EXPERIMENTAL INVESTIGATION OF AA7075 REINFORCED WITH WC &SiC METAL MATRIX COMPOSITES

G.Arunkumar[#1],Dr.C.MathalaiSundaram[*2], A.Vembathurajesh[*3], J.Eswaran[*4], Dr.B.Radhakrishnan[*5]

Address for Correspondence
[#1,*3,4,5]Assist. Professor, Department of Mechanical Engineering,
Nadar Saraswathi College of Engineering and Technology
Theni, Tamilnadu, India
[*2]Principal, Nadar Saraswathi College of Engineering and Technology
Theni, Tamilnadu, India

ABSTRACT

Metal Matrix Composites (MMCs) have evoked a keen interest in recent times for potential applications in aerospace and automotive industries owing to their superior strength to weight ratio and high temperature resistance. In the present study a modest attempt has been made to develop aluminum based silicon carbide particulate MMCs with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenous dispersion of ceramic material. Experiments have been conducted by varying weight fraction of SiC (5%, 10%, 15%) & WC (5%, 10%, 15%) while keeping all other parameters. An increasing trend of hardness and impact strength with increase in weight percentage of SiC& WC has been observed. The frictional heat generated by the welding tool and the surrounding material causes the softening of the material and allows the tool to be moved along the weld line. Initially, the material is plasticized, and then it is transferred from the leading edge of the tool to trailing edge, leaving a solid-phase bond between the plates. The advantages of this process also encompass better mechanical properties, low residual stress and deformation, and reduced occurrence of defects. The widespread adoption of particulate metal matrix composites for engineering applications has been hindered by the high cost of producing components. Although several technical challenges exist with casting technology yet it can be used to overcome this problem. Aluminium materials found to be the best alternative with its characteristics like high strength to weight ratio and low density. As development of light weight materials has provided numerous possibilities for weight reduction. By conducting various test for analyze the various properties like mechanical properties and metallurgical properties.

KEYWORDS:MMC, Stir casting, AA7075, WC &SiC.

1. INTRODUCTION

Metal matrix composite (MMC) materials increasingly replace traditional materials used in building engineering, aeronautics, mechanical engineering and in many other domains. “A composite material is formed by a close combination of at least two chemically and physically distinct materials which should remain separate and distinct while a good and continuous interface between them is maintained the reinforcing components in the whole volume of the matrix should be as uniform as possible.” Metal matrix composite materials have found application in many areas of daily life for quite some time. Materials like cast iron with graphite or steel with a high carbide content, as well as tungsten carbides, consisting of carbides and metallic binders, also belong to this group of composite materials. Metal matrix composites become interesting for use as constructional and functional materials, if the property profile of conventional materials either does not reach the increased standards of specific

demands, or is the solution of the problem. Metal matrix composite is engineered combination of the metal (Matrix) and hard particle/ceramic (Reinforcement) to get tailored properties.

Like all composites, aluminum-matrix composites are not a single material but a family of materials whose stiffness, strength, density, thermal and electrical properties can be tailored. The matrix alloy, reinforcement material, volume and shape of the reinforcement, location of the reinforcement and fabrication method can all be varied to achieve required properties. The literature review reveals that the major problem was to get homogenous dispersion of the ceramic particles by using low cost conventional equipment for commercial applications. In the present work, a modest attempt have been made to compare the dispersion of WC &SiC particles in Al matrix fabricated with the help of different processes viz.

(a) Without applying stirring process
(b) With manual stirring process
(c)Two-step mixing method of stir casting.

An effort has been made to establish a relationship between hardness, impact strength and weight fraction of WC &SiC in particle reinforced MMC's developed with the help of two - step mixing method of stir casting technique. Metal matrix composite especially aluminium matrix and particulate reinforced composites are getting most applications in present days. Comparatively the liquid state processing has been preferred due to simplicity in method and large quantity of production.

The method in which the reinforcements are added to molten matrix externally is called Ex-situ method and the one in which it is melted along with is called In-situ method. Materials like cast iron with graphite or steel with a high carbide content, as well as tungsten & silicon carbides (WC &SiC) consisting of carbides and metallic binders, also belong to this group of composite materials.

For many researchers the term metal matrix composites is often equated with the term light metal matrix composites. Also, the mechanical properties decrease quite sharply due to the formation of structure in the weld zone, when welded through conventional fusion techniques. This paper discusses the fabrication of AA7075 having a thickness ratio of 1.3 as detail studies on dissimilar aluminum alloys, Tungsten Carbide and Silicon Carbide having thickness ratio greater than unity.

The kind of the precursor source could be the one of the parameters influencing the microstructure of WC&SiC coatings deposited by PVD method. In the presented work two kinds of precursors were used in the electron beam physical vapour deposition method (EBPVD). The effects of their influence on microstructure and properties of WC &SiC coatings were investigated. Characteristic X-rays that are produced by the interaction of electrons with the sample may also be detected in an SEM equipped for energy-dispersive X-ray spectroscopy or wavelength dispersive X-ray spectroscopy. When the primary electron beam interacts with the sample, the electrons lose energy by repeated random scattering and absorption within a teardrop-shaped volume of the specimen known as the interaction volume, which extends from less than 100 nm to approximately 5 µm into the surface. The size of the interaction volume depends on the electron's landing energy, the atomic number of the specimen and the specimen's density.

2. PROPERTIES OF MATERIAL USED

2.1 ALUMINIUM 7075

Aluminium alloy 7075 is a medium strength alloy commonly referred to as an architectural alloy, it is normally used in intricate extrusions, it has a good surface, high corrosion resistance, and it's readily suited to welding and can be easily. Most commonly available as T6 temperature in the T4 condition it has good formability. AA7075 is a variation of 7075 with great strength but retains the same good surface finish quality and affinity for anodizing

Table 2.1 AA7075 Mechanical Properties

S. NO.	PROPERTY	VALUE
1	Proof stress	170 Min Mpa
2	Tensile strength	215 Min Mpa
3	Elongation A50 MM	8 MIN%
4	Brinell Hardness	75 HB
5	Elongation	10 Min%

2.1.1 APPLICATIONS OF AA7075

AA7075 is used in the same applications as AA7075. It is also used in following

1. Road transport
2. Rail transport
3. Extreme sports equipment

2.2 WC (TUNGSTEN CARBIDE)

Tungsten carbide (WC) is a chemical compound (specifically, a carbide) containing equal parts of tungsten carbon atoms. In its most basic form, tungsten carbide is a fine gray powder, but it can be pressed and formed into shapes for use in industrial machinery, cutting tools, abrasives, armor-piercing rounds, other tools and instruments, and jewelry. Tungsten carbide is approximately two times stiffer than steel, with a Young's modulus of approximately 530–700 GPa and is double the density of steel nearly midway between that of lead and gold.

Table 2.2 WC Chemical Properties

S.NO	PROPERTIES	VALUE
1	Oxidation	500 - 600 □C
2	Temperature	400 □C

Table 2.3 WC Physical Properties

S.NO	PROPERTIES	VALUE
1	High Melting Point	2,870 °C
2	Boiling point	6,000 °C
3	Standard Atmosphere	100 kPa
4	Thermal Conductivity	110 W·m−1·K−1
5	Thermal Expansion	5.5 µm·m−1·K−1
6	Vickers Number	2600
7	Young's Modulus	530–700 Gpa
8	Bulk Modulus	630–655 Gpa
9	Poisson's Ratio	0.31

2.2.1 APPLICATIONS OF WC

Tungsten carbide cutting tools are very abrasion resistant and can also withstand higher temperatures than standard high speed steel tools. Carbide cutting surfaces are often used for machining through materials such as carbon steel or stainless steel, as well as in situations where other tools would wear away, such as high-quantity production runs. Because carbide tools maintain a sharp cutting edge better than other tools, they generally produce a better finish on parts, and their temperature resistance allows faster machining. The material is usually called cemented carbide, hard metal or tungsten-carbide cobalt: it is a metal matrix composite where tungsten carbide particles are the aggregate and metallic cobalt serves as the matrix. Manufacturers use tungsten carbide as the main material in some high-speed drill bits, as it can resist high temperatures and is extremely hard.

2.2 SiC (SILICON CARBIDE)

Silicon carbide is a compound of silicon and carbon with chemical formula SiC. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bullet proof vests. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and

detectors in early radios were first demonstrated around 1907. SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both. Silicon carbide with high surface area can be produced from SiO2 contained in plant material. Silicon carbide is a popular abrasive in modern lapidary due to the durability and low cost of the material. In manufacturing, it is used for its hardness in abrasive machining processes such as grinding, honing, water-jet cutting and sandblasting. Particles of silicon carbide are laminated to paper to create sandpapers and the grip tape on skateboards. Silicon carbide is a semiconductor in research and early mass-production providing advantages for fast, high-temperature and/or high-voltage devices.

Silicon Carbide is possesses interesting electrical properties due to its semiconductor characteristics, the resistance of different compositions varying by as much as seven orders of magnitude.Silicon Carbide are that it is a refractory material (high melting point), it has excellent thermal conductivity and low thermal expansion, consequently it displays good thermal shock resistance

Table 2.4 Properties of SiC

S.NO	PROPERTIES	VALUE
1	Chemical formula	SiC
2	Molar mass	40.10 g.mol−1
3	Density	3.21 g.cm−3
4	Melting point	2,730 °C

2.3.1 APPLICATIONS OF SiC

In all of the applications outlined above, where a high precision engineering components are required, it is important to recognize the difficulties of machining Silicon Carbide. Despite the high hardness values it displays, it is nevertheless a relatively brittle material and can only be machined using diamond grinding techniques. Consequently, it is beneficial that a skilled and experienced operator conducts the machining operations as incorrect procedures can generate sub-surface damage and micro-cracks that may lead to premature failure once the component is subjected to operating stresses in service. There is also chemical vapor deposited silicon carbide called CVD Silicon Carbide, which is an extremely pure form of the compound. In addition, the high hardness, corrosion resistance and stiffness lead to a wide range of applications where wear and corrosion resistance are primary performance requirements.

3.STIR CASTING ELECTRODE PREPARATION

3.1 STIR CASTING

Here we have been adopting the stir casting method for the preparation of metal matrix AA7075, WC &SiC composites. This whirlpool technique provides the high strength homogeneous set of aluminium composite materials. The necessary apparatus are required to fabricate the materials with step wise procedures are discussed below.

3.2 FRAME OF STIRRING SYSTEM

Frame of stir –casting system is prepared by 1x1 MS square iron pipe. The height of frame is 70 cm from the ground and its length and width is 70 cm each side. The two square pipes are joined in the middle side at a distance 27 cm from both sides which is used for the fitting of motor cum stirrer.

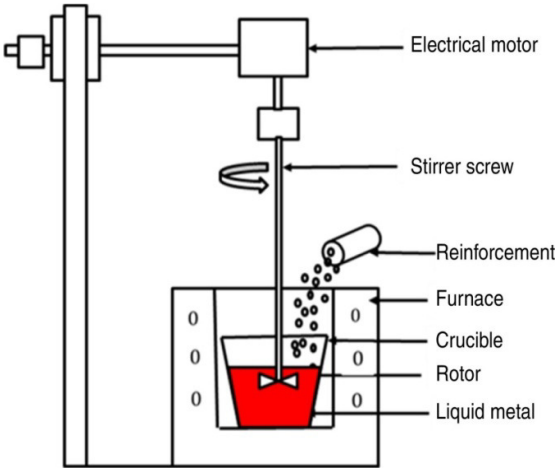


Fig 3.1 Stir Casting Process

3.3 STIRRER FABRICATION

Stirrer is made up of mild carbon steel. The length of stirrer is 95 cm and exactly plus sigh blade zigzag angle 90 degree of each side. The length of every of stirrer blade is 9 cm each.

3.4 GRAPHITE CRUCIBLE

Graphite crucible is used for heating the matrix material. The height of the crucible is 12 inch and upper diameter is 8inch and the bottom side diameter of the crucible is 6 inch.

3.5 MOTOR DIAMETER

The motor is fitted on the centre of the frame having 200 to 1400 rpm for string process and the rate of speed is adjusted by dimmer (0 to 260 volts)

3.6 FURNACE SPECIFICATION

Underground Electrical furnace is used for the preparation of the homogenous metal matrix. The furnace opening dimension 15''x15'' and the depth is 30''. Electrical supply is used fuel in the preparation.

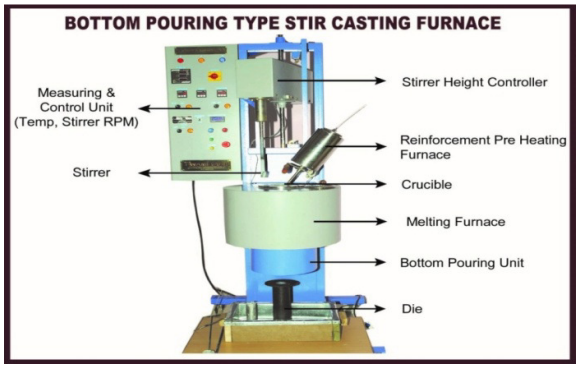


Fig 3.2 Bottom Pouring Type Stir Casting Furnace

3.7 METHODOLOGY

In the preparation process of this method, stirring has been carried out in graphite crucible in electrical furnace with continuous stirring of the molten metal matrix gives homogeneous mixture of composites and instantaneously poured in to the Die cavity to get solidify. Electrical supply is used as a fuel for preparation. The working diagram of the stir casting is given in the figure 4.1.

3.8 EXPERIMENTATION

The experimental arrangement has been assembled by the coupling gear box motor mild steel four blade stirrers used. First the scraps of aluminium were preheated 3 to 4 hours at 450◦ C and WC &SiC powder is heated with 900◦ C and both the preheated mixtures is then mechanically mixed with each other below their melting points. The metal matrix AA7075, WC &SiC is poured into the graphite crucible and put into the electrical furnace at 800◦ C temperatures. The furnace temperature was first increase above the composites completely melt the scraps of aluminium and then cooled down just below the components temperature and kept it in a semi solid state. At this stage the preheated WC &SiC were added with manually mixed with each other.

Table 3.1 Grams used in materials

S.NO	MATERIALS	GRAMS	PERCENTAGE
1	WC &SiC	7.5	1%
2	WC &SiC	15	2%
3	WC &SiC	22.5	3%
4	WC &SiC	30	4%
5	WC &SiC	37.5	5%
6	WC &SiC	45	6%

Fig 3.3 Specimen - I
(AA7075 94%, WC 3%, SiC 3%)

Table 3.2 Mixture of grams used in materials
(AA7075 94%, WC 3%, SiC 3%)

S.NO	MATERIALS	USED FOR GRAMS	AVERAGE
1	AA7075	765	94%
2	WC	22	3%
3	SiC	22	3%

Fig 3.4 Specimen – II
(AA7075 95%, WC 2%, SiC 3%)

Table 3.3 Mixture of grams used in materials
(AA7075 95%, WC 2%, SiC 3%)

S.NO	MATERIALS	USED FOR GRAMS	AVERAGE
1	AA7075	750	95%
2	WC	15	2%
3	SiC	22	3%

Fig 3.5 Specimen – III
(AA7075 95%, WC 3%, SiC 2%)

Table 3.4 Mixture of grams used in materials (AA7075 95%, WC 3%, SiC 2%)

S.NO	MATERIALS	USED FOR GRAMS	AVERAGE
1	AA7075	750	95%
2	WC	22	3%
3	SiC	15	2%

The temperature rate of electrical furnace should be controlled at 760◦ C in final mixing process. After complete the process the slurry has been taken into the die cavity with in thirty seconds allow it to solidify.

4. MECHANICAL TESTING

4.1 HARDNESS TESTS

Hardness may be defined as the ability of a material to resist scratching, cutting or penetration. The hardness test is performed on a material to know its resistance against indentation and abrasion.

4.1.1 TYPES OF HARDNESS TESTS

1. Brinell hardness test
2. Rockwell hardness test
3. Compression test

4.1.2 BASIC COMMON PRINCIPLE

The hardness is measured from an indentation produced in the component by applying a constant load on a specific indenter in contact with the surface of the component for a fixed time. In other words an indenter is pressed into the surface of the material by a slowly applied known load and the extent of the resulting impression is measured mechanically. A large impression for a given load and indenter indicates a soft materials and a small impression indicates a hard material.

4.2 BRINELL HARDNESS TEST

One of the earlier standardized methods of measuring hardness was the Brinell test. In the brinell test a hardened steel ball indenter is forced into the surface of the metal to be tested. The diameter of the hardened steel indenter is 10 mm standard loads rage between 500 kg and 3000 kg increments. During a test the load is maintained constant for 10 to 15 second.

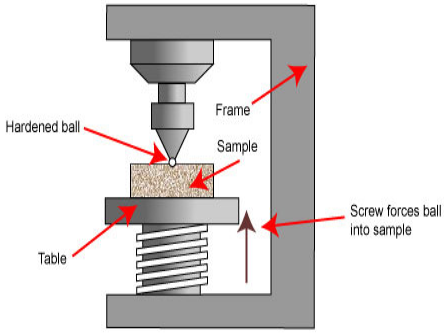


Fig 4.1 Brinell Hardness Test

Table 4.1 Diameter of indentation Average Value for Each Specimen

TRIAL/SPECIMEN	SPECIMEN - I (AA7075 94%, WC 3%, SiC 3%)	SPECIMEN - II (AA7075 95%, WC 2%, SiC 3%)	SPECIMEN - III (AA7075 95%, WC 3%, SiC 2%)
TRIAL – I	5.7	5.5	5.6
TRIAL – II	5.9	5.6	5.8
TRIAL – III	5.5	5.4	5.5
AVERAGE	**5.7**	**5.5**	**5.6**

The Brinell hardness shows in figure 4.1 performed by pressing a steel ball also known as a indenter into the spice men. The diameter of the resulting impression is measured with the help of calibrated microscope. The measured diameter is converted into equivalent Brinell hardness number using the following equation.

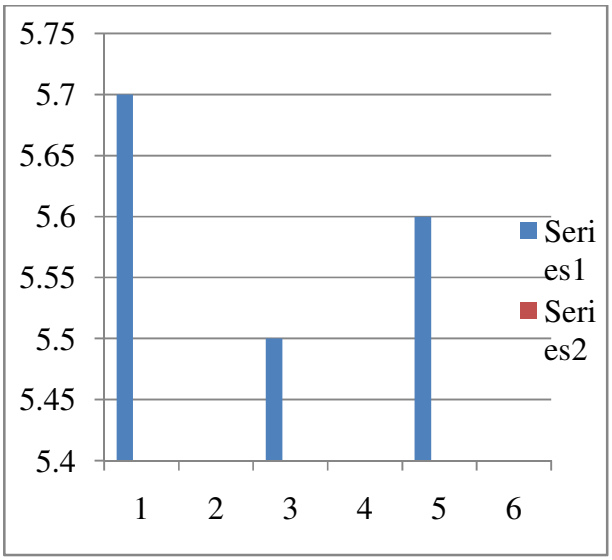
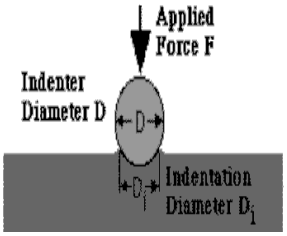


Fig 4.2 Chart for Each Specimen Diameter of indentation Average Value

Series 1 - AA7075 94%, WC 3%, SiC 3%,

Series 2 - AA7075 95%, WC 2%, SiC 3%

Series 3 - AA7075 95%, WC 3%, SiC 2%



$$BHN = \frac{F}{\frac{\pi}{2} D \left(D - \sqrt{D^2 - D_1^2}\right)}$$

Fig 4.3 Brinell Hardness Test Indentation

Where,

F – Load applied on the indenter in kg

D – Diameter of steel ball indenter in mm

d – Diameter of ball impression in mm

If the BHN value is higher than the material is said to be harder. If BHN is less, than the metal is soft.

4.2.1 TESTING PROCEDURE

The procedure for measuring Brinell hardness is as follows.

1. The materials to be tested are held on the anvil of the machine.
2. The test piece is raised by turning the hand wheel, till it just touches the indenter.
3. A minor load of 3000 kg is applied to set the specimen.
4. Now the major load is applied to the indented to procedure a deeper indentation.
5. After the indicating pointer has come to rest the major load is removed.
6. Which the major load removed the pointer now indicates the Brinell hardness number on the appropriate scale of the dial.

4.2.2 FIRST PROPORTIONAL MATERIAL USED IN BHN

(AA7075 94%, WC 3 %, SiC 3%)

Brinell hardness (H) = $\frac{P}{(\frac{\pi x D}{4})\{D-\sqrt{D^2-d^2}\}}$

Where,

P - Load

D - Diameter of the ball

d - Diameter of the indentation

P = 3000 kg => 300 N
D = 10 mm
d = 5.7 mm
H = $\frac{300}{(\frac{\pi x 10}{4})\{10-\sqrt{10^2-(5.7)^2}\}}$
H = 21.41 BHN

4.2.3 SECOND PROPORTIONAL MATERIAL USED IN BHN

(AA7075 95%, WC 2 %, SiC 3%)

Brinell hardness (H) $= \frac{P}{(\frac{\pi x D}{4})\{D-\sqrt{D^2-d^2}\}}$

Where,

P - Load

D - Diameter of the ball

d - Diameter of the indentation

P = 3000 kg => 300 N
D = 10 mm
d = 5.5 mm

$H = \frac{300}{(\frac{\pi x 10}{4})\{10-\sqrt{10^2-(5.5)^2}\}}$

H = 23.17 BHN

4.2.4 THIRD PROPORTIONAL MATERIAL USED IN BHN

(AA7075 95%, WC 3 %, SiC 2%)

Brinellhardness (H) $= \frac{P}{(\frac{\pi x D}{4})\{D-\sqrt{D^2-d^2}\}}$

Where,

P - Load

D - Diameter of the ball

d - Diameter of the indentation

P = 3000 kg => 300 N
D = 10 mm
d = 5.6 mm

$H = \frac{300}{(\frac{\pi x 10}{4})\{10-\sqrt{10^2-(5.6)^2}\}}$

H = 22.27 BHN

4.3 COMPRESSION TEST

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together),where as tensile strength resists tension (being pulled apart). In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently. Compressive strength can be measured by plotting applied force against deformation in a testing machine, such as a universal testing machine. Some materials fracture at their compressive strength limit others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Since atoms in solids always try to find an equilibrium position, and distance between other atoms, forces arise through out the entire material which oppose both tension or compression. The strain is the relative change in length under applied stress, positive strain characterizes an object under tension load which tends to lengthen it, and a compressive stress that shortens an object gives negative strain.

Fig 4.4 Compression Test Machining Process

Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine. Measurements of compressive strength are affected

by the specific test method and conditions of measurement.

$$\text{Compressive Strength} = \frac{\text{compressive maximum load}}{\text{Average area of the bed faces}}$$
$$\text{N/mm}^2$$

Compressive strength are usually reported in relationship to a specific technical standard. When a specimen of material is loaded in such a way that it extends it is said to be in tension. On the other hand, if the material compresses and shortens it is said to be in compression. On an atomic level, the molecules or atoms are forced apart when in tension where as in compression they are forced together.

$$\text{Crushing Strength} = \frac{\text{load}}{\text{area}}$$
$$= P/A$$

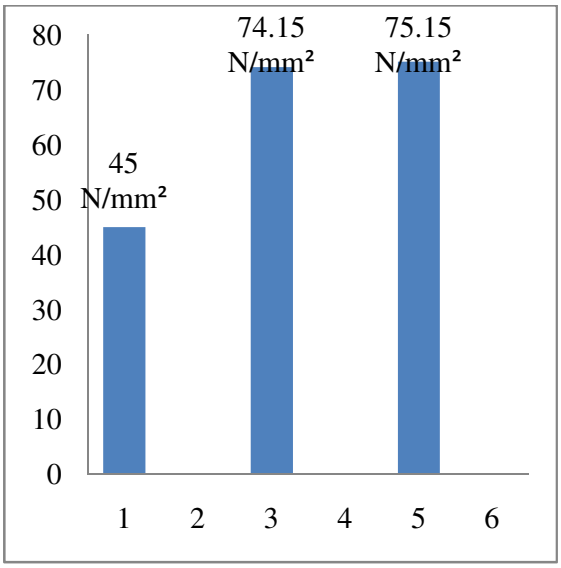


Fig4.5 Chart of Crushing Strength Value in Each Specimen

Tension tends to pull small sideways deflections back into alignment, while compression tends to amplify such deflection into buckling. Compressive strength is measured on materials, components and structures. By definition, the ultimate compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test

5.TESTING

5.1 SEM TEST

A scanning electron microscope (SEM) is a type of electron microscope that images a sample by scanning it with a beam of electrons in a raster scan pattern. The electrons interact with the atoms that make up the sample producing signals that contain information about the sample surface topography, composition, and other properties such as electrical conductivity

5.1.1 HISTORY

The first SEM image was obtained by Max. Knoll. Who in 1935 obtained images of silicon steel showing electron channeling contrast. Further pioneering work on the physical principals of the SEM and. Beam specimen interactions was performed by Manfred von Adrienne in 1937, who produced a British patent but never made a practical instrument. The SEM was Further developed by Professor Sir Charles Oatley and his postgraduate student Gary Stewart and was first marketed in 1965 by the Cambridge Scientific instrument company as Stereo scan.

Fig 5.1 SEM Testing Machining Process

5.1.2 WORKING PROCESS

The types of signals produced by SEM. Include secondary electrons back scattering electrons (BSE), characteristics X –ray light specimens current and transmitted electrons.

Secondary electrons detectors are common in all SEM, but it is rare that a single machine would have dectors for all possible signals the signals results form integrations of the electron beam with atoms at or near the surface of the sample in the most common or standard detection mode, secondary electron imaging the SEM can produce very high – resolution images of a sample surface revealing details less than 1 nm in size. Due to the very narrow electron beam, SEM micrographs have a large depth of field yielding characteristics three – dimension appearance useful for understanding the surface structure of a sample. The is exampled by the micrograph of pollen the surface structure of a sample. This is explained by the micrograph of pollen shown to right. A wide range of magnifications is possible, from about 10 times to more than 500,000 times about 250 times the magnification limit of the best light microscopes.

All samples must be of an appropriate size to fit in the specimen chamber and are generally mounted rigidly on a specimen holder called a specimen stub. Several models of SEM can examine any part of a 6-inch (15 cm) semiconductor wafer, and some can tilt an object of that size to 45°. For conventional imaging in the SEM, specimens must be electrically conductive, at least at the surface, and electrically grounded to prevent the accumulation of electrostatic charge at the surface. Metal objects require little special preparation for SEM except for cleaning and mounting on a specimen stub.

Nonconductive specimens tend to charge when scanned by the electron beam, and especially in secondary electron imaging mode, this causes scanning faults and other image artifacts. Embedding in a resin with further polishing to a mirror-like finish can be used for both biological and materials specimens when imaging in backscattered electrons or when doing quantitative X-ray microanalysis. The main preparation techniques are not required in the environmental SEM outlined below, but some biological specimens can benefit from fixation.

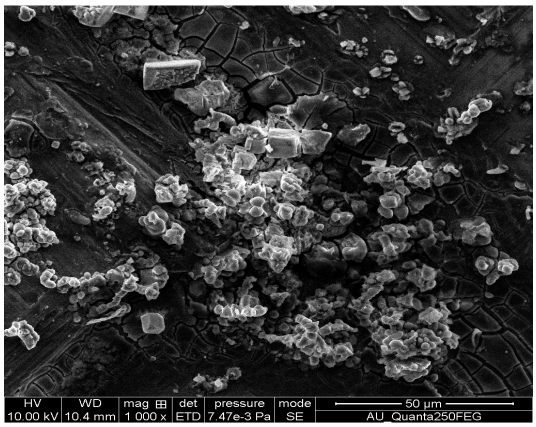


Fig 5.2 Specimen – I

(AA7075 94%, WC 3%, SiC 3%)

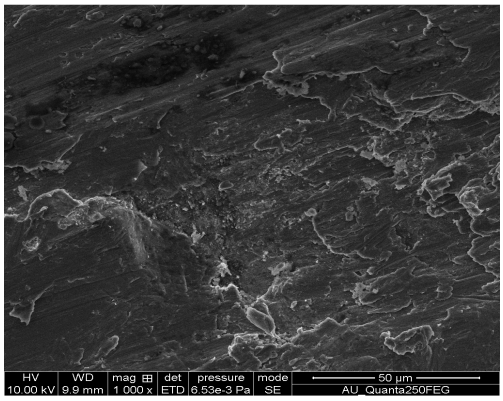


Fig 5.3 Specimen – II

(AA7075 95%, WC 2%, SiC 3%)

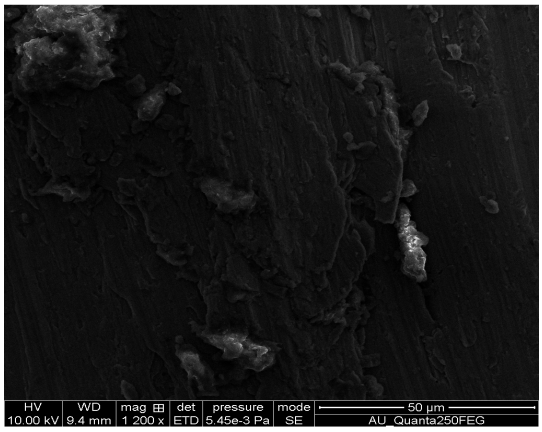


Fig 5.4 Specimen – III

(AA7075 95%, WC 3%, SiC 2%)

Back scattered electrons (BSE) are beam electrons that are reflected from the sample by elastic scattering .BSE are often used in analytical SEM along with the spectra made from the characteristics X –rays Because of the BSE signal is strongly. Related to the atomic number (Z) of the specimen, BSE images can provide information about the distribution of different elements in the sample. For the same reason, BSE imaging can image colloidal gold immune- labels of 5 or 10 nm diameters, which would otherwise be difficult or impossible to detect in secondary electron images in biological specimens. Characteristics X –rays are emitted when the electron beam removes an inner shell electron from the sample, causing a higher – energy electron to fill the shell electron from the sample, causing a higher – energy electron to fill the shell and release energy. These characteristics X – rays are used to identify the composition and measure the abundance of elements in the sample.

5.2 EDAX TESTING

EDAX Analysis stands for Energy Dispersive X-ray analysis. It is sometimes referred to also as EDS or EDAX analysis. It is a technique used for identifying the elemental composition of the specimen, or an area of interest thereof. The EDAX analysis system works as an integrated feature of a scanning electron microscope (SEM). Interaction of an electron beam with a sample target produces a variety of emissions, including x-rays. An energy-dispersive (EDS) detector is used to separate the characteristic x-rays of different elements into an energy spectrum, and EDS system software is used to analyze the energy spectrum in order to determine the abundance of specific elements. EDS can be used to find the chemical composition of materials down to a spot size of a few microns, and to create element composition maps over a much broader raster area. Together, these capabilities provide fundamental compositional information for a wide variety of materials.

5.2.1 WORKING PROCESS

During EDAX Analysis, the specimen is bombarded with an electron beam inside the scanning electron microscope. The bombarding electrons collide with the specimen atoms' own electrons, knocking some of them off in the process. A position vacated by an ejected inner shell electron is eventually occupied by a higher-energy electron from an outer shell. To be able to do so, however, the transferring outer electron must give up some of its energy by emitting an X-ray.

The amount of energy released by the transferring electron depends on which shell it is transferring from, as well as which shell it is transferring to Furthermore, the atom of every element releases X-rays with unique amounts of energy during the transferring process.

Thus, by measuring the amounts of energy present in the X-rays being released by a specimen during electron beam bombardment, the identity of the atom from which the X-ray was emitted can be established.

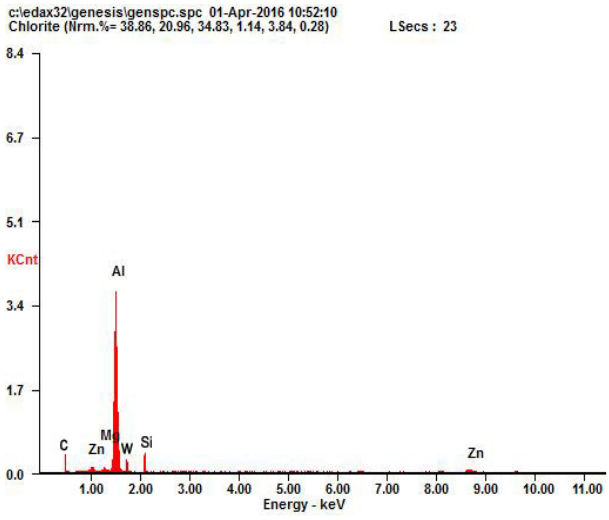


Fig 5.5 EDAX Result (AA7075 94%, WC 3%, SiC 3%)

Table 5.1 Specimen – I EDAX Result Value

(AA7075 94%, WC 3%, SiC 3%)

S.NO	ELEMENT	Wt%	At%
1	Zn	4.76	1.45
2	C	4.59	9.47
3	Mg	1.29	1.54
4	Al	85.81	84.13
5	W	1.81	1.75
6	Si	1.74	1.66

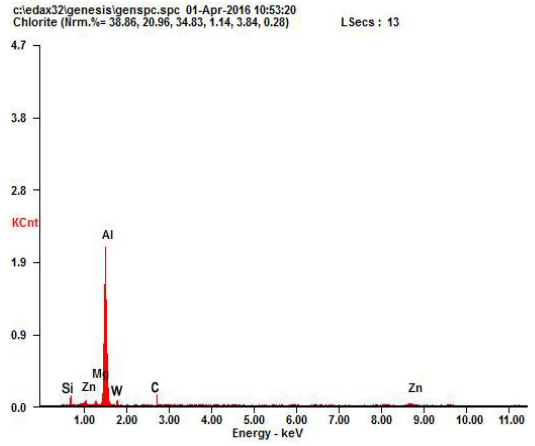


Fig 5.6 EDAX Result (AA7075 95%, WC 2%, SiC 3%)

Table 5.2 Specimen – II EDAX Result Value

(AA7075 95%, WC 2%, SiC 3%)

S.NO	ELEMENT	Wt%	At%
1	Zn	4.94	1.14
2	C	4.71	7.27
3	Mg	1.38	1.21
4	Al	86.72	88.13
5	W	1.19	1.16
6	Si	1.06	1.09

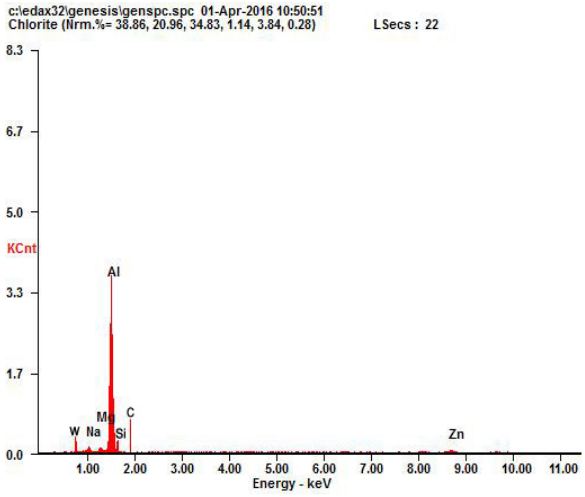


Fig 5.7 EDAX Result (AA7075 95%, WC 3%, SiC 2%)

Table 5.3 Specimen – III EDAX Result Value

(AA7075 95%, WC 3%, SiC 2%)

S.NO	ELEMENT	Wt%	At%
1	Na	1.90	2.03
2	C	3.91	5.97
3	Zn	4.71	1.42
4	Mg	1.63	1.89
5	Al	85.57	86.22
6	W	1.02	1.38
7	Si	1.26	1.09

5.2.2 EDAX SPECTRUM

The output of an EDAX analysis is an EDAX spectrum. The EDAX spectrum is just a plot of how frequently an X-ray is received for each energy level. An EDAX spectrum normally displays peaks corresponding to the energy levels for which the most X-rays had been received. Each of these peaks is unique to an atom, and therefore corresponds to a single element. The higher a peak in a spectrum, the more concentrated the element is in the specimen.

An EDAX spectrum plot not only identifies the element corresponding to each of its peaks, but the type of X-ray to which it corresponds as well. For example, a peak corresponding to the amount of energy possessed by X-rays emitted by an electron in the L-shell going down to the K-shell is identified as a K-Alpha peak. The peak corresponding to X-rays emitted by M-shell electrons going to the K-shell is identified as a K-Beta peak shown in the figure below.

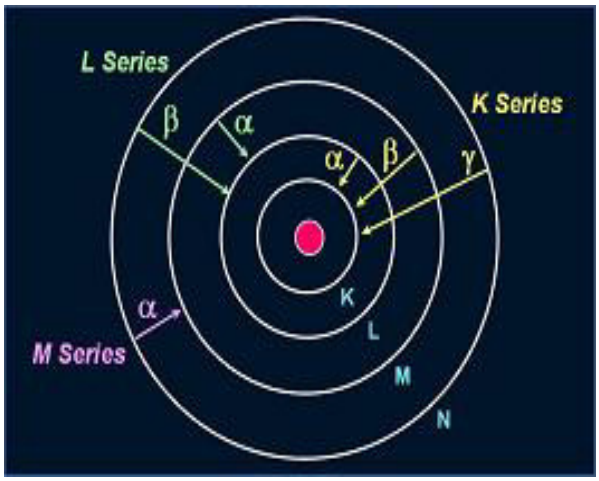


Fig 5.8 Elements In An EDAX Spectrum Are Identified Based On The Energy

When performing EDAX analysis, the following must be observed,

- The probe current must be adjusted such that data collection is just between 10%-30% dead.
- Spot Mode operation must be used for contaminants suspected to be concentrated in very small regions.
- The EHT level used during the analysis must be higher than the energy peaks corresponding to the elements of interest.

5.2.3 FAILUREMECHANISMS/ATTRIBUTES TESTED FOR BY EDAX ANALYSIS

A typical EDS spectrum is portrayed as a plot of x-ray counts vs. energy (in keV). Energy peaks correspond to the various elements in the sample. Generally they are narrow and readily resolved, but many elements yield multiple peaks. For example, iron commonly shows strong Kα and Kβ peaks. Elements in low abundance will generate x-ray peaks that may not be resolvable from the background radiation.

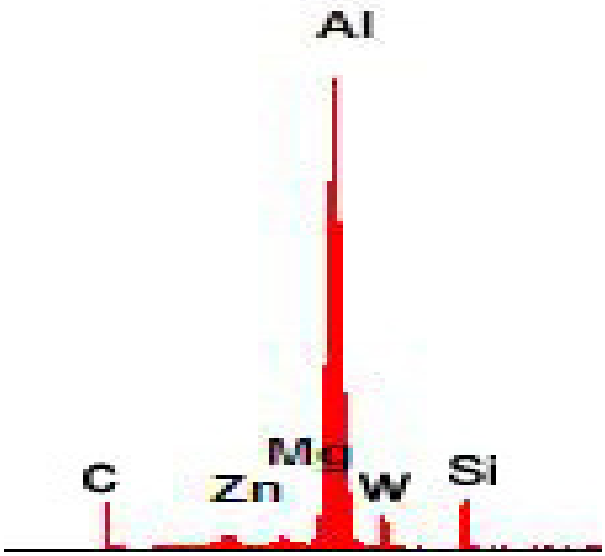


Fig 5.9 Example of an EDAX Spectrum

5.2.4 STRENGTH

- When used in "spot" mode, a user can acquire a full elemental spectrum in only a few seconds. Supporting software makes it possible to readily identify peaks, which makes EDS a great survey tool to quickly identify unknown phases prior to quantitative analysis.
- EDS can be used in semi-quantitative mode to determine chemical composition by peak-height ratio relative to a standard.

5.3 SEM / EDAX ANALYSIS

A Scanning electron microscope (SEM) can be utilized for high magnification imaging of almost all materials. With SEM in combination of EDAX it is also possible to find out that different part of the sample contains which elements. This means the SEM/EDAX instrument is a powerful and flexible tool for solving a wide range

of product and processing problems for a diverse range

SEM/EDAX analysis carried out in many industrial sectors including electronics and semiconductors, pharmaceutical, petrochemicals, plastics and polymers, aerospace, automotive, medical devices, engineering, chemicals, materials and metallurgy .

5.4 APPLICATIONS OF EDAX

Typical Applications include:-

- Identification of metals and materials
- Particle contamination identification and elimination
- Classification of materials
- Product and process failure and defect analysis
- Examination of surface morphology (including stereo imaging)
- Analysis and identification of surface and airborne contamination
- Powder morphology, particle size and analysis
- Cleaning problems and chemical etching
- Welding and joining technology quality evaluation and failure investigation
- Paint and coating failure and delaminating investigation
- Identification and elimination of corrosion and oxidization problems
- Contamination or stain investigation
- Structural analysis
- Reverse engineering of products and processes

The SEM/EDAX is the ultimate tool for

- Deposits and Wear Debris Analysis
- Particle Sizing and Characterization
- Failure Analysis
- Contaminant Analysis
- Metallurgical Studies

5.5 RANGE OF MATERIALS FOR INVESTIGATION BY SEM/EDAX

- Metals, Glass and Ceramics
- Semiconductors
- Plastics and polymers
- Powders and Dust
- Composite Materials
- Fibers (Textile, fabric , man-made, natural, carbon fibers, glass fibers, Kevlar)

Some Applications of EDAX are explained below:

5.6 EDAXANALYTICAL CAPABILITIES

Viewing three dimensional images of microscopic areas only solves half the problem in an analysis. It is often necessary to identify the different elements associated with the specimen. This is accomplished by using the “built-in” spectrometer called an Energy Dispersive X-ray Spectrometer. EDS is an analytical technique which utilizes x-rays that are emitted from the specimen when bombarded by the electron beam to identify the elemental composition of the specimen. To explain further, when the sample is bombarded by the electron beam of the SEM, electrons are ejected from the atoms on the specimens.

A resulting electron vacancy is filled by an electron from a higher shell, and an x-ray is emitted to balance the energy difference between the two electrons. The EDS x-ray detector measures the number of emitted x-rays versus their energy and the energy of the x-ray is characteristic of the element from which the x-ray was emitted. A spectrum of the energy versus relative counts of the detected x-rays is obtained and evaluated for qualitative and quantitative determinations of the elements present as shown in Image below

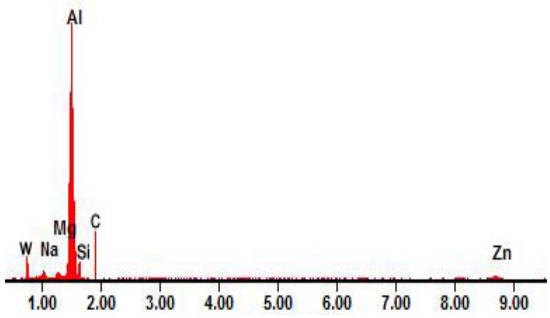


Fig 5.10 EDAX Spectrums Of Elements Detected In Sample

5.7 ANALYSIS OF THIN FILMS

EDAX analysis was carried out on a thin evaporated layer on top of a nickel / iron alloy. The layer contained a mixture of barium, strontium and oxygen, with a small amount of magnesium. The thickness of the layer was calculated to be ~ 38 nm.

6. CONCLUSION

The AA7075 with Tungsten Carbide & Silicon Carbide Metal Matrix Composites with Various Percentage such as (94%, 3%, 3%), (95%, 2%, 3%) & (95%, 3%, 2%) have been Successfully Produced by Stir Casting Method from those proportions the decisions were derived. The percentage of increase of Tungsten Carbide & Silicon Carbide the Aluminium metal matrix composite produces a corresponding change in the value of the elongation. The results of study suggest that with increase in composition of WC&SiC, an increase in hardness, impact strength and normalized displacement have been observed. The results of study suggest that with increase in composition of WC&SiC an increase in hardness, impact strength and normalized displacement have been observed. AA7075 metal matrix composites have been produced by a novel route which enables the nucleation of solid AA 7075 on the WC &SiC reinforcing phase to occur and results in line as-cast grain sizes.

Scanning Electron Microscope (SEM) shows that particles of various chemical compositions are involved in AA7075 + WC + SiC above mentioned proportions of SEM image shows less cracks & greater atomic strength compared to other three proportions. Energy Dispersive X-Ray spectroscopy (EDAX) shows various percentages of compositions are involved in particular proportion is listed in graph. From that graph the following decision were made. AA7075 + WC + SiC having the greater carbon content compared with other proportion of various percentages, due to this greater the carbon content the hardness value are increased.

The value of percentage increase of Tungsten Carbide & Silicon Carbide in the Aluminium metal matrix composite produces a corresponding change in the Life of the component. The Aluminium Alloy7075 with WC &SiC composite can be used in the automobile Bike frame and connecting rod presently in use. This would increase the hardness, tensile strength and the fatigue life of the shaft for various loading.

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