Processing And Analysis of Metal Matrix Composition on Nanocomposite

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Abstract- *In this work, Aluminium – based composite has been fabricated for the various mechanical behaviour. Aluminium A6061 alloy has been chosen for base alloy and Silicon Carbide are taken as the reinforcement material. Squeeze casting direct pressure method and stir casting process. The amount of reinforcement has been varied and was fabricated using the stir casting process in which A6061 is well stirred with Silicon Carbide. The molten metal is then subjected to die of cylindrical shape and pressure applied. After getting the component, the fabricated metal matrix composite was subjected to various mechanical testing and analysis procedures obtained, then, finally the results are concluded.*

Keywords- Aluminium A6061 alloy, Silicon Carbide.

I. INTRODUCTION

The modern technology mostly focuses on the improvement and optimization of the properties of the existing materials or metals to obtain maximum useful properties from the material. One such optimization/improvement technique is the formation of Metal Matrix Composite (MMC). The Metal Matrix Composites consists of two phases namely the reinforcing material in a discontinuous phase which is embedded inside a continuous phase or the matrix material. In this, the reinforcement material is seen to have very high strength and hardness compared to the matrix phase. The most commonly seen Metal Matrix Composites are the Aluminium or Al-based Metal Matrix Composites; TiB_2 has been recently noted for its high hardness at high temperatures and high electrical conductivity. The Aluminium based composites are recognized for its improved mechanical properties without the change in its density. They are also noticed for having high hardness, thermal stability, resistance to plastic deformation, high melting point, etc. Processing of Composites, the parameters need to be selected carefully. The stirring speed, time and selection of materials have to be studied precisely before fabricating the composites. In this study, stirring technique is used to mix the reinforcement with the base alloy. The mechanical properties are identified and it has been correlated with wear behaviour of the composites. 6061 is one of the most commonly used grades Aluminium grades in the world. Whether it's an Aluminium sheet, Aluminium plate, Aluminium bar, or Aluminium angle, 6061 is the choice for a wide range of applications, including boats, furniture, and structural applications.

So, what makes 6061 so versatile Like with any grade, it starts with the makeup of the metal. Its major alloying elements are magnesium (1.0%) and silicon (0.6%). This makes it highly resistant to corrosion, stress, and cracking. This also means the grade features good formability and weldability.6063 is another commonly used grade of aluminum and is often compared to 6061. Both 6061 and 6063 are made up of magnesium and silicon as their primary alloying elements, meaning they exhibit many of the same properties. The difference between 6061 and 6063 is mainly in the end use. 6063 is a common grade used for custom extrusions.

1. COMPOSITES STRUCTURE:

The composites constitute a major proportion in the category of engineering materials where application ranges from day-to-day products to products for complex applications, such that they conquer the market. There is a steady and substantial growth of composite materials. Several combinations of the matrix materials, the current challenge is to make them cost-effective. Many innovative manufacturing methods resulted in the production of composites in more economic manner with short manufacturing lead time. But the manufacturing technique is not only the solution for making cost-effective composites. The Integration of Designing, Tooling, Materials selection, Quality control and manufacturing management technique should be done to give a better cost-effective composite, with achievement of concurrent engineering.

2. Matrix phase

The primary phase, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it.

3. Dispersed (reinforcing) phase

The second phase is embedded in the matrix in a discontinuous form. This secondary phase is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is sometimes called reinforcing phase. Many of common materials (metal alloys, doped Ceramics and Polymers mixed with additives) also have a small number of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents (physical properties of steel are similar to those of pure iron).**6061** (Unified Numbering System (UNS) designation A96061) is a precipitation hardened Aluminiumalloy, containing magnesium and silicon as its major alloying elements. Originally called "Alloy 61S", it was developed in 1935. It has good mechanical properties, exhibits good weldability, and is very commonly extruded (second in popularity only to 6063). It is one of the most common alloys of aluminum for general-purpose use.It is commonly available in pre-tempered grades such as 6061-O (annealed), tempered grades such as 6061-T6 (solutionized and artificially aged) and 6061-T651 (solutionized, stress-relieved stretched and artificially aged.

4. CHEMICAL COMPOSITION

	6061 Aluminum Alloy Composition by Mass %						
Al	Mg	Si	Fe	Cu	Cr	Zn	Ti
95.85 - 98.56	0.8 - 1.2	0.40 - 0.8	0.0 - 0.7	0.15 - 0.40	0.04 - 0.35	0.0 - 0.25	0.0 - 0.25

5. PROPERTIES

The mechanical properties of 6061 depend greatly on the temper, or heat treatment, of the material. Young's Modulus is 69 GPa (10,000 ksi) regardless of temper. Annealed 6061 (6061-O temper) has maximum ultimate tensile strength no more than 150 MPa (22 ksi), and maximum yield strength no more than 83 MPa (12 ksi) or 110 MPa (16 ksi). The material has elongation (stretch before ultimate failure) of 10–18%. To obtain the annealed condition, the alloy is typically heated at 415 °C for 2-3 hours. T4 temper 6061 has an ultimate tensile strength of at least 180 MPa (26 ksi)[8] or 210 MPa (30 ksi) and yield strength of at least 110 MPa (16 ksi). It has elongation of 10-16%.6061-T6Edit6061-T6 Aluminum Standard Heat Treating ProcessmT6 temper 6061 has been treated to provide the maximum precipitation hardening (and therefore maximum yield strength) for a 6061 aluminum alloy. It has an ultimate tensile strength of at least 290 MPa (42 ksi) and yield strength of at least 240 MPa (35 ksi). More typical values are 310 MPa (45 ksi) and 270 MPa (39 ksi), respectively. This can exceed the yield strength of certain types of stainless steel in comparison. In thicknesses of 6.35 mm (0.250 in) or less, it has elongation of 8% or more; in thicker sections, it has elongation of 10%. T651 temper has similar mechanical properties. The typical value for thermal conductivity for 6061-T6 at 25 °C (77 °F) is around 152 W/m K. A material data sheet defines the fatigue limit under cyclic load as 97 MPa (14 ksi) for 500,000,000 completely reversed cycles using a standard RR Moore test machine and specimen. Note that aluminum does not exhibit a well defined "knee" on its S-n graph, so there is some debate as to how many cycles equates to "infinite life". Also note the actual value of fatigue limit for an application can be dramatically affected by the conventional de-rating factors of loading, gradient, and surface finish.

6. MICROSTRUCTURE

Different aluminum heat treatments control the size and dispersionof Mg_2Si precipitates in the material. Grain boundary sizes also change, but do not have as important of an impact on strength as the precipitates. Grain sizes can change orders of magnitude based upon stress and can have grains as small as a few hundred nanometers, but are typically a few micrometers to hundreds of micrometers in diameter. Iron, manganese, and chromium secondary phases(Fe_2Si $_2Al$ $_9$, (Fe, Mn, Cr) $_3SiAl$ often form as inclusions in the material. Grain boundaries in extruded plate 6061 aluminum alloyGrain sizes in aluminum alloys are heavily dependent upon the processing techniques and heat treatment. Different cross-sections of material which has been stressed can cause order of magnitude differences in grain size. Some specially processed aluminum alloys have grain diameters which are hundreds of nanometers, but most range from a few micrometers to hundreds of micrometers.

7. CHARACTERISTICS OF THE COMPOSITES

The composites comprise of 2 phases – a discontinuous phase call reinforcement embedded in a cent / Matrix phase. The reinforcement may be one (or) more in number which is usually stronger and harder than the Matrix part.The composites property is highly dependent on the properties of Matrix and reinforcement materials. The distribution of reinforcement and the interaction of the reinforce with the Matrix phase decide the property of the composite as a whole. The geometry of reinforcements (Size, shape, orientation and distribution) also influences the properties of the composite to major extent. The reinforcements shape may be spherical / cylindrical if the aspect ratio is i.e. (l/d) is 1. Else the shape of the reinforcement may be rectangular cross-section platelets. The volume fraction of the reinforcement is correlated with the interfacial area, that determines the extent of bonding between the Matrix and reinforcements phase.The addition of reinforcements to the Matrix phase is expressed in terms of either volume fraction (or) mass fraction which determines the overall properties of the composites. The mixing of reinforcements with the matrix is the uncontrollable parameter, while fabricating the composite. The process parameters should be well – defined while performing casting techniques, where the isotropy of the composite as a whole should not get deviated.In Aerospace industries, the Research focus is done on fibre reinforced Aluminium /Titanium Metal Matrix composite. The fibres of Boron, Silicon and Alumina are some of the reinforcements that are commonly used. Titanium reinforced with SiC and sometimes Beryllium are used for the manufacture of compressor blades. The unidirectional orientations of fibres / whiskers in the Metal Matrix are used to achieve good elastic modulus, through the bonding between the Matrix and the reinforcement is weak. But a strong Metal Matrix is required for achieving better shear strength and Traverse loading.

8. POLYMER MATRIX COMPOSITES

Polymer Matrix Composites (PMCs) have reinforcements (fibers, whiskers or particulates) embedded in a polymer resin matrix (e.g. Polyesters, vinyl esters, PEEK, PPS). These composites are used in a broad range of applications from aircraft structures to office furniture. Among the PMC's Glass Fibre Reinforced Polymer (GFRP) composites find a diversified range of applications from automobile bodies to containers. Epoxy based polymer matrix composites exhibit high strength to weight ratios which are used in aerospace and space technologies. In addition, a Carbon Fiber Reinforced Polymer (CFRP) composite finds application in sports and recreational equipment, aircraft structural components pressure vessels, Rocket motor cassis. Automotive industries consume increased amounts of PMCs in an attempt to reduce the weight of the vehicle weight in order to improve the fuel efficiencies.

II. LITERATURE SURVEY

B. Prakash , M. Manimaran Investigations on mechanical properties of Al6061-SiC nanocomposites fabricated via stir casting process-2018 Silicon Carbide (SiC) to Al6061 alloy the percentage of SiC was varied composites were fabricated by the stir casting process. The fabricated composites were analyzed for morphological and mechanical tests.It was found that the addition of SiC by 7 wt% resulted in enhanced properties. SEM shows that there was a uniform distribution of SiC in Al6061 matrix which resulted in an enhancement in properties.The tensile strength characteristics were enhanced when SiC particles was added at 7 wt% which is due to proper bonding between the matrix and filler.The addition of SiC by 7 wt% resisted the indentation which increased the hardness particles.The impact was more when SiC was added at 7 wt% and it is due to the presence of more amount of harder SiC particles in it.

R.Padhmanabhan ,B.J MacDonald in Elastic–plastic behaviour of an AlSiC MMC rod under combined tension and torsion loading.Structural members subjected to external load achieve extra strength by an initial permanent deformation. During the initial stages of elasto-plastic deformation, increasing stress is needed to cause plastic strain in the member, due to strain hardening. In practice, the stresses imposed by service loadings are likely to be complex. When safety factors are reduced to save weight the stresses in the material will approach the yield condition. In most conventional engineering alloys, plasticity will offer the safety margin required. The present study examines the critical elasto-plastic load carrying capacity of pAlSiC MMC rod under combined axial and shear stress states.

Milind S. Mhaske ,Uddhav M. Shirsat in An investigation of mechanical properties of Aluminium based silicon carbide (AlSiC) metal matrix composite by different manufacturing methods. The effect of reinforcement material and manufacturing process on the mechanical properties of non-asbestos material has been studied. Metal matrix composites (MMCs) shows good properties from the combination of a soft material like Aluminium or magnesium with hard reinforcement material such as silicon carbide (SiC) or graphite. Such composites are formed by regulating the constituent surface morphology to obtain the optimum combination of properties. The properties of the composites depend on the characteristics of the components, their relative quantity, and the structure of the dispersion process consisting of the size, shape, and orientation of the particle in the matrix. Mechanical properties and microstructural analysis of Al-SiCComposites produced under different process conditions were investigated in this work to understand their process structure–property relationships through the optimization method. The addition of silicon carbide particles to base material Aluminium has shown improved mechanical properties.

K.RAharwal, C.M Krishna in Optimization of Material Removal Rate and Surface Roughness in EDM Machining of Metal Matrix Composite using Genetic Algorithm.Aluminium Silicon Carbide (AlSiC) is most widely used in the fields of aerospace, electronics, military, automobile and medical etc., in the form of dies, components, and products. The present work has been carried out to optimize the machining parameters on Electric Discharge Machine (EDM) using AlSiC as work piece and pure copper as electrode. Machining parameters which are investigated in this work are Material Removal Rate (MRR) and surface roughness. Control parameters used are discharge voltage (v), discharge current (Ip), Pulse duty factor (Tau), Pulse on time (Ton). Taguchi technique (L16b orthogonal array) was used for design of experiments and genetic algorithm for optimization. The analysis of material removal rate yields optimum values when current is high and voltage is low where as surface roughness is best when both are low.

B.Torres , J.Rams in Thermal spray coatings of highly reinforced Aluminium matrix composites with sol–gel silica coated SiCparticles.Low porosity coatings made of Aluminium matrix composites reinforced with SiC particles were fabricated by a thermal spray method. The initial spray material used was a mixture of Aluminium powder and SiC particles which were directly fed in the thermal spray gun flame without any previous sintering. Sol–gel silica coatings with different structural characteristics were deposited on the SiC particles before mixing with Aluminium powder to increase the wettability of reinforcement by molten Aluminium during the spray while avoiding the appearance of any degrading reaction between Aluminium and SiC particles. The thermal spray coatings were manufactured with different reinforcement degrees from 4 vol.% to 47 vol.% SiC using mixtures of sol–gel coated SiC particles in the 20% to 70% range. Porosity was in most cases below 1%. The relevance of using sol–gel coatings on reinforcement particles and of the sol–gel structure is analysed

BaskaranJ., Raghuvaran P., Ashwin S.-Experimental investigation on the effect of microstructure modifiers and heat treatment influence on A356 alloy-2020 Compared to other aluminum alloys, refined A356 alloy is particularly attractive for various auto-motive applications. Grain refinement of aluminum gives a number of technical advantages, including reduced cracking, better homogeneity, better mechanical deformation characteristics and improved mechanical properties. Cast A356 alloy with added copper was studied with their unique mechanical behaviour and microstructure. This is carried out in both as cast condition and heat treated condition and properties are investigated. Addition of Cu to A356 results in Fine and dispersed Silicon phase conversion of coarse a-Al dendritic structure to equiaxed structure. This may be due to Al2Cu intermetallic particles leads to adequate of a-Al dendrites. Dendrite arm spacing also decrease which makes themicrostructure finer resulting improved mechanical properties, Addition of copper was improved the percentage of elongation and hardness value (75%) at first, but further addition the values were changed drastically.A Fine Al2Cu precipitate caused by the increment of copper which influences much improvement in both the tensile and hardness values.

Yuncan Tian, Dongye Yang, Mengqi Jiang, and Bo he accurate simulation of complex temperature field in counter-pressure casting process using a356 aluminum ALLOY -2020Cast Aluminium steering knuckles are usually produced using some type of enhanced low-pressure casting process, like counter-pressure casting. Compared with aluminum forging and sand cast ductile iron, it can improve the production speed and achieve the adequate casting quality.Various methodologies such as dynamic thermomechanical analysis, differential scanning calorimetry, and the laser flash method were employed to study the thermophysical properties of AlSi7Mg0.3. Further, the physical model of a counter-pressure casting system with an aluminum interior was established based on the combination of the tested and the theoretical properties of Aluminium this was achieved with the consideration of the presence of other factors including rapid solidification. The temperature field of the system was computed and verified by thermocouples at six different points during the tooling and the shrinkage simulation. It was observed that the plot shape of the computed temperatures and that of the simulated ones correlated further, the difference between the peaks and the valleys was controlled to be 3% on an average, with the maximum variation of 7% at only one point. Moreover, all the predicted shrinkages were verified by the casting.Compared with the database of the simulation software, it was observed that the measured density of materials was 3–10% higher, specific heat capacity was approximately 10% higher, and measured thermal conductivity was 2% higher in addition, the measured solid- and liquid-phase temperatures decreased by 12 °C and 8 °C.

K Logesh, P Hariharasakthisudhan, A Arul Marcel Moshi, B Surya Rajan and Sathickbasha K Mechanical properties and microstructure of A356 alloy reinforced AlN/MWCNT/graphite/Al composites fabricated by stir casting(2019) The influence of different shaped reinforcement in the microstructure and mechanical behaviour of composites. The reinforcements (AlN& MWCNT) were added and the graphite was maintained in 0.5 vol%. The composites were fabricated using stir casting followed by ultrasonic vibration treatment. Particle strengthening and grain refinement strengthening were found to be operative in the composites. The SEM micrograph of fractured surface of composites with MWCNT exhibited the crack bridging effect as strengthening mechanism apart from particle strengthening. The porosity and cluster of reinforcements were observed in the composites with MWCNT more than 1 vol% of and AlN 0.75 vol%.The composites with different shape reinforcements AlN (blocky) and MWCNT (Tube) were fabricated using stir casting followed by ultrasonic Vibration treatment.The tensile strength and ductility of the composites increased integrally as the grain refinement enhanced the plastic deformation of the composites. The ductile fracture was observed in the composites with AlN and MWCNT. The mixed mode of ductile and brittle fracture was observed in composites with agglomeration of AlN in the composites.The optimum vol% of reinforcements was identified as 1% for MWCNT and 0.75% for AlN. The particle-porosity cluster was identified when the vol% of reinforcement increased more than above said limits.

Varun Jurwall, Ashok Kumar Sharma, and Anand Pandey Fabrication characterization and machining of micro hybrid Al6061 Aluminium composite Fabrication and characterization and machining of AA 6061/ ZrO_2 and TiO_2 AMMC (Aluminum Metal Matrix Composites) by stir casting . ZrO_2 and TiO_2 particles were consistently dispersed in the base alloy and it was concluded that these have well-bred the grains of the aluminum matrix. Clusters of ZrO_2 and TiO_2 particles was identified in few sites. Hardness at micro level and wear defiance has been enhanced by the reinforcements of ZrO_2 and TiO_2 particles.

Manish Maurya, Sudhir Kumar, Vivek Bajpai and Nagendra Kumar Maurya Effect of SiC Reinforced Particle Parameters in the Development of Aluminium Based Metal Matrix Composite-2020 SiC particles on Al 6061 alloy composites are prepared with varied weight percent of SiC particles through electromagnetic stir casting technique.. The hardness and tensile strength is significantly improved up to 8 wt % of SiCparticles.In this present work, series of Al 6061 alloy matrix composite containing 2, 4, 6, and 8 wt% SiC content were casted using electromagnetic stir casting technique. Homogeneous and uniform dispersion of SiC particles was observed in the aluminum matrix. The density of the composite was increased with the increase of silicon carbide content. 1.11% density of the composite was increased with incorporating 8 wt% of silicon carbide. Considering the result of Rockwell hardness test, the maximum hardness was 51 HRB. 27.5% hardness was enhanced to Al6061/8wt%SiC in comparison to base alloy Al 6061. The maximum tensile strength was enhanced to 298 MPa for Al 6061/8wt%SiC composite in reference to Al 6061 alloy, having 276 MPa. The UTS was improved with the addition of SiC particles. Al 6061/8wt%SiC composite had maximum UTS of 324.7 MPa in context to base alloy, having 299.3 MPa. With the enhanced UTS, the ductility of the composite was reduced.

Morteza Tayebi a, Mahdi Tayebi a ,Mohammad Rajaee b, * , Vahid Ghafarnia c , AsiyeMobasheriRizi d Improvement of thermal properties of Al/Cu/SiC composites by tailoring the reinforcement microstructure and comparison to thermoelastic models-2020 Density measurements revealed that the samples Al/15Cu/10SiC and Al/45Cu/20SiC had the highest and lowest relative density (97% and 90%),. Microhardness evaluations displayed that the composite hardness improved as the Cu and/or SiC contents increased. Besides, the coefficient of thermal expansion of the composites increased nonlinearly by elevating the temperature and it reduced with increasing the SiC content. A comparison of thermal expansion coefficient values to the Turner and Kerner models showed a slight difference (lower that 8%) only for Al/15Cu/10SiC and Al/45Cu/20SiC samples. Thermal cycles examination exhibited that as the number of cycles increased, the thermal strain of the composites increased. Furthermore, the thermal expansion coefficient of Al/45Cu/20SiC reduced to values lower than 7 ppm that indicates the significance of Cu network structure

R.TaherzadehMousavian, S.Behnamfard, R.AzariKhosroshahi, J.Zavašnik, P.Ghosh, S.Krishnamurthy, A.Heidarzadeh, D.Brabazon Strength-ductility trade-off via SiC nanoparticle dispersion in A356 Aluminium matrix(2020) A process was developed to disperse β-SiC nanoparticles (NPs), with a high propensity to agglomerate, within a matrix of A356 aluminum alloy. A suitable dispersion of 1 wt.% SiC NPs in the A356 matrix was obtained through a hybrid process including a solid-state modification on the surface of the NPs, a two-step stirring process in the semi-solid and then the liquid-state, and a final hot-rolling process for fragmentation of the brittle eutectic silicon phase and porosity elimination. Titanium and nickel where used as the nanoparticle SiC surface modifiers. Both modifiers were found to improve the mechanical properties of the resulting material, however, the highest improvement was found from the nickel surface modification. For the nickel modification, compared to the non-reinforced rolled alloy, more than a 77 %, 85 %, and 70 % increase in ultimate tensile strength (UTS), yield strength (YS), and strain % at the break, respectively were found with respect to the unreinforced rolled A356. For the rolled nanocomposite containing 1 wt. % SiCnp and nickel modification, an average YS, UTS, and strain % at the break of 277MPa, 380 MPa, and 16.4% were obtained, respectively, which are unique and considerable property improvements for A356 alloy.A suitable dispersion of fine and coarse NPs suitable dispersion caused a considerable interaction of fine NPs with dislocations, and dislocation bowing was detected and shown. 3- With improved microstructure, a suitable combination of strength and ductility (380 MPa for UTS and 16.4 % elongation to failure) was obtained for the Ni-rich samples compared to previous reports. 4- No Ni was detected around an individual fine SiC NP showing that Ni modifier interacted with melt during stirring, and they were not effective on the solidification process of NPs.

III. EXPERIMENTAL SETUP

Experimental Setup Different processing methods such as stir casting, powder metallurgy and squeezecasting, etc., have been attempted and discussed to synthesize dual particles reinforced Aluminium matrix composites (AMCs).

a. Casting Process

Casting is a manufacturing process in which a liquid material is usually poured intoa Mould, which contains a hollow cavity of the desired shape,and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the Mould to complete the process. Casting materials are usually metals or various time setting materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomicalto make by other methods.Heavy equipment like machine tool beds, ships, propellers, etc. can be cast easily in the required size, rather than fabricating by joining several small pieces. In metalworking, metal is heated until it becomes liquid and is then poured into a mold. The mold is a hollow cavity that includes the desired shape, but the mold also includes runners and risers that enable the metal to fill the mold. The moldandthe metal are then cooled until the metal solidifies. The solidified part (the casting)is then recovered from the mold. Subsequent operations remove excess material caused by the casting process

b. Cutting

The large body of the investigated material is not necessarilyhomogeneous; therefore the specimen should be taken from the region, adequately representing the structure and other features of the large sample. Sometimes the directional factor is essential: preferential direction of crystals formed in directional solidification, elongated grains and inclusions after rolling. In these cases direction of the cut surface is taken into account. Cutting operation itself may change the specimen micro-structure, due to heating and mechanical damage. Cutting technique is selected in a way, preventing such effect.

- Soft non-ferrous alloys are cut by resin bonded SiC discs.
- Steels and hard non-ferrous alloys are cut by resin bonded alumina discs.
- Ceramics, minerals, composite and electronic materials are cut by low speed diamond wafer blades.

c. Mounting

Mounting metallographic specimen serves for protection of the specimen edges and improvement of its irregular shape, enabling both easy manual and automated grinding/polishing operation. Compression mounting is the most popular method for metal specimens.

- Phenolic resin is the most widely used low-cost mounting material.
- Acrylic resin is used when clarity of the mounting is important.
- Epoxy resin is used when hardness of the mount is required.

d. Grinding

Surface damages, created by cutting discs, are reduced by grinding. Dry or wet silicon carbide abrasive paper is used for grinding operation. Special grinding tables equipped with clamps for strips of grinding paper are used for manual grinding. Rotary grinding/polishing machine is used for automated grinding. The rotation speed, which initially is about 300 RPM should be decreased to150 RPM in the course of grinding. Grinding is carried out on a series of stages with increasing the fineness of the paper: 240, 400, 600, 1000. The fineness number indicates a number of SiC grains on square inch. Each grinding operation removes the marks, produced in the previous operation. After each grinding stage the specimen should be thoroughly washed in order to prevent carry-over the coarser grit to the grinding paper. The grinding direction of each stage should be changed by 90° relative to the direction of the previous stage. This makes easier indication of completion of the grinding stage (removal of the scratches from the previous stage).

e. Polishing

The fine scratches caused by final grinding operation are removed by polishing. Flaky powders of different fineness are used as polishing abrasives. A mixture of powder and water is spread over a rotating disc covered with polishing velvet cloth. Alumina, magnesia and diamond powders of various fineness (12-15mkm, 5-6mkm, 1mkm) are usually used for successive polishing stages. The specimen is thoroughly washed after each stage in order to prevent contamination of the polishing cloth by coarse powder particles from the previous stage. Rotary disc machines with adjustable rotation speed are used for polishing. The machine may be equipped with an appliance for the specimens holding and loading. Etching is the operation of revealing microstructural features (grain boundaries, phases, precipitates and other micro-structure constituents) of the polished specimen through selective chemical attack of its surface. The specimen must be washed and degreased in boiling alcohol and then cooled in running water before etching in order to prevent uneven attack and stains.Clean specimen is etched by being immersion in the etching reagent for a given time. Then the specimen is quickly removed from the reagent and immediately swilled in running water.The etched specimen is then visually inspected. Its surface should have slightly dull appearance (bright appearance requires additional etching).Then the wet specimen should be dried in alcohol.

f. DE-WINTOR INVERTED TRINOCULAR METALLURGICAL MICROSCOPE

Magnification : 50X to 1000X
Eyepiece : Paired 15X and 10X
Objective : 5X, 10X, 20X, 25X, 45X 50X and 100X (Oil)
Power : 12 Volt, 50Watts Halogen lamp
Shaft : X-Y direction with 360° Rotation
Polarization : With Polarizer Prism
Micro Scale : Attached with 0.01mm Occular scale.
The microscope is attached with a 3 M. Pixils camera
Image Analysis Software details:
Soft ware name: De-winter Material plus version-2
Features:

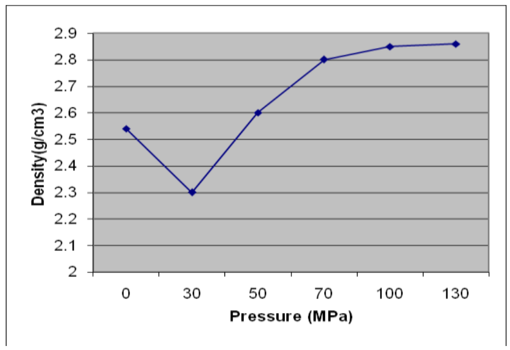
1) Phase contrast study and evaluations.
2) Grain size measurements
3) Phase segmentations
4) Inclusion rating as per international standards.
5) Case depth
6) Nodularity in different S.G. irons.
7) Characteristics of different type of flaked graphites.
8) Porosities evaluations in given area.
9) nature of grains and it percentages in given matrix.
10) Crack length and propagations.
11) De carburized depth.
12) Study of wear pattern with standards.

IV. TESTING METHODS

(1) Pressure Vs Density

Sample No	Pressure (Mpa)	Density (g/cm^3)
1	0	2.51
2	30	2.3
3	50	2.6
4	70	2.8
5	100	2.85
6	130	2.86

(2) Density and Pressure



(3) Hardness sample 1

Distance in mm Edge	Hardness in Vickers Scale @ 0.5 kg load.
1	79.8
2	73
3	68.7
4	72.2
5	63.4
6	70.8
7	72.7
8	69.5
9	65.7
10	66.8
11	67.1
12	73.6
13	64.7
14	80.1
15	88.4
16	85.9
17	68.6
18	66.9
19	64.5
20	69.8
21	67.6
22	65.1
23	69.9
24	69.7
25	64.3

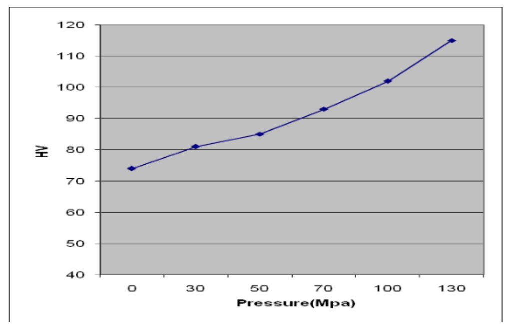
(4) Hardness sample 2

Distance in mm Edge	Hardness in Vickers Scale @ 0.5 kg load.
1	92.6
2	86.9
3	84.3
4	87.3
5	73.5
6	72.8
7	69.4
8	66.2
9	84.1
10	69.9
11	66.4
12	64.5
13	88.2
14	69.7
15	87.2
16	62.8
17	87.3
18	69.9
19	92.1
20	68.2
21	92.1
22	88.3
23	89.3
24	68.7
25	88.2
26	63.4

(5) Hardness sample 3

Distance in mm Edge	Hardness in Vickers Scale @ 0.5 kg load.
1	92.6
2	86.9
3	84.3
4	87.3
5	73.5
6	72.8
7	69.4
8	66.2
9	84.1
10	69.9
11	66.4
12	64.5
13	88.2
14	69.7
15	87.2
16	62.8
17	87.3
18	69.9
19	92.1
20	68.2
21	92.1
22	88.3
23	89.3
24	68.7
25	88.2
26	63.4

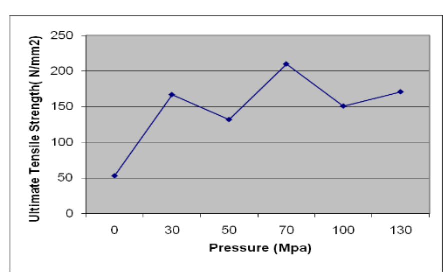
(6) Pressure Vs Hardness



(7) Tensile

Sample. no	Pressure (Mpa)	Ultimate Tensile strength (N/mm^2)
1	0	53
2	30	167
3	50	132
4	70	210
5	100	151
6	130	171

(8) Pressure Vs Tensile Strength



(9) Pressure Vs Density

S.no	Pressure (Mpa)	Area %
1	0	1.724
2	30	1.413
3	50	6.8
4	70	1.95
5	100	9.397
6	130	14.055

In this present work, series of Al 6061 alloy matrix composite containing and wt% SiC content were casted using stir casting techniqueattempts have been made to fabricate a composite using Alumunium and SiC as reinforcement. The fabricated composites showed enhanced tensile and mechanical properties.

(10) The following conclusion can be drawn from this study:

1) Tensile Strength and elongation increased with the introduction of reinforcement due to proper dispersion of reinforcement particles.

2) Out of all fabricated composite samples, sample 4 showed the maximum UTS value as the load is transferred to strongly bonded reinforcement, releasing most of the stress from the Al matrix.

3) Microhardness was improved with the presence of reinforcement particles and all reinforced samples had microhardness more than the base material.

4) Sample 6 showed the maximum microhardness because of presence of hard SiC.

5)Homogeneous and uniform dispersion of SiC particles was observed in the aluminum matrix. The density of the composite was increased with the increase of silicon carbide content of 1.11%

Considering the result of Vickers hardness test, the maximum hardness was 51 HRB. 27.5% hardness was enhanced to Al6061/8wt%SiC in comparison to base alloy Al 6061.

6)The maximum tensile strength was enhanced to Al 6061/8wt%SiC composite in reference to Al 6061 alloy, Embedded hard SiC particles had improved

The UTS was improved with the addition of SiC particles. Al 6061/8wt%SiC composite had maximum UTS of 324.7 MPa in context to base alloy, having 299.3 MPa. With the enhanced UTS, the ductility of the composite was reduced.

(11) Process Parameters and Variables

- Molten metal pouring temperature
- Melt Volume
- Melt quality and quantity
- Preform preheating temperature
- Die temperature
- Applied squeeze pressure
- Pressurization rate
- Pressure applied duration
- Lubrication Level

V. CONCLUSIONS

The flowing conclusion may be drawn from the present work: From the study it is concluded that we can use fly ash for the production of composites and can turn industrial waste into industrial wealth. This can also solve the problem of storage and disposal of fly ash. Fly ash up-to 0.5% by weight can be successfully added to commercially pure aluminum by stir casting route to produce composites. Addition of silicon carbide and Fly ash improves the wet ability of fly ash with aluminum melt and thus increases the retention of the fly ash in the composite. Hardness of commercially pure aluminum is increased from 208BHN to 210BHN with addition of fly ash and Silicon carbide. The Ultimate tensile strength has improved with increase in Aluminum content. Whereas ductility has decreased with increase in Silicon carbide content. The effect of increased reinforcement on the wear behavior of the MMCs is to increase the wear resistance and reduce the coefficient of friction. The MMCs exhibited better wear resistance due to its superior load bearing capacity. Increased normal load and sliding velocity increases magnitude of wear and frictional force.

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