Evaluation and Investigation of Mechanical Properties and Microstructure Behaviour of Al Composites

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this Project Report "**Investigation Of Mechanical Behaviour and properties of aluminium alloys used in Automotive Application**" is the bonafide work of "**KATARI MANOJ KUMAR (210418114066) KAVALI JASWANTH BABU (210418114067) MOKKAPATI NAVEEN (210418114086)**" who carried out the project under Supervision.

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ABSTRACT

Aluminium is the lightest metal used as the source for constructional alloys. Today Aluminium based metal matrix composites are widely used in aerospace, structural, oceanic and automobile applications for its light weight, low density(two thirds that of aluminium), good high temperature mechanical properties. The project elaborately determines the effect of tungsten carbide (WC) reinforced aluminium metal matrix composite for mechanical and micro structural behavior have been investigated. Fabrication of the Al-MMC was done by the stir casting process using stir casting furnace. Mechanical properties such as tensile strength, impact strength and hardness of the composites were analyzed. Improvement in the mechanical property was found in WC reinforced Al-MMC as compared with pure Al. A significant fact was that, addition of WC enhanced the wear resistance of Al-MMC. The presence of WC reinforcement in the matrix alloy can significantly enhance the compressive, tensile strength and wear resistance of aluminum hybrid composite

CHAPTER-1
INTRODUCTION

1. INTRODUCTION

The term composite is defined as the materials composed of two or more constituents materials with different physical and chemical properties. These constituents are combined at a microscopic level and are not soluble with each other. Generally composites consist of reinforcing particles which were dispersed in the matrix materials. The matrix of a composite can be a metal, ceramic or polymer and reinforcements can be fibers, particles, flakes, fillers and whiskers Miracle. These new combined materials will exhibit better strength than strengths observed in each individual material. Composites can be produced to possess high strength, high toughness, light weight, low cost, good damping capacity, wear resistance, corrosion resistance, hardness, conductivity, creep strength, fatigue strength, negative thermal expansion coefficient and unusual combinations of electric, magnetic, and optical properties. The importance of composites as engineering materials is reflected by the fact that out of over 1600 engineering materials available in the market today, more than 200 are composites. Composite materials play a significant role in the field of science and engineering as well as advanced manufacturing, due to exceptional demands by virtue of technological sphere rapidly advancing activities in aircrafts, aerospace, sporting goods, marine and automotive industries. Owing to enormous scope and application of these composite materials, these will play a major role in the material field for a very long period in the forthcoming years.

1.1 ALUMINIUM ALLOYS

Aluminum alloys are the most popular MMCs. The Al alloys are quite attractive due to their low density, their capability to be strengthened by precipitation, good corrosion resistance, high thermal, electrical conductivity, and their high damping capacity. In Aluminium Metal Matrix Composites (AMMCs), the main constituent is aluminum/aluminium alloy, which forms percolating network and is termed as the matrix phase. The other constituent is embedded in a matrix and serves as reinforcement, which is usually non-metallic and commonly ceramic such as SiC and Al2O3. The properties of AMMCs can be tailored by varying the nature of constituents and their volume fractions. Now, AMMCs have a proven track record as the successful “high-tech” materials in a range of applications. The AMMCs utilization provides significant benefits, including performance benefits like component lifetime, improved productivity, economic benefits like energy savings or lower maintenance cost and environmental benefits, like lower noise levels and fewer airborne emissions. The AMMCs have different types of reinforcements (whiskers/particles/short-fibers/continuous-fibers) and produced both by solid state and liquid state processing has found their way to many practical applications. In the automotive field, for the use in casing process, aluminum alloys allow near-net-shape components to be produced, also for structural applications because of their high strength-to-weight ratio in heat-treated conditions. In particular, aluminum-silicon alloys have widespread applications in the field of transport because of their good castability, their corrosion resistance and their excellent recycling behavior. Moreover, technological innovation and the increased usage of aluminum alloy could reduce emissions and energy consumption in the automotive sector.

Aluminum casting alloys with silicon as a major alloying element have excellent stability, weldability, pressure tightness, and corrosion resistance. Presently, for both the wrought and casting, aluminium alloys containing Si have found extensive use in manufacturing automotive, aerospace, defense and domestic components. Few Al alloys containing Cu and a few containing Mg and Si are heat-treatable in the cast condition due to the precipitation strengthening mechanisms. One of the most versatile Al-Si-Mg casting alloys is A356 alloy. The A356 casting alloy is widely used for the casting of high strength components in automotive, aerospace and military applications due to its excellent castability, weldability, high strength, and pressure tightness and corrosion resistance. The alloy is generally heat-treated to provide various combinations of desired mechanical properties like strength, toughness and physical properties.

1.2 Advantages of Aluminium Alloys

The advantages of magnesium and its alloys are listed below:

1. Good creep resistance
2. High damping capacity due to ability to absorb vibration
3. Ability to decrease vibration and noise in many applications.
4. High thermal conductivity permitting rapid heat dissipation
5. Good machinability
6. Lowest density of all metallic constructional materials
7. High specific strength

1.3 Challenges and Opportunities Al MMCs

Several challenges are to be overcome in order to intensify the engineering usage of Al-MMCs. Design, research and product development efforts and business development skills are required to overcome these challenges. In this pursuit, there is an imperative need to address the following issues.

1. To produce high quality and low-cost Al-MMCs by selecting usable reinforcement.
2. Efforts should be made on the development of Al-MMCs based on non-standard aluminium alloys as matrices.
3. To classify different grades of Al-MMCs based on property profile and manufacturing cost.

CHAPTER-2
LITERATURE SURVEY

Nagaraj.etal**(2016)** fabricated Mg based MMC through an in situ process that undergoes both liquid and solid state processing. Silicon oxy carbonitride (SiCNO) particles were used as the reinforcement for property enhancement of Mg matrix. During initial stage, liquid state polymer was injected to the solid state magnesium at 800^{o}C.

Falcon-franco.etal **(2016)** adopted pressure-less infiltration technique to develop Aluminium Nitride (AlN) reinforced Mg MMC for light weight structural application. AZ91E alloy was used as the matrix material for weight reduction and the attained results notified that addition of AlN particle enhanced hardness and elastic modulus to a great extent. Better tribological behaviour was observed during wear analysis at dry lubrication condition.

Fida Hassan.etal**(2015)** developed Nickel (Ni) reinforced Mg MMC through powder metallurgy method and further investigation over its microstructure revealed for uniform dispersion of Ni particles. In addition to this, Ni dispersion into Mg matrix improves hardness upto 54 HV with an improved tensile strength, while ductility showcased a declining trend.

Mindivan.etal **(2014)** developed Carbon Nano Tube (CNT) reinforced Mg MMC through powder metallurgy route for varying wt. % (0.5, 1, 2, 4) and its basic and functional properties were analyzed. Results exposed that increase in CNT content showcase a decremental trend in desired properties of MMC like hardness, wear and corrosion resistance. Among the fabricated MMC‟s, specimen with 0.5 wt. % has shown better hardness and corrosion resistance while compared with its base metal.

Rashad.etal **(2015)** utilized semi-powder metallurgy route to disperse Graphene Nano Platelet (GNPs) of varying wt. % (0.09,0.18 and 0.30 wt.%) into Mg matrix so as to improve its mechanical strength at room temperature. Observation over mechanical properties notifies that the developed MMC"s showcased an increment in young's modulus and tensile strength while compared to pure Mg.

Xiang.etal **(2017)** fabricated GNPs reinforced Mg MMC following disintegrated melt deposition and hot extrusion route. In this research Mg was chosen as the base matrix material and GNPs with 0.10 and 0.25% was added as reinforcement. Examinations over microstructure and revealed mechanical properties showcased that addition of GNPs has improvised ductility but have weakened the fibre texture behavior of MMC. Whatsoever the adopted method has helped in to achieve uniform dispersion of GNPs and thereby attain fine grain refinement by means of twinning mechanism

Ayyappadass.etal **(2017)** fabricated CNT reinforced Mg MMC through accumulative roll bonding method. Investigation over its micro-structural and mechanical behavior shows for the increment in strength and uniform dispersion of CNT particles. This newer technique adopted has also proved that smaller amount of CNT improves the mechanical properties of Mg matrix material

Soorya Prakash.etal **(2016),** developed hybrid Mg based MMC through powder metallurgy route in which SiC with varying weight percentage (wt. %) and graphite with constant wt. % was used as reinforcement. The results demonstrated for considerable improvement in hardness and wear resistance.

Kondon.etal **(2010)**, fabricated Multiwall Carbon Nano Tube (MWCNT) reinforced Mg (AZ31) MMC through powder metallurgy route and proved that addition of reinforcement up to 1 vol.% delivers drastic improvement in the tensile strength but have poor ductility.

Rashed.etal **(2015)** developed Mg based MMC with varying percentage (0.9, 0.18 and

0.30) of GNPs through powder metallurgy process. Results depicted that addition of GNPs up to 0.30 wt. % improves the hardness and mechanical strength of developed MMC‟s. Study also stated that MMC reinforced with GNPs showcased better strength while comparing with that of CNT reinforced MMC due to its high surface area.

Aniruddha Das.etal **(2014)**, developed Mg based MMC through spark plasma sintered technique using SiC nano-particle and GNPs as reinforcement, and studied the influence of GNPs and SiC nano particles over its tribological behavior and found that increase in addition of GNPs up to 5 vol.% with 2 vol.% of SiC improve the wear resistance. But hardness of MMC show decremental trend anywhere beyond 2 vol.% (SiC and GNPs) of reinforcement.

Renold Elsen.etal **(2016)** investigated dry sliding wear behavior of Zirconia reinforcement alumina ceramic composite fabricated through powder metallurgy route. This experiment was carried out based on Box-Behnken design. In this, wear parameters like applied load, sliding velocity and sliding distance was kept constant and the material parameters like sintering temperature and reinforcement wt.% was varied. Analysis of variance (ANOVA) results depicts that SWR of developed composite decreases with respect to increase in reinforcement wt. %

Selvam.etal **(2014)** investigated the dry sliding wear behaviour of zinc oxide reinforced Mg MMC through powder metallurgy. The influence of applied load, sliding velocity and sliding distance over SWR was studied and analysed. Results illustrate that sliding velocity and applied load are the major factors that affects SWR and increment in any of these factor results in increment of SWR.

Kongjie jin.etal **(2015)** investigated the tribological properties of bronze-Cr-Ag composite sliding on AISI 52100 steel under dry sliding condition. The friction co-efficient of developed composite was investigated for a load of 15N and sliding velocity 0.05 m/s. Results showed that addition of Cr and Ag improves the wear resistance and lubrication properties of fabricated MMC.

Afsaneh dorrimoghadam.etal **(2015)** investigated the mechanical and tribological behavior of powder metallurgy processed self lubricating MMC reinforced with CNT and graphene. Results revealed that incorporation of CNT and graphene into matrix metal tends to increase the tensile properties, at the same time decrease the co-efficient of friction and wear rate of developed MMC.

CHAPTER-3

PROBLEM STATEMENT

3.1 PROBLEM IDENTIFICATION

From the detailed literature study the following problems were identified.

- A limited research work has been reported on aluminium metal matrix composites reinforced with tungsten carbide (WC).
- A very few study investigates the particle distribution plays a very vital role in the properties of the aluminium metal matrix composites, it improves intensive shearing.
- The fabrication method of aluminium used in stir casting technique was not explained in detail in the past scenarios.
- The investigation of aluminium metal matrix composites depends on the mechanical testing of the samples and hence no work highlighted the characterization of mechanical properties of the prepared composite samples.
- Even though there are wide range of applications are investigated in composites section but there were no prospect of developing low cost metal matrix composites.

CHAPTER-4

OBJECTIVES

OBJECTIVES

The main objectives of this study are categorized below,

- To investigate the aluminium metal matrix composites in detail about the nature of occurring and preparation.
- To identify the microstructure of pure aluminium & composite aluminium.
- To investigate the mechanical properties of various composition of aluminium metal matrix composites.
- To record the inference of the research on aluminium composite alloy for the future research.

CHAPTER -5
WORKING METHODOLOGY

WORKING METHODOLOGY

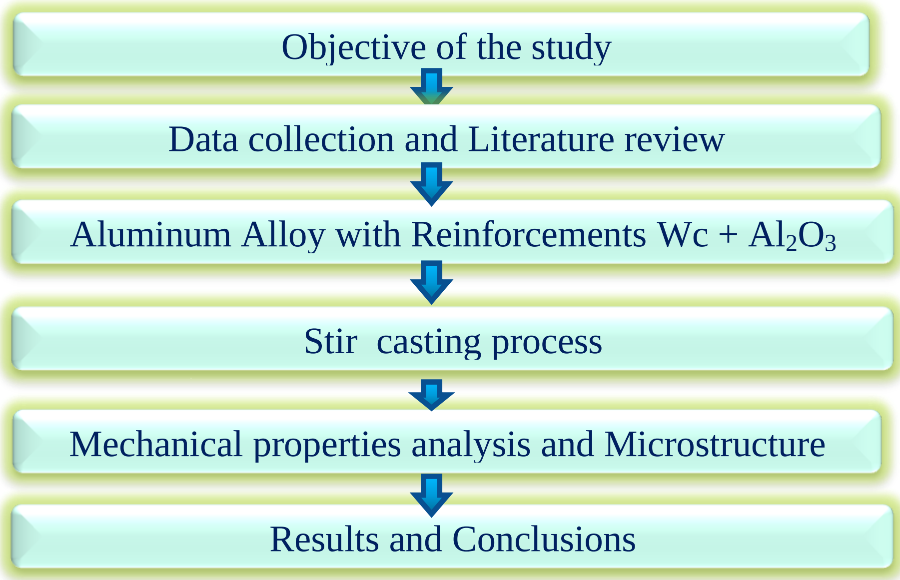


Figure 4.1 Working Methodology of the study

CHAPTER- 6
EXPERIMENTAL SETUP

6. EXPERIMENTAL SETUP

6.1 STIR CASTING

Stir casting is a type of casting process in which a mechanical stirrer is introduced to form vortex to mix reinforcement in the matrix material. It is a suitable process for production of metal matrix composites due to its cost effectiveness, applicability to mass production, simplicity, almost net shaping and easier control of composite structure.

Stir casting setup consist of a furnace, reinforcement feeder and mechanical stirrer. The furnace is used to heating and melting of the materials. The bottom poring furnace is more suitable for the stir casting as after stirring of the mixed slurry instant poring is required to avoid the settling of the solid particles in the bottom the crucible. The mechanical stirrer is used to form the vortex which leads the mixing of the reinforcement material which is introduced in the melt. Stirrer consist of the stirring rod and the impeller blade. The impeller blade may be of, various geometry and various number of blades. Flat blade with three numbers is the preferred as it leads to axial flow pattern in the crucible with less power consumption. This stirrer is connected to the variable speed motors; the rotation speed of the stirrer is controlled by the regulator attached with the motor. Further, the feeder is attached with the furnace and used to feed the reinforcement powder in the melt. A permanent mould, sand mould or a lost-wax mould can be used for pouring the mixed slurry.

The matrix materials are kept in the bottom pouring furnace for melting. Simultaneously, reinforcements are preheated in a different furnace at certain temperature to remove moisture, impurities etc. After melting the matrix material at certain temperature the mechanical stirring is started to form vortex for certain time period then reinforcements particles are poured by the feeder provided in the setup at constant feed rate at the centre of the vortex, the stirring process is continued for certain time period after complete feeding of reinforcement’s particles. The molten mixture is then poured in preheated mould and kept for natural cooling and solidification. Further, post casting process such as heat treatment, machining, testing, inspection etc. has been done. There are various impeller blade geometry are available. Melting of the matrix material is very first step that has been done during this process.

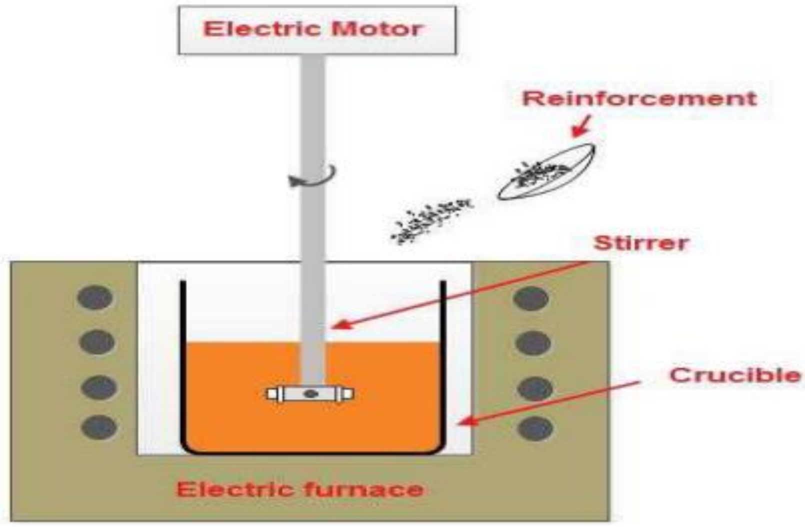


Figure 6.1 Stir Casting

6.2 Universal Testing Machine

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile).

The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fixturing, gauge length (the length which is under study or observation), analysis, etc. The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test.

If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips.

Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen. Machines range from very small table top systems to ones with over 53 MN capacities.

Figure 6.2 Universal Testing Machine

6.3 **HARDNESS TESTING**

Both the bulk and micro-hardness of the base alloy and composite samples have been measured by Rockwell and Vickers hardness test method respectively. Bulk hardness of all the samples were measured by digital Rockwell hardness tester (model TRSND, Fine manufacturing Industries, India) with 1/16 inch diameter steel ball indenter at 100 kg load at B scale. Micro-hardness values at different phases were measured using Vickers micro-hardness testing machine (model: MVK_HO, Mitutoyo, Japan). Each value of hardness is an average of the ten separate values taken from the different places of the samples at 100 gf load. The microhardness test specimens of the heat treated MMCs and the fabricated joints were milled using a CNC milling machine to acquire the required dimensions. The Vicker's hardness testing machine (Make: SHIMADZU, Japan; Model: HMV-T1) used for measuring the micro-hardness is shown in Figure 3.8b. The specimens were sectioned to the rectangular size of 30 mm x 30 mm x 6 mm from traverse direction of the weld region as per ASTM-E384-99E1 guiding principle for micro-hardness test. The micro-hardness measurements were made by applying a load of 0.5 kg for a loading time of 15 seconds. The specimens were sectioned to the rectangular size of 30 mm X 10 mm X 6 mm respectively. The specimen was cut with the longer edge perpendicular to the traverse direction of the weld.

Figure 6.3 Hardness Test

6.4 Impact Test

The impact test machine selected for this research work was able to conduct Charpy impact test. The specimen was held horizontally in the anvil of the impact test machine. The V notch faced away from the point of contact during the test. A dead weight of 25 kg mass was used as the hammer to provide the impact load. The reading of the test was observed from the readings indicated in the analogue scale in the test machine.

The impact test specimen was prepared to meet the specifications required for the Charpy test. The dimension of the specimen was set to meet ASTM A370 standard 55 mm x 10 mm x 6 mm. A V notch of size 5 mm side, 2 mm deep and 45o notch radius was provided along one of the longer edges.

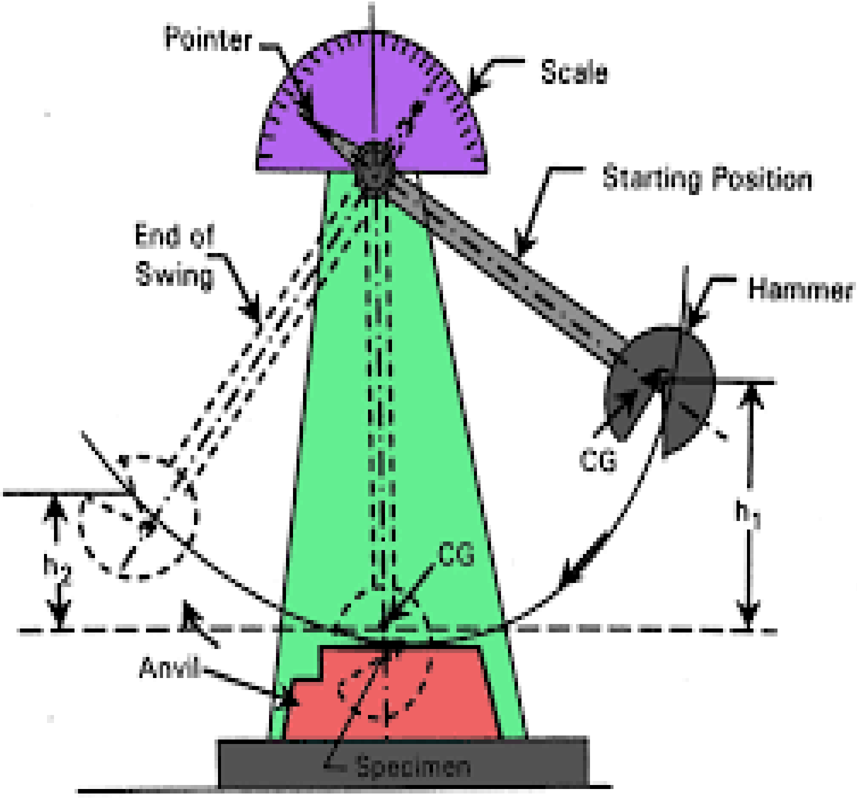


Figure 6.4 Impact Test

6.5 Scanning Electron Microscope Analysis

The Scanning Electron Microscope (Make: Hitachi Model - S3000H) used in this research work is shown in Figure 3.8e. The SEM analysis was made to identify the morphology of the fracture surface in the composite material and also along the FSW joint. The magnification factor4 of the SEM ranged from 50X to 1000X. The microscope was able to make Energy Dispersive and X-ray spectroscopy (EDAX) analysis to determine the constituents of the specimen used for the analysis. The specimen for SEM analysis was cut from the heat treated MMC and prepared in the same manner used in the optical microscopic analysis. The dimension of the specimen was 10 mm x 10 mm x 6 mm respectively. For fracture analysis, the specimens were left untreated in order to analyze the fracture surface.

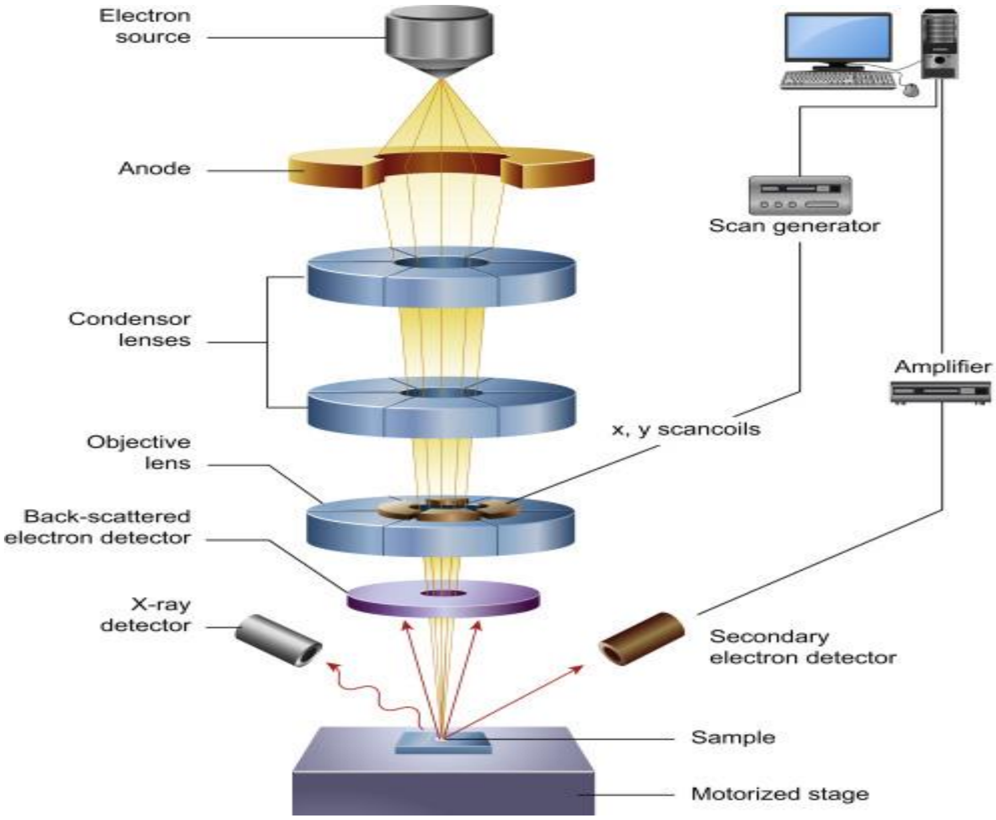


Figure 6.5 Scanning Electron Microscope

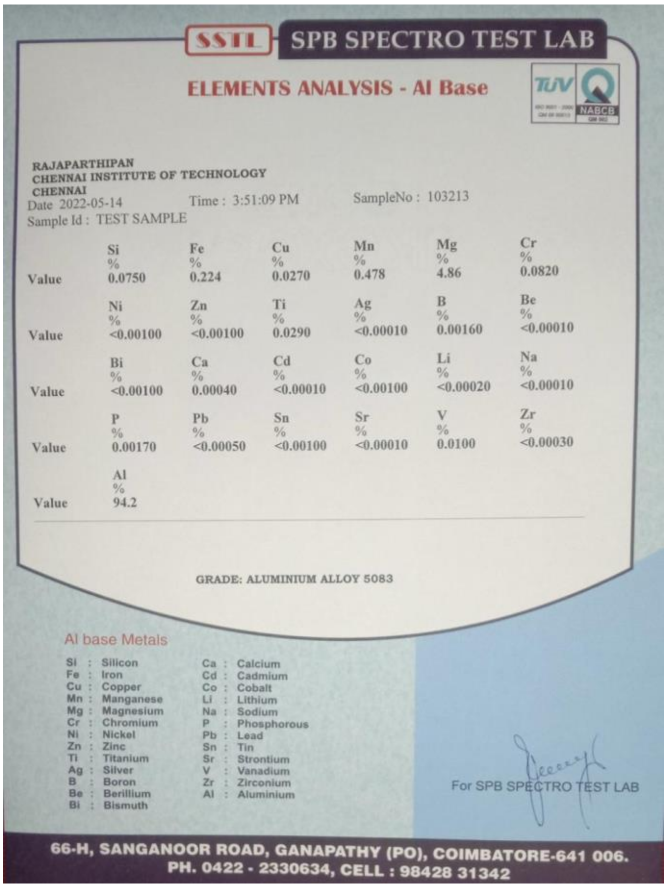
CHAPTER -7
MATERIALS & MANUFACTURING METHODS

7. Raw-Materials Selection

Aluminium Alloy (Al 5083) has been used as the base material due to its importance in automobile industries. The chemical composition and physical properties of the work piece are listed in Tables 1 and 2. The ceramic material tungsten carbide (WC) has been chosen with the particle size of 125 μm for the study. The reinforcement particles have been included in hybrid Aluminium metal matrix alloy under various weight percentages of 5, 7.5 and 10%. This liquid metallurgy technique is the most inexpensive method for producing metal matrix hybrid composite. Among various liquid metallurgy process stir casting process has been utilized for fabrication Al5083/ WC hybrid composites . The alloy has been melted in a crucible furnace at 750 °C for twenty minutes. The furnace temperature has been raised above the liquidus temperature of matrix alloy near about 780 °C. The reinforcement particles have been preheated at 500 °C to remove moisture presence in the reinforcement to enhance the wettability of reinforcement between matrix alloy and reinforcement. Then the preheated reinforcement particles with different weight percentage have been added manually in to the vortex. The uniform dispersion of the reinforcement particles in the aluminum matrix alloy depends on the parameters such as stirring speed and stirring time. In the present study, the stirring speed and stirring time has been maintained at 400 RPM and 5 min respectively to ensure the uniform distribution of the particles in the liquid. This creates superior interface bond between reinforcement and matrix alloy. The stir casting of Al5083 has been carried out in an electrical resistance heating furnace. The furnace has been maintained at a temperature of 450 °C before loading the matrix material into the furnace. The aluminium material has been placed in electrical resistance heating furnace for a period of 10 min. The composite mixture has been reheated after stirring at semisolid phase and hold at a temperature 900 °C to make the composite mixture in liquid phase.

Figure 7.1 Raw Aluminium

The Figure 7.1 is a Raw Aluminium . which is used in this Experiment. Because it has magnificiant mechanical properties like High Strength to weight ratio , Ductile at low temperature , corrosive resistance and light weight.



SSTL SPB SPECTRO TEST LAB

ELEMENTS ANALYSIS - Al Base

RAJAPARTHIPAN
CHENNAI INSTITUTE OF TECHNOLOGY
CHENNAI
Date 2022-05-14 Time : 3:51:09 PM SampleNo : 103213
Sample Id : TEST SAMPLE

	Si %	Fe %	Cu %	Mn %	Mg %	Cr %
Value	0.0750	0.224	0.0270	0.478	4.86	0.0820
	Ni %	Zn %	Ti %	Ag %	B %	Be %
Value	<0.00100	<0.00100	0.0290	<0.00010	0.00160	<0.00010
	Bi %	Ca %	Cd %	Co %	Li %	Na %
Value	<0.00100	0.00040	<0.00010	<0.00100	<0.00020	<0.00010
	P %	Pb %	Sn %	Sr %	V %	Zr %
Value	0.00170	<0.00050	<0.00100	<0.00010	0.0100	<0.00030
	Al %					
Value	94.2					

GRADE: ALUMINIUM ALLOY 5083

Al base Metals

Si : Silicon	Ca : Calcium
Fe : Iron	Cd : Cadmium
Cu : Copper	Co : Cobalt
Mn : Manganese	Li : Lithium
Mg : Magnesium	Na : Sodium
Cr : Chromium	P : Phosphorous
Ni : Nickel	Pb : Lead
Zn : Zinc	Sn : Tin
Ti : Titanium	Sr : Strontium
Ag : Silver	V : Vanadium
B : Boron	Zr : Zirconium
Be : Berillium	Al : Aluminium
Bi : Bismuth	

For SPB SPECTRO TEST LAB

66-H, SANGANOOR ROAD, GANAPATHY (PO), COIMBATORE-641 006.
PH. 0422 - 2330634, CELL : 98428 31342

Figure 7.2 Testing of Al alloy 5083

The above Analysis report is done in the **SPB SPECTRO TEST LAB** is used to identify the taken is alloy Belongs to 5083 or to other series.

7.1 Fabrication of the Composites - Stir Casting Process

The stir casting route is used for the development of the composite. This process involves the mixing of the particles into magnesium melt with the help of the stirrer and then allows the material to solidify in the mould at the normal environmental conditions. In this technique, the required quantity of Al5083 alloy was taken in the graphite crucible and was melted at 800^{o}C in the electric furnace. Three blades with graphite impeller inclined at angle of 45^{o} were used for stirring. During melting, the impeller was kept at a distance of 2/3 in the melt, so that during stirring melt should not be thrown upward which will increase the porosity of the composite. Rutile particles were preheated at a temperature of 300^{o}C to remove the moisture. These powders were charged to the melt from the side of the vortex created during rotation with the help of the funnel at the rate of 12-15 gm/min. During charging of rutile particles the melt temperature and impeller speed was maintained constantly. The stirring was continued for 5 minutes even after the addition of the particle to ensure the homogenous distribution of the particulate in the melt.

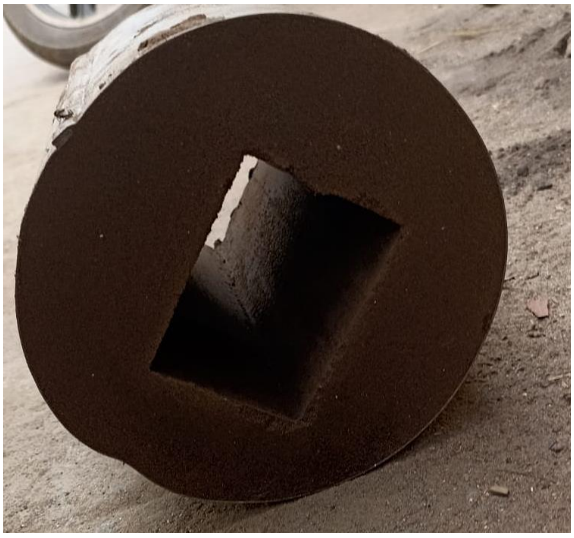


Figure 7.3 Cavity

The cavity behavior found at different tensile stages. avitation is a function of external factors such as temperatures and grain sizes, which are both related to the second phase particles

Figure 7.4 Formation of Mould

The sand is poured in a box and the cavity is inserted in the box of sand for support and the mixture of aluminium magnesium powder and titanium is poured in the cavity after certain amount of time molten is being cooled down and the part can be takeN out.

Figure 7.5 Mould Cavity

7.2 Microstructure Analysis

Microstructure of Al5083/WC Composites The microstructure performs a significant role on evaluating the mechanical properties of any alloys and composite. The properties of aluminium hybrid composites depend on the microstructure, reinforcement particle size, shape and distribution of reinforcement in the matrix alloy. The prepared samples have been examined to study the distribution of reinforcement in the matrix alloy using optical microscope. The higher percentage additive of reinforcement particles showed marginal effect in the distribution and some lower agglomeration of the particles.

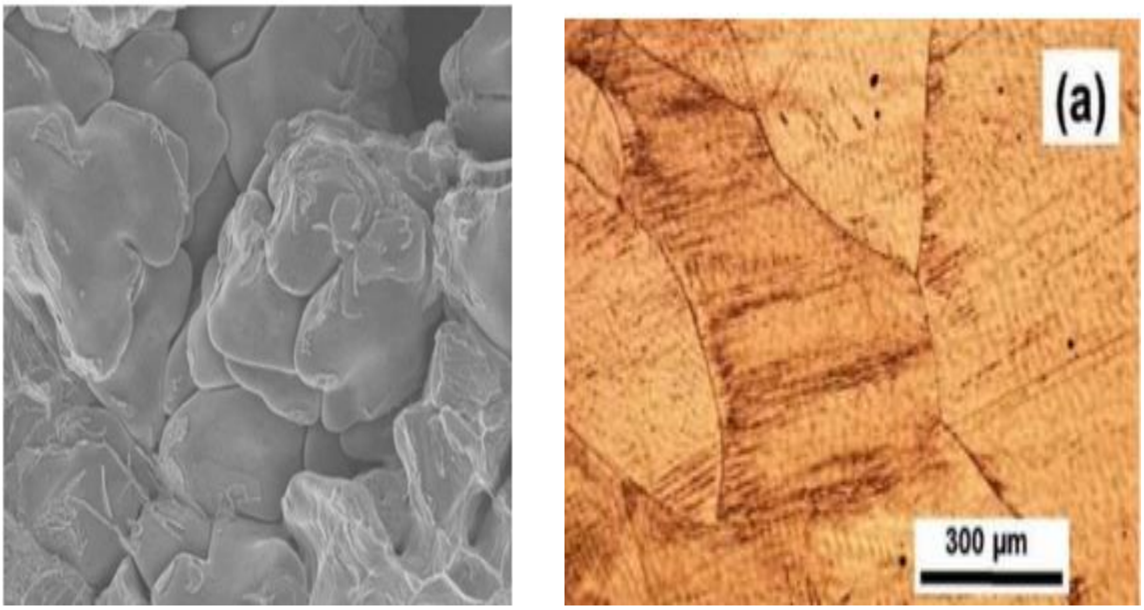


Figure 7.6 Microstructure Analysis of Pure Aluminium 5083 (a) Fracture surface of Pure Al

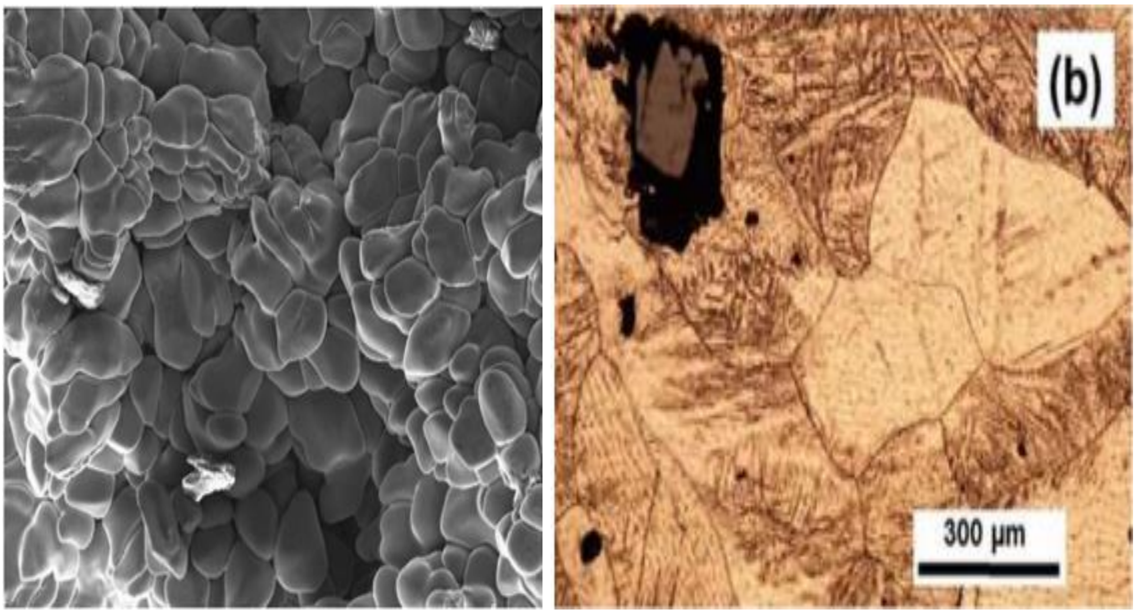


Figure 7.7 Microstructure Analysis of Aluminium 5083 reinforced with WC (b) Fracture surface of Al composites

The addition of dissimilar weight percentage of reinforcement material in matrix alloy has modified the surface morphology of the composites. The reinforcement particles have dispersed uniformly in the matrix. However at some location of the casting, the agglomeration of the reinforcement particles has been observed. The prepared samples have been examined to study the reinforcement particles and their distribution in the matrix alloy using Scanning Electron Microscope (SEM). The etched matrix clearly indicates the position of the reinforcement particles more preferential at the grain boundary cavity.

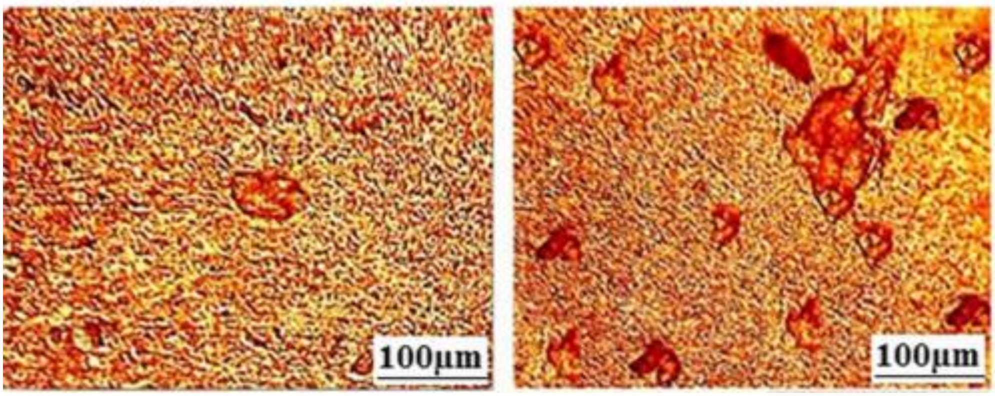


Figure 7.8 Al/5% WC

The Following MicroStructure contains 5% of Titanium carbide . WC has Extremely hard refractory which is similar to the Tungsten Carbide . The Melting point and Boiling point is high.

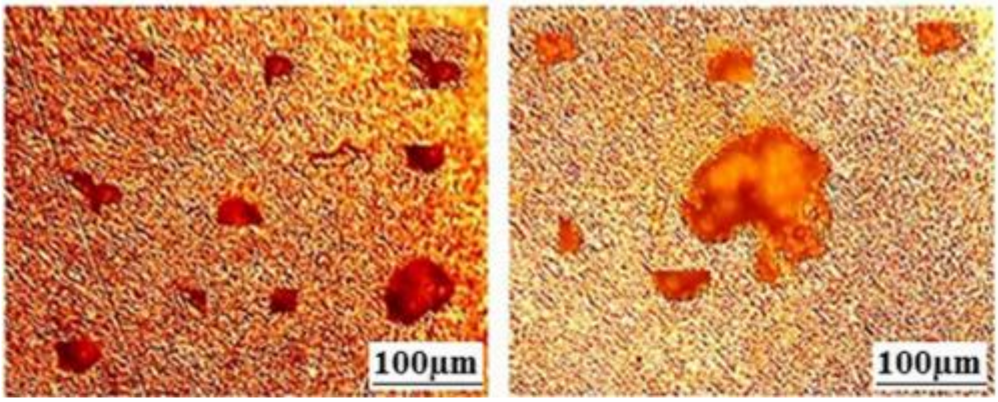


Figure 7.9 Al/10% WC

The Following MicroStructure contains 10% of Titanium carbide.

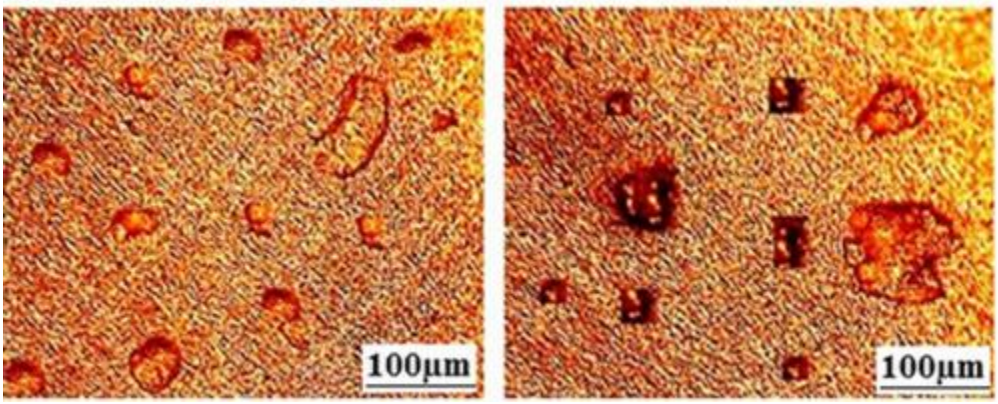


Figure 7.10 Al/15% WC

The Following MicroStructure contains 15% of Titanium carbide.

CHAPTER - 8
MECHANICAL TESTING & EVALUATION

8 Tensile Test

The tension tests were conducted according to the ASTM standard E8M-08. The tensile test specimens having gauge length of 96mm and 9mm diameters were machined from the cast forged and age hardened specimens. The room temperature tensile tests were carried out for the polished specimen in a computerized universal testing machine. The cast forged and age hardened specimen were polished in different stages to eliminate the effects of surface roughness on the tensile test. Four tests are conducted for each sample and the average value is taken. The ability of any material to withstand a static loading condition can be found by testing it in the direction of tensile or compression.

The determination of mechanical behavior of any material is important from both research and usage point of view. The testing of these materials helps us to evaluate the quality of the materials and understanding its fundamental nature. It is very important to know how much load a material can withstand when it is subjected to service conditions. It should be strong and rigid enough to withstand different loading conditions at various temperatures. The most common test to evaluate the tensile behavior of any material is the Tensile Test. The stress-strain curve obtained in this test gives the Ultimate Tensile Strength (UTS), Modulus of Elasticity (E), percentage elongation and reduction in area(A%). Additional information's like poisons ratio (u), Resilience, etc., can be inferred through the Tensile Test. The Tensile Test specimen is prepared, such that the ends of the specimen are gripped into the jaws of the testing machine. The Tensile Test is performed by a standard Universal Testing Machine (UTM). The specimen may be rectangular or cylindrical. But it should be machined according to test standards. For composites usually a rectangular or square cross sectional material is preferred. A load in a tensile direction is applied to the test specimen until it fractures. The load required to make certain elongation on the specimen is recorded. The tensile behavior of the material is obtained by plotting a load elongation curve.

Table 8.1 results of tensile test

Sample	Composition	Tensile Strength(N/mm2)	Elongation (%)
Sample 1	Al5083+ 5% WC	175.74	7
Sample 2	Al5083+ 10% WC	182.64	5
Sample 3	Al5083+ 15% WC	238.26	4

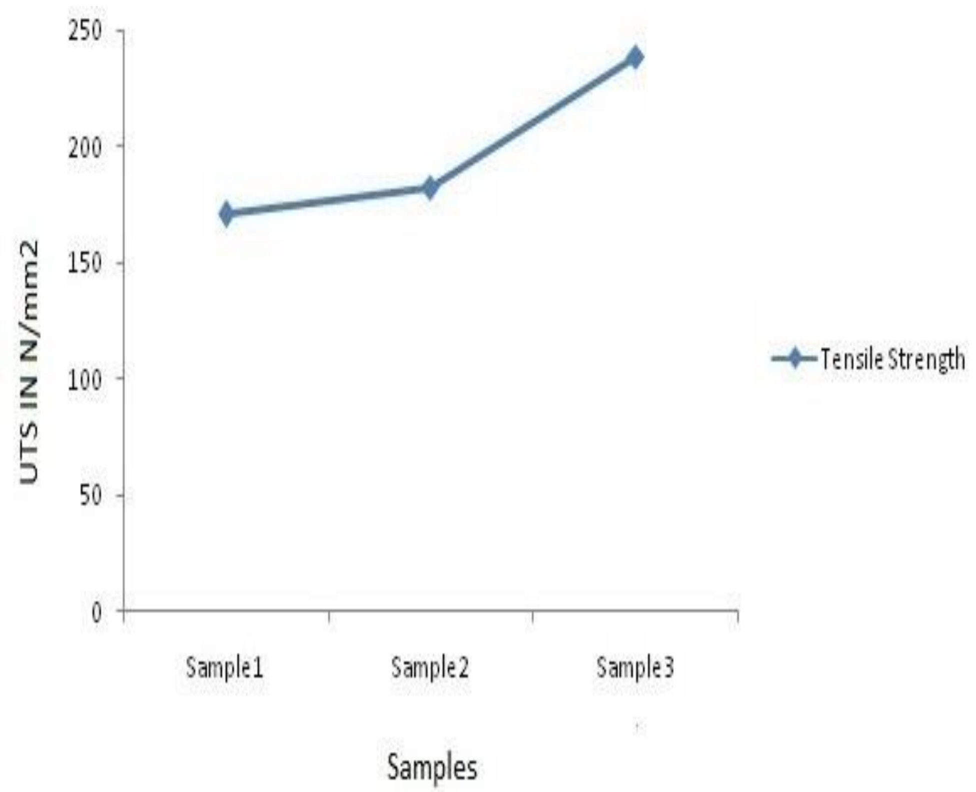


Figure the effect of the weight fraction on the UTM

Figure 8.1 UTS VS Sample

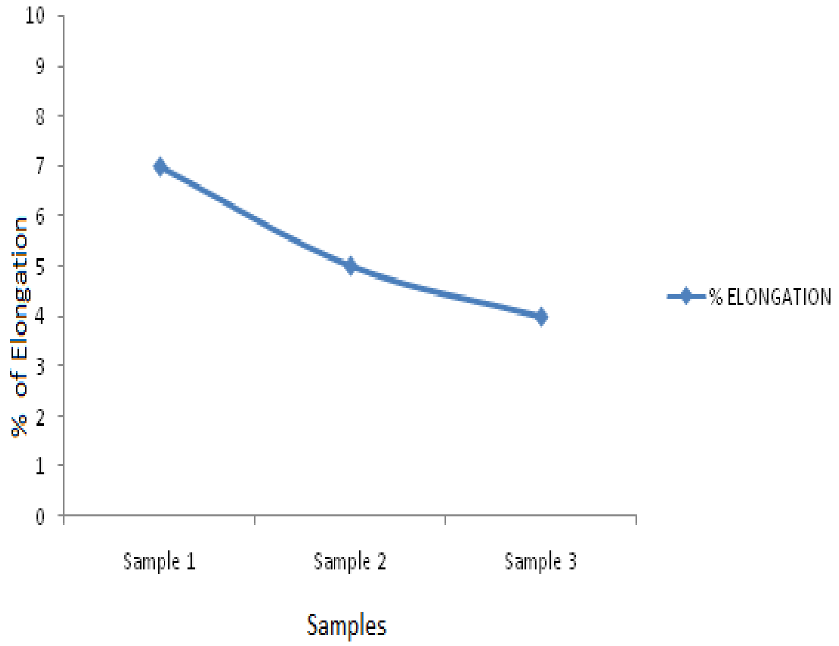


Figure the effect of the weight fraction on the % of Elongation

Figure 8.2 % OF Elongation VS Samples

8.2 Impact Test

The Charpy impact test, also known as the Charpy v-notch test, is a standardized high strain- rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness. The results of impact test.

Table 8.2 results of Impact test

Sample	Composition	Energy Absorbed (Kg-m)
Sample 1	Al5083+ 5% WC	6.8
Sample 2	Al5083+ 10% WC	7.5
Sample 3	Al5083+ 15% WC	8.5

8.3 Hardness Test

Hardness analyzer utilized in this examination was Vickers Micro Hardness analyzer at Materials Testing Lab, Faculty of Mechanical and Manufacturing, Universiti Tun Hussein Onn (UTHM). The test load utilized for CFRP, GFRP and all kind of Hybrid Composite were 2.942 N (HV 0.3). The motivation behind why these heap utilized depends on space impact delivered for every case and dependent on preliminary outcomes accomplished after burden was connected.

This project assumes the significant job in ascertaining hardness esteem when hardness test was completed. The Micro hardness trial of ASTM E-384 indicates a scope of light loads utilizing a jewel indenter to make a space which is estimated and changed over to a hardness value

Table 8.3 Results of Hardness test

Sample	**Trial 1**	**Trial 2**	**Trail 3**	**Avg Hardness (HRC)**
Sample 1	32.3	32.9	31.2	32.13
Sample 2	34.1	33.4	32.1	33.23
Sample 3	35.5	35.8	33.9	35.06

CHAPTER – 9
CONCLUSION

In the present study Al5083//WC hybrid aluminium composites has been reinforced under stir casting method and its mechanical properties has been characterized. From the experimental results, the following conclusions have been made.

1. It appears in this study that Tensile Strength starts increases with increase in weight percentage of WC. It found that elongation tends to decrease with increasing particles weight percentage which confirms that addition tungsten carbide increases the brittleness.
2. The impact strength of Hybrid composite increases with increase in weight percentage of tungsten carbide.
3. The Al-WC composites are one among the new materials that have come to occupy important fields such as aerospace, defence, automobile, biomaterial as well as sports and leisure.

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