloy with Al₂O₃

In order to create aluminium-based composites, the goal of this work is to reinforce 0, 3, 6, 9, and 12 weight percent of Al₂O₃ particles with Al 1100 (Mg) alloy using the melt stirring method. Hot extrusion is also used for the same composites. Extruded alloys and composites will be the subject of mechanical characteristics such as hardness and tensile strength as well as microstructural investigations such as scanning electron microscopy (SEM) using EDAX. Comparisons have been made between differences in mechanical characteristics and microstructures. [20]

2.4 Aluminum Alloy FSP with Boron Nitride Powder

This study looked at how different boron nitride powder (BNp) percentages affected the friction stir aluminium alloy (AA-2024) surface composite's properties. The tensile strength and wear rate of surface composite have been designed and studied using the Taguchi technique, taking into account the impact of welding speed, tool rotation speed, and volume percentage of BNp. Because of its low weight and excellent strength, AA-2024 alloy has found application in the automotive and aerospace industries. Confirmation experiments have been used to determine and validate the ideal tensile strength and wear rate. The microstructure of the fractures has been examined using the specimen created for the confirmation experiments. The ideal specimen has a maximum tensile strength of 594 MPa and a minimal wear rate of 1.37 mm³/Nm. The ideal process parameter values are: 50 mm/min welding speed, 1200 rpm tool rotation speed, and

15% of BNp. Additionally, it was shown that the tool's rotating speed and the volume percentage of BNp are important FSP parameters that affect wear rate and tensile strength. [41]

2.5 Aluminium Alloy Casted with B₄C-Gr

Medium Frequency Induction Melting (MFIM) casting is successfully used to create AA2195-B₄C-Gr composites. Hot rolling at 480 °C is followed by ageing. The inclusion of B₄C nanoparticles and graphite into the matrix phase improves the microhardness of AA2195-B₄C-Gr composites. Tensile test results indicate that as casted composites' graphite and B₄C particle compositions increase the composites' tensile strength up to 6 weight percent and 8 weight percent, respectively. However, above 6 weight percent and 8 percent, the strength of the composites decreases due to high porosity and high particle agglomeration and composition. In contrast, under hot rolling and ageing conditions, the ultimate strength values increased more quickly as Gr and B₄C composition increased because of more homogeneous distribution and less porosity. Due to homogenous particle distribution, decreased porosity composition, and microstructure refinement, hot-rolled composites exhibit increased ductility when compared to as-cast composites. In comparison to casted composites, the hot-rolled and heat-treated composites exhibit higher strength and hardness. Better hardness, tensile strength, density reduction, and percentage elongation were found in the mechanical parameters of the hot-rolled AA2195-B₄C-Gr composite than in the casted composites. [42]

2.6 Aluminium Reinforced with Tungsten Carbide

The mechanical characteristics of composites made of aluminium alloy (AA 6082) reinforced with tungsten carbide particles are the subject of this study. The aluminium composite specimen was created using the stir casting method, which involved adjusting the weight percentage of tungsten carbide to 2, 4, 6, 8, and 10%. Density, hardness, tensile, and impact tests were conducted on the composite materials. The fractured tensile and impact test specimen's mechanism was examined using a scanning electron microscope. As the amount of tungsten carbide added to the composites grew, the hardness of the materials increased but the density, impact strength, and elongation dropped. The composites' tensile strength first rose before trending downward. Dimples, holes, cracks, ridges, pits, and particle fracture are characteristics of composite fracture. Strong interfacial adhesion between the tungsten carbide and aluminium matrix at high strain rates causes brittle fracture of composites in the form of cracks and particle fracture. Composites with high impact strength are thought to have ductile failure in the form of dimples, whereas those with low impact strength are thought to have brittle and plastic deformation, which is typified by particle fracture and micro- and macrocracks. [43]

2.7 Aluminium Reinforced with Silicon Carbide

Aluminium silicon carbide (Al/SiC) composites were made using a powder metallurgical process for the current study. The study examined the mechanical and morphological evaluation of aluminium matrix reinforced with varying amounts of SiC powder (10, 15, and 20 weight percent). The fabrication of Al/(SiC) composites was compared between the stir casting and powder metallurgy methods, and the particle reinforcements were seen using scanning electron microscopy (SEM). The findings showed that hardness rose as the weight percentage of SiC particles increased. Dislocation strengthening and effective stress transfer were credited for this. Furthermore, the densification behaviour of the composites was examined, and it was discovered that SiC particles had a significant impact on the density of the composites. [44]

III. CASTING

3.1. Different Casting Methods:

3.1.1. Die Casting

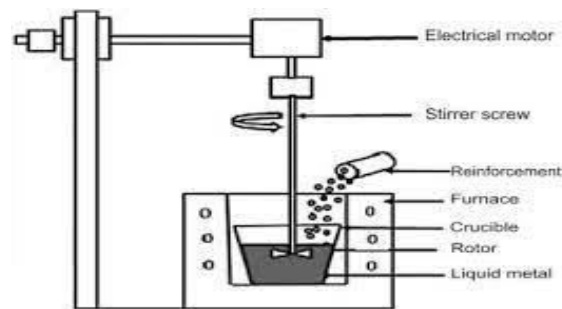
This investigation used four-millimetre-thick ADC12 aluminium die casting alloy plates. The plate had a gas concentration of approximately 2.6 ml/100 g Al. The chemical compositions of the ADC12 base material. These plates measure 300mm long, 100mm wide, and 4mm thick. Stir-in-plate welding was used using a load control type FSW equipment to determine the range of ideal welding settings for ADC12. The tool features a columnar shape and a screw probe. SKD61 was employed as the tool material. The shoulder's diameter was 15 mm. The probe's diameter and length were 5 and 3.9 millimetres, respectively. The backing plate was made of mild steel. The tilt angle was 3°. The tool plunge downforce was changed from 6.9 to 14.2kN. The tool rotation speed in the clockwise direction and the welding speed were changed from 500 to 1500 rpm and from 250 to 1000 mm/min, respectively Visual and X-ray radiography inspections of the FSW joints were performed in order to reveal the weld defects on the surfaces and in the inner zones

of the welded joint. Metallurgical inspection was performed on the cross-sections of the FSW joints. They were polished and etched with a 5% hydrofluoboric acid (HBF₄) water solution for the optical microscopic observations. [24]

3.1.2. Stir Casting

Stir casting process is mainly used for manufacturing of particulate reinforced metal matrix composite (PMMC). It is a primary process of composite production whereby the reinforcement ingredient material is incorporated into the molten metal by stirring. The stir casting of metal matrix composites involves producing a melt of the selected matrix material followed by the introduction of a reinforcement material into the melt before adding the reinforcement material the melt should be subjected to degassing by a suitable medium, because the molten metal reacts with atmospheric oxides and undergoes oxidation by degrading the properties of the base material.

The next step is to solidify the melt containing suspended dispersoids under specific conditions to achieve the required distribution of the dispersed phase in the cast matrix. In the stir casting with bottom pouring technique, the Mold is held directly below the furnace and has an aperture at the bottom for pouring. This configuration improves particle integration while also reducing pouring time. The composite qualities are getting closer to improvement as the pouring time is reduced and particulates are introduced more effectively into the Mold.



Above figure shows the matrix material melted in a crucible by heating it in a crucible furnace. The stirring is activated by means of a motor at the top of the stirrer. The stirrer can be moved up and down by means of a rack and pinion arrangement. Reinforcement is added to the matrix after stirring the matrix material for a certain amount time. Preheating is also carried out to avoid thermal distortion of the composite material. Mixing techniques are used for introducing and homogeneously dispersing the discontinuous phase since most of the ceramic reinforcement materials are denser compared to matrix alloy, otherwise the reinforcement material may settle at the bottom of the crucible if not agitated properly.

Stir casting is appealing because it is the most cost-effective method of producing metal matrix composites among all the alternatives available and uses a traditional metal processing route. In big volume production, the cost is expected to drop to a tenth. The cost of creating composite material using this approach is roughly one-third to half that of the other competitive technologies. [25]

IV. EXPERIMENTATION

4.1. TRIBOLOGICAL PROPERTIES:

4.1.1. Immersion Corrosion Test

Salt mist Under a thin liquid coating, experiments were conducted to mimic atmospheric spherical corrosion of metals. The salt spray test chamber DCTC-1200P was used for the studies. A 5wt% sodium chloride (NaCl) solution was made, with a volume of 2 mL and an experimental temperature of 35 C and salt spray sedimentation for 80 cm 98 hours. Diluted hydrochloric acid was used to bring the pH of the solution down to 3.5 in order to create an acidic atmosphere. In the immersion studies, the same solution was used, and to maintain a temperature of 35 C, the Beakers holding the immersion samples were submerged in a water bath of consistent temperature. After a period of ½ day, 1 day, 2, 4, 7, and 14 days of experimentation, the corroded samples were evaluated. Three samples were used for each test, and after gently washing their surfaces with deionized water to remove any salt buildup, they were quickly dried in

cold air. Following that, measurements of SKP 108, electrochemical measurements, and corrosion morphology were carried out in order. [26]

4.1.2. Potentiodynamic Polarization

The electrochemical corrosion of the alloys (AA2195 and AA2219) was evaluated through potentiodynamic polarization tests using a computer controlled Zhaner IM6ex electrochemical workstation. Samples were taken from the rolling plane of both the alloys to make specimens with an area of 0.5 cm². The corrosion behaviour of the samples was examined in 3.5% NaCl solution (mass fraction) prepared using reagent-grade NaCl salt and deionised water. The tests were carried out using a standard three-electrode setup with platinum as the counter electrode, saturated calomel electrode (SCE) as the reference electrode, and the test specimens as the working electrode. A scan rate of 0.5 mV/s was used. All the scans were started from a potential of 300 mV below the corrosion potential (ϕ_{corr}). Prior to the experiment, the samples were ground with SiC papers up to 1000 grit followed by cleaning in acetone and water.[27]

Potentiodynamic polarization tests (ASTM G3) and electrochemical impedance tests (EIS) have been used in corrosion research. The experiments are conducted using a software-based PAR basic electrochemical system. All of the studies were conducted using a flat cell, with a 5 mm broad nugget serving as the working electrode, carbon serving as an auxiliary electrode, and a saturated calomel electrode serving as the reference electrode. The electrolyte used was 3.5% NaCl. Tests for potentiodynamic polarization were conducted using a starting potential of -0.25 mV and a scan rate of 0.166 mV/s. When the applied voltage is higher than the E_{pit} value, it indicates that the passive film has broken, which causes the corrosion current to grow significantly. The samples were submerged in the electrolyte for thirty minutes prior to the electrochemical impedance test. The samples were exposed (0.16 cm²) so that the remaining portions were covered and just the nugget was tested for corrosion. The frequency range used for EIS tests was 10 mHz to 100 kHz. [28]

4.1.3. Weight Loss Experiment

For immersion testing, specimens were cut into coupons measuring (25mm * 25mm *3mm) and (25mm*25mm *1.5mm) Prior to being exposed, the samples were lubricated with distilled water and physically polished with emery papers (400, 500, and 600). The polished samples were placed over a desiccant, dried in the open, cleaned with acetone, and then cleaned again with distilled water. They were suspended in the test solution for 30 days after being weighed to determine their initial weight (w₀). After being taken out of the solutions, the corroded specimens were cleaned with distilled water, allowed to dry, and then submerged in nitric acid (HNO₃) for two to three minutes in order to eliminate the corrosion products. To determine the final weight (w₁), the coupons were lastly dried, cleaned with distilled water, then weighed one more time. [29]

4.1.4. Wear Test

The pin-on-disk wear test equipment was used to conduct wear tests. At loads of 10, 20, and 30 N, an electrical motor was used to drive the disk at a constant sliding velocity of 2 m/s. The temperature was 200°C and the relative humidity was 55% during the experimentation period. Throughout the wear testing, experimental data, such as coefficient of friction and time, were continuously recorded. Following this procedure, 2 ms⁻¹ sliding velocity was obtained. The experiment was then stopped after measurements of 400, 800, 1200, and 1600 meters were made. Wear samples were then taken out, and the wear surfaces were measured with 0.001 mg accuracy using a sensitive scale. [30]

V. MECHANICAL PROPERTIES

5.1. Hardness Test

The hardness of all composites is higher than A356.1 due to the presence of MgO particles with high hardness. Despite a generally upward trend in hardness versus MgO content, samples with 2.5 vol% MgO content are harder than composites with 5 vol% MgO. This could have resulted from composites with a higher MgO content having increased porosity. Hardness also rose in response to temperature increases. This could be because heating has a beneficial effect on strengthening metal MgO binds at surfaces and making materials more wetttable. [23]

A firm, spherical indenter is pressed into the surface of the metal to be evaluated in a Brinell test. The tungsten carbide or hardened steel indenter has a diameter of 5 to 10 mm. Standard loads are 500–3000 kg, and they are held steady for a predetermined amount of time (ten to thirty seconds) during testing. Here, we employed a hardened steel indenter ball

with a 5 mm diameter, and the 750 kg weight was held steady for 10 seconds. Next, a hand microscope is used to measure the indentation on the specimen. [31]

A local seller is where I get the 50 mm size aluminium metal powder. The waste aluminium oxide sample is gathered from Oman's oil refinery business. The powder metallurgy process has chosen a die size of 25 mm in diameter and 150 mm in height. For ten minutes, hand stirring is used to combine the reinforcement and matrix. With a 49KN applied load, the prepared powder is poured into the die and compacted with the aid of a top punch utilizing a UTM machine. Ultimately, the green compact is sintered for five hours at 530°C before being cooled to room temperature. Wilson Wolpert machine (model number: MVD 410) in Vickers hardness scale is used to evaluate the produced samples for hardness value. The sample was subjected to a 0.3 kgf load and a 10-second dwell period at three distinct sites. The average of the hardness values was then used to get the hardness number. [39]

5.2. Charpy V-Notch Test

The Charpy V-notch tests were a highly useful method of determining the materials' relative capacity for energy absorption. Charpy V-notch tests were used in the study to assess the chosen Al alloys' fracture toughness. We only ran the experiments at ambient temperature. three distinct V-notched test specimens measuring 55 mm in length, 8 mm in ligament length, and 45° angles of the notch were made. The stock was machined into the V-notched specimens. [32]

5.3. Tensile Testing

Yield stress is incorporated by researchers into the relationships that exist between fracture toughness and Charpy V-notch tests. Thus, using tensile tests, the yield stress values of the chosen Al alloys were determined. ASTM E8-09: Standard test methodology for tension testing of metallic materials was followed in the execution of the tensile tests. [24]. The Shimadzu Autograph (50kN) testing apparatus with a video extensometer was utilized for the tensile tests. During the testing, the elongation was captured by two CCD cameras. The ram was chosen to move at a speed of 3 mm/min, which translates to a 7.14×10^{-4} s⁻¹ initial strain rate. Three separate waisted test specimens with a 45 mm gauge length and a 9 mm diameter were machined from the stock. The tensile specimens' dimensions are displayed. [32] Tensile testing was carried out at room temperature at a strain rate of 4 104 s⁻¹ using an Instron universal testing machine. The tensile properties for each condition, namely the yield stress (YS) at a 0.2% offset strain, ultimate tensile strength (UTS) and fracture elongation (%El), are reported as an average value of six test samples. [22]

Tensile testing of metallic materials was carried out using an MTS servo-hydraulic test machine in stroke control mode, adhering to the standards specified in ASTM: E8-M-08 for RT testing and ASTM: E1450-09 for cryotemperature testing. 0.5 mm/min for 20 K, 1 mm/min for 77 K, and 2 mm/min for RT were the displacement rates that were employed. For samples evaluated at cryotemperatures, strain was measured using a linear variable differential transformer (LVDT); for samples tested at room temperature, strain was measured using a 25 mm extensometer. The fit-back method was used to calculate the percent elongation. [33]

5.4. Bending Test

Mechanical tests called bending tests, sometimes referred to as flexural tests, are used to evaluate how materials behave under bending forces. A specimen is often supported at both ends and loaded in the middle of the test, or at another predefined location. The specimen deforms as a result of bending or flexural stress caused by the applied force. Many parameters can be measured during a bending test, such as Flexural Strength: The maximum stress that the specimen could withstand before failing, typically expressed in MPa or psi, or units of force per unit area. The stiffness or resistance to deformation of a material under bending stresses is represented by the modulus of elasticity, commonly referred to as the flexural modulus or Young's modulus in bending. [34].

A square sample of side 60 mm is set on two rollers with a diameter of 30 mm. The distance between the rollers is 2 mm, which corresponds to two times the sheet thickness. A sharp blade with a radius of 0.2 mm at its extremity is used for the bending. The load and displacement of the blade were also recorded during the test. It can be seen that there is a good reproducibility of the load displacement signal over several tests. Two transitions can be noticed, at points A and B defined. Point A corresponds to the elastoplastic transition. From A to B, the angle between the two straight parts of the blank decreases, thus leading to an increase of the strain in the area located under the blade. After point B, bending over the blade radius is finished and there is only a sliding of the blank on the roller. Strain distribution was measured by stereo correlation: a black and white pattern was sprayed on the outer surface before bending and pictures were

taken with two cameras of the area of interest before and after bending. Strain component ϵ_{XX} is highly localized in the bent area and reaches a maximum value of approximately 0.43 for a blade displacement of 12 mm. [40]

5.5. Microstructural Evaluation

Microstructural of alloy and each composite was observed using X-ray diffraction (XRD) is a non-destructive analytical technique used to analyse the crystalline structure of materials. It provides valuable information about the composition, crystallography, and phase identification of a sample. In XRD analysis, a beam of X-rays is directed at a crystalline sample, and the resulting diffraction pattern is recorded and analysed to determine the atomic arrangement and lattice spacing within the sample. The specimen was polished with emery grades series (220,320,800,1000,1200) in order to remove the surface scratches. At the final stages, these specimens were polished using velvet cloth polisher impregnated with very fine Al₂O₃ powder to get a mirror like finish. Super-finished specimens were etched with Keller's reagent, and their microstructures were observed. [35]

For every composition, the XRD analyses were comparable. Aluminium (Al), silicon (Si), and magnesium oxide (MgO) were only found, despite the fact that their peak intensities differed. demonstrates the XRD pattern of a nanocomposite that was created at 850°C and contained 2.5 vol.% MgO. Aluminium and magnesium oxide cubic (fcc) might be used to index all peaks. In the XRD pattern, no further crystallographic structure was found. This demonstrates that during casting, there are no significant interactions between the reinforcing phase and the base metal that could lead to the production of intermetallic phases. The comparatively strong MgO peaks indicate a nearly homogeneous distribution of ceramic particles within the metal matrix. [38]

5.6. SEM

This study used a transverse slice from an industrial AA2195 cast ingot made by Rio Tinto Alcan's Dubuc Works utilizing direct chill (DC) casting process. The measured cross section of the ingot, which had a length of several meters and a chemical composition of Al-4.04 Cu-1.05 Li-0.28 Mg-0.3 Ag-0.13 Zr (wt%), was 295 x 1372 mm². 150 x 20 x 18 mm³ rectangular samples were cut from the centre of the ingot for tensile testing and microstructural examination. Using optical and scanning electron microscopes (SEM, JEOL JSM-6480LV) for metallographic examination, the as-cast and heat-treated samples were polished and etched. [22]

The effect of porosity on the characteristics of Al/MgO nanocomposites, the microstructures of the cast samples were studied via SEM. Scanning electron micrographs of the as-cast Al/MgO nanocomposites with different amount of reinforcement phase, cast at 800, 850, and 950° C. The images are taken in BSE (back-scattered electron) mode in order to distinguish between different phases based on the difference of average atomic numbers of each phase, mainly A356.1 matrix, MgO, and pores. In this respect, the notable microstructural phenomena are agglomerations and porosity voids which appear as lighter and darker areas compared with ambient gray color of background, respectively, MgO has a higher density than aluminium alloy matrix, and so tends to appear brighter, accordingly. Notwithstanding, uniform distribution of reinforcement particles of MgO is attained in non-agglomerate areas (background area).[38]

5.7. Optical Microscope

The plate was received and its three orthogonal directions were used to cut metallographic samples. Using water as a lubricant, the samples were mounted in Bakelite and wet ground on silicon carbide paper with grit sizes of 320, 400, and 600. The ground samples were then mechanically polished with a polishing compound based on 1 µm alumina. To show the grain boundaries and general grain morphology, the polished samples were etched with Keller's reagent, inspected under an optical microscope, and photographed using a common bright-filled illumination approach. Transmission electron microscopy (TEM) revealed fine microstructural characteristics. [36]

5.8. FESEM

AA6063 alloy is used as the matrix alloy and fly ash as the reinforcement material to produce AA6063-FA composites. The fly ash particulates are collected from a thermal power station The fly ash particulates are initially preheated at temperature of 900°C for two hours to remove the impurities and water contents, and improve the wettability of the reinforcement particles with AA6063 alloy. Weight fraction of the fly ash particulates to synthesise the composites is set between 0-6 wt.%, in steps of 2%. The AA6063 rod is cut and charged into crucible inside the induction furnace, heated to temperature of 750°C ± 50°C above the liquidus temperature of the alloy and then the temperature in the furnace is reduced to 600°C to get semi-solid state of the alloy. At this temperature, the preheated fly ash is added to the

molten AA6063 alloy and the mix is manually stirred for about 15 minutes. The composite slurry is then superheated to 750°C and stirred using the mechanical stirrer at a speed of 300 rpm to improve the fly ash particles distribution in the molten AA6063 alloy. The slushy composites are cast into preheated steel moulds. AA6063 alloy is prepared by casting for experimentation control. The cast test samples are then heat-treated for two hours at 560°C, where they are quenched in water at room temperature and then aged for three hours at 160°C. The specimens prepared are polished and etched as per the standard metallographic procedure. The microstructures of these etched specimens are observed using the Field Emission Scanning Electron Microscope FESEM. [37]

VI. CONCLUSION

The above review for the stir cast aluminium-based metal matrix composite leads to the following conclusions:

- Stir casting method can be successfully used to manufacture metal matrix composite with desired properties.
- From the extensive literature, it is evident that the majority of study papers concentrated on examining various mechanical and tribological features.
- Tests for mechanical properties such as tensile, hardness, impact, and bending tests; testing for tribological qualities such as wear, potentiodynamic polarization, immersion, and weight loss experiments.
- Reinforcing Aluminium and its alloys with magnesium particles has shown an appreciable increase in its mechanical properties and tribological properties.

REFERENCES

- [1] G.E. Hatch, Aluminum, in: Properties and Physical Metallurgy, ASM International, Metals Park, OH, 1984, pp. 30-35.
- [2] D. Hull, An Introduction to Composite Material, second ed., McGraw-Hill, New York, 1981, pp. 196-252.
- [3] W.F. Smith, Principles of Materials & Engineering, McGraw-Hill, New York, 1996.
- [4] S.B. Hassan, O. Aponbiede, V.S. Aigbodion, J. Alloys Compd. 466 (2008) 268-272
- [5] S. Zhang, Y. Zhao, G. Chen, X. Cheng, J. Alloys Compd. 475 (2009) 261-267.
- [6] W. Jianhua, Y. Danqing, S. Xuping, Y. Fucheng, L. Hongwu, Mater. Des. 30 (2009) 78-81.
- [7] Y. Sahin, M. Kok, H. Celik, J. Mater. Process. Technol. 128 (2002) 280-291.
- [8] S. Chou, J. Huang, D. Lii, H. Lu, J. Alloys Compd. 419 (2006) 98-102
- [9] K.M. Shorowordi, T. Laoui, A.S.M.A. Haseeb, J.P. Celis, L. Froyen, J. Mater. Process. Technol. 142 (2003) 738-743.
- [10] EL. Pen, D. Baptiste, G. Hug, Int. J. Fatigue 24 (2002) 205-214.
- [11] M. Khakbiz, F. Akhlaghi, J. Alloys Compd. 479 (2009) 334-341.
- [12] G.R. Li, Y.T. Zhao, H.M. Wang, G. Chen, Q.X. Dai, X.N. Cheng, J. Alloys Compd. 471 (2009) 530-535.
- [13] J.K.M. Kwok, S.C. Lim, Compos. Sci. Technol. 59 (1999) 55-63.
- [14] J. Hashmi, L. Looney, M.S.J. Hashmi, J. Mater. Process. Technol. 92/93 (1999) 1-7.
- [15] X.J. Wang, X.S. Hu, K. Wu, K.K. Deng, W.M. Gan, C.Y. Wang, M.Y. Zheng, Mater Sci. Eng. A 492 (2008) 481-485.
- [16] B. Previtali, D. Pocci, C. Taccardo, Compos. Part A: Appl. Sci. Manuf. 39 (2008) 1606-1617.
- [17] A. Daoud, M. Abo-Elkhar, J. Mater. Process. Technol. 120 (2002) 296-302.
- [18] G.E. Dieter, Mechanical Metallurgy, third ed., McGraw-Hill, New York, 1986.
- [19] Evangelia Georgantzia *, Michaela Gkantou, George S. Kamaris;
Aluminium alloys as structural material: A review of research
- [20] Ghanaraja.S.a, Vinuth Kumar.K.L.b*, Raju.H.P.c and Ravikumar. K.S.d ; Processing and Mechanical Properties of Hot Extruded Al (Mg)-Al₂O₃ Composites
- [21] Jae-Hee Kim a, Jeong-Hoon Jeun b, Hyun-Jin Chun c, Ye Rim Lee d, Joon-Tae Yoo a, Jong-Hoon Yoon a, d, Ho-Sung Lee a, d, *; Effect of precipitates on mechanical properties of AA2195
- [22] A. Hekmat-Ardakan a, E.M. Elgallad b, F. Ajersch c, X.-G. Chen b,n ; Microstructural evolution and mechanical properties of as-cast and T6-treated AA2195 DC cast alloy
- [23] A. Ansary Yar^a, M. Montazerian^b, H. Abdizadehb, H.R. Baharvandi^c ; Microstructure and mechanical properties of aluminum alloy matrix composite reinforced with nano-particle MgO.
- [24] Y.G. Kima,*, H. Fujii b, T. Tsumura b, T. Komazaki c, K. Nakata b; Three defect types in friction stir welding of aluminum die casting alloy

- [25] Ulhas .K. Annigeria* G.B. Veeresh Kumarb; Method of stir casting of Aluminum metal matrix Composites: A review
- [26] Yangguang ZHANG, Yueliang CHEN*, Yong ZHANG, Guixue BIAN, Chenguang WANG, Andong WANG; Initial corrosion behavior and mechanism of 7B04 aluminum alloy under acid immersion and salt spray environments.
- [27] R. GHOSH, A. VENUGOPAL, P. RAMESH NARAYANAN, S. C. SHARMA, P. V. VENKITAKRISHNAN; Environmentally assisted cracking resistance of Al–Cu–Li alloy AA2195 using slow strain rate test in 3.5% NaCl solution.
- [28] K. Surekha, B.S. Murty *, K. Prasad Rao; Microstructural characterization and corrosion behavior of multipass friction stir processed AA2219 aluminium alloy
- [29] R. Rosliza ^{a*}, W.B. Wan Nik ^b, H.B. Senin ^b; The effect of inhibitor on the corrosion of aluminum alloys in acidic solutions.
- [30] Ahmet Meyveci ^a, I' smail Karacan^a, Ug' ur C, alıg' ül' ub, Hülya Durmus ^c ; Pin-on-disc characterization of 2xxx and 6xxx aluminium alloys aged by precipitation age hardening.
- [31] B.Babu, S.K.Karthikeyan, V.Adithya; Experimental Investigation and Analysis of Corrosion and Hardness using Aluminium Composites
- [32] Rasid Ahmed Yildiz^{1,2*}; Evaluation of fracture toughness and Charpy V-notch test correlations for selected Al alloys.
- [33] Niraj Nayan a, *, S.V.S. Narayana Murty a, Abhay K. Jha a, Bhanu Pant a, S.C. Sharma a, Koshy M. George a, G.V.S. Sastry b; Mechanical properties of aluminium–copper–lithium alloy AA2195 at cryogenic temperatures
- [34] Lademo OG, Engler O, Keller S, Berstad T, Pedersen KO, Hopperstad OS. Identification and validation of constitutive model and fracture criterion for almgsi alloy with application to sheet forming. Mater Des 2009;30: 3005–19.
- [35] ANOOP KUMAR TULI, PRADEEP SINGH-"@, S DAS", D P MONDAL* and J P SHAKYA; Analysis of microstructural, mechanical and thermal behaviour of thixocast LM25-10wt% SiC composite at different processing temperatures.
- [36] T. S. SRIVATSAN, S. SRIRAM, D. VEERARAGHAVAN, V. K. VASUDEVAN; Microstructure, tensile deformation and fracture behaviour of aluminium alloy 7055
- [37] A M Razzaq^{1,5}, D L Abang Abdul Majid^{2,*}, M R Ishak² and M B Uday^{3,4} ; Microstructural characterization of fly ash particulate reinforced AA6063 aluminium alloy for aerospace applications
- [38] H. Abdizadeh^{1,2} , P. H. Vajargah¹ , M. A. Baghchesara³ *; Fabrication of MgO nanoparticulates reinforced aluminum matrix composites using stir-casting method
- [39] R. Akash a, R. Muraliraja b,[†], R. Suthan a, V.S. Shaisundaram c ; Synthesis and testing of aluminium composite using industrial waste as reinforcement
- [40] S. Thuillier [†], N. Le Maoût, P.Y. Manach; Influence of ductile damage on the bending behaviour of aluminium alloy thin sheets
- [41] Sampath Boopathi a,[†], M. Jeyakumar b, G. Robert Singh c, Francis Luther King c, M. Pandian d, Ram Subbiah e, V. Haribalaji f ;An experimental study on friction stir processing of aluminium alloy (AA-2024) and boron nitride (BNp) surface composite
- [42] Srinivasa Rao. M1*, K. T. Balaram Padal1; Influence of Rolling and Ageing on Mechanical Properties of AA2195 Based Metal Matrix Composites
- [43] K. Ravikumar [†], K. Kiran, V.S. Sreebalaji ; Characterization of mechanical properties of aluminium/tungsten carbide composites
- [44] Ali Dad Chandio*, Muhammad Basit Ansari, Shahid Hussain, Muhammad Ali Siddiqui; Silicon Carbide Effect as Reinforcement on Aluminium Metal Matrix Composite



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