MECHANICAL CHARACTERIZATION OF AA5083(O) ALUMINIUM METAL MATRIX COMPOSITE REINFORCED WITH RECYCLED CERAMIC POWDER

A Project Submitted by

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DEPARTMENT OF MECHANICAL ENGINEERING

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BONAFIDE CERTIFICATE

Certified that this project report "**MECHANICAL CHARACTERIZATION OF AA5083(O) ALUMINIUM METAL MATRIX COMPOSITE REINFORCED WITH RECYCLED METAL POWDER"** is the bonafide work of "**SAMUELSON G (PRK21ME5002)"** who carried out the project work under my supervision during the academic year 2022-2023.

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ABSTRACT

In most of the engineering applications such as aviation, defense, marine and automotive requires components with light weight and along with favorable mechanical properties; this demand perhaps satisfied by metal matrix composites (MMCs) of aluminium by virtue of its distinguished achievement. Also MMCs suffer from insufficient process stability, in-adequate economic efficiency and reliability. In the present research work an experiment was developed to synthesize metal matrix composite adopting Aluminium Alloy AA5083(O) as matrix material reinforced with recycled fuse carrier ceramic particulates (4 wt %, 8 wt % & 12 wt %) using stir casting process. Experiments were implemented to analyze mechanical and tribological properties like ultimate tensile strength, hardness, and wear characteristics. From the above investigations, it is revealed that hardness increases with decrease in tensile strength with upsurge in more wt % of reinforcement. Due to the very high self-lubricating property of fuse carrier ceramic significant reduction in wear can be observed with deepen in wt % of fuse carrier ceramic.

Keywords: AA5083(O), Fuse carrier ceramic, Metal Matrix Composite, Stir casting

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CHAPTER 1
INTRODUCTION

1.1 GENERAL INTRODUCTION

In today's modern technological world, material science plays a major role in developing various new mechanical components, which has special mechanical and material characteristics for different environmental conditions. Conventional materials are durable and denser hence abundant in weight, hence exploration has been shifted from alloys to composite.

It is very well established that aluminium metal matrix composite are exemplify as the materials that are typically fortified by strong ceramic particles for instance nitrides, carbides or oxides in to the matrix. In MMCs, hard ceramic reinforcements are infused in to soft metal matrix to achieve combination of enhanced elevated working temperatures, excellent resistance to wear, light weight, better strength, better hardness, good thermal and electrical conductivity. Composite materials are usually used for buildings, structural application namely boat hulls, bridges, panels in swimming pools, race car bodies, bathtubs, imitation granite, storage tanks. Norul Amierah Binti Nor Zamani et.al investigated the mechanical and tribological behaviour of aluminium-graphite (Al-Gr) composite fabricated using powder metallurgy process. In order to evaluate the tribological behaviour, 3 – 7 wt % of graphite was chosen to determine its potential self-lubricating property under dry sliding condition. The graphite particles in the composite form a thin layer amidst the contact surface and act as a lubricant, which diminishes metal to metal influence. K.Sekar developed Aluminium alloy (AA) 2014 reinforced with B4C & Gr hybrid composites with disparate wt% of reinforcement particulates using conventional stir casting process. Microstructural analysis reveals uniform distribution of reinforcement with sufficient bonding strength among the reinforcement and matrix particulates after preheating. Mechanical properties for instance tensile strength, hardness and impact strength were analysed. The results reveal that, by adding B4C & Gr reinforcement particles an oxide layer was advanced in composite materials on the surface, the density of the composite and stress relieves of the composites increased, so that hardness of the developed composite material increases gradually with escalation in wt % of ceramic particles. V.Mohanavel et.al pinpointed on the development of Aluminium Alloy (AA) 6351 matrix reinforced with 0 – 12 wt % in stages of 4 wt % of graphite particulates by adopting stir casting method. V.N.Gaitonde et.al evaluated the aftermath of the corrosion and wear properties of Al5083 bolstered with 3 & 6 wt % of Al_2O_3 and graphite developed by stir casting method. The experimental results reveal that the developed composite material curtail the wear rates after increasing the wt % of ceramic reinforcement particulate.

1.2 Motivation for the research

To synthesize and characterize of aluminium metal matrix composite in a sustainable manner. In the sustainable manner i used recycled fuse carrier ceramic particulates for reinforcement.

1.3 Problem Definition

Recycling of wasted fuse carrier by adding with aluminium AA5083(O) and recycled ceramic powder mixture.

1.4 Objective

- To synthesize aluminum metal matrix composite.
- To do mechanical and metallurgical aluminum metal matrix composite.

CHAPTER 2
LITERATURE REVIEW

J.Pradeep Kumar, D.S.Robinson Smart, Erick C. Jones (2019). Experimental Evaluation of Mechanical, Wear and Corrosion properties of AA5083/Graphite Metal Matrix Composite Prepared using Compocasting Process

In most of the engineering applications such as aviation, defence, marine and automotive requires components with light weight and along with favorable mechanical properties; this demand perhaps satisfied by metal matrix composites (MMCs) of aluminium by virtue of its distinguished achievement. Also MMCs suffer from insufficient process stability, in-adequate economic efficiency and reliability. In the present research work an experiment was developed to synthesize metal matrix composite adopting Aluminium Alloy (AA) 5083 as matrix material reinforced with graphite particulates (6 wt %, 8 wt % & 10 wt %) using two stage in-situ stir casting process. Experiments were implemented to analyze mechanical and tribological properties like ultimate tensile strength, microhardness, wear characteristics and corrosion properties. From the above investigations, it is revealed that microhardness increases with decrease in tensile strength with upsurge in more wt % of reinforcement. Due to the very high self-lubricating property of graphite significant reduction in wear can be observed with deepen in wt % of graphite. Also corrosion rate decreases with more amount of graphite particulate when compared with base matrix material.

Syed Nasimul Alam, Lailesh Kumar (2016). Mechanical Properties of Aluminium Based Metal Matrix Composites Reinforced with Graphite Nanoplatelets

In this work Al-matrix composites reinforced by exfoliated graphite nanoplatelets (xGnP) is fabricated by powder metallurgy route and their microstructure, mechanical properties and sliding wear behaviour were investigated. Here, xGnP has been synthesized from the thermally exfoliated graphite produced from a graphite intercalation compound (GIC) through rapid evaporation of the intercalant at an elevated temperature. The xGnP synthesized was characterized using scanning electron microscope (SEM), high-resolution transmission electron microscope (HRTEM), x-ray diffraction (XRD), atomic force microscopy (AFM), x-ray photoelectron spectroscopy (XPS), differential scanning calorimetry and thermogravimetric analysis (DSC/TGA), Raman spectroscopy and Fourier transform infrared spectroscopy (FTIR). The Al and xGnP powder mixtures were consolidated under a load of 565 MPa followed by sintering at 550°C for 2 h in an inert atmosphere. Al-1, 2, 3 and 5 wt. % xGnP nanocomposites were developed. Results of the wear test show that there was a significant improvement in the wear resistance of the composites up to the addition of 3 wt. % of xGnP in the Al matrix. The hardness of the various Al-xGnP composites also shows improvement upto the addition of 1 wt. % xGnP beyond which there was a decrease in the hardness of the composites. The tensile strength of the Al-xGnP composites continuously reduced with the addition of xGnP due to the formation of Al4C3 particles at the interface of the Al and xGnP in the composite.

Abou Bakr Elshalakany, Vineet Tirth , Emad El-Kashif, H.M.A. Hussein , W. Hoziefa (2020). Characterization and mechanical properties of stirrheo-squeeze cast AA5083/MWCNTs/GNs hybrid nanocomposites developed using a novel preformbillet method

This study explores the development and characterization of Aluminum alloy (AA) 5083 based nanocomposites, reinforced with equal proportion of graphene nanosheets (GNs) and multi-walled carbon nanotubes (MWCNTs) using stir-rheo-squeeze casting. To control the problem of segregation of the nano dispersoids, the study successfully employs a novel approach of making nano-preform billets of the reinforcements by green compacting and then introducing their sections to the alloy melt having compositions 0.5, 1, 1.5, 2, and 2.5% by weight, while stirring. MWCNTs and GNs in 1:1 ratio mixed and milled with ten times the high purity Aluminum (Al) powder volume. HRTEM images and XRD patterns conformed to the size and purity of MWCNT and GNs. SEM images confirmed their sound mixture. The structure was refined by about 60% in 3 wt.% composite, but agglomeration and cracks appeared at this composition. BHN increased consistently as the reinforcement was increased. Tensile and compressive strength increased initially but declined in the composite with 3 wt.% nanofillers due to agglomerations and weak interface bonding. Elongation first decreased and then increased due to counter slip systems introduced by the presence of MWCNTs and GNs. Prominent crack growth was observed in the fractography in 3 wt.% composite. An optimum reinforcement concentration of 1.5e2 wt.% has

Rajan Verma, Saurabh sharma, Dinesh Kumar (2017). Analysis of Mechanical Properties of Aluminium Based Metal Matrix Composites Reinforced with Alumina and Sic

In the present work, Al356 alloy is taken as base material and then it is reinforced with alumina(Al2o3) and siliconcarbide(sic). The prepared aluminium metal matrix composite samples are in the ratio of Al356:Al2O3=9:1 and Al356:Sic=9:1. The fabrication method used for sample preparation is Stir Casting Process. After Preparation of suitable samples certain tests are performed to analyse various mechanical properties like Tensile strength, Compressive strength, Shear strength, Impact strength and Hardness. After that microstructure of the samples is also observed under microscope. At last, a comparison is made between the mechanical properties of base aluminium alloy and the prepared aluminium metal matrix composites.

S. Gopalakrishnan, N. Murugan (2012) [6] done an experiment in which Aluminium Alloy AA6061 is taken as matrix material and TiC particle as reinforcement. They prepared composite by Stir Casting in which Magnesium Mg is taken as filler material. They have found that Specific strength increases by the addition of TiC particle in the composite, Wear rate increases with the addition of TiC particle.

David Raja Selvam et al. (2013) [7] uses Aluminium Alloy as matrix and SiC and Fly Ash as reinforcement. They prepared a composite material by taking 1% of magnesium particle and SiC particle 7.5 to 10% and 7.5% fly ash by %wt. and fabricated through Stir Casting. Various mechanical testing shows that there is Enhancement in the tensile strength of aluminum matrix and composites, the micro and macro-hardness of the composites also increase.

S. Amirkhanlou et al. (2010) [5] have opted Aluminium Alloy AA356 as matrix and SiC particle as reinforcement to produce composite by Stir Casting and Compocasting. Samples are taken in different variation. Addition of SiC particles in the form of Al-SiCp composite powder and casting in semisolid state increases the hardness of the composites by 10% and decreases the porosity by 68% approximately also Impact energy is influenced by the form of the reinforcement addition.

Prasanna M et al. (2014) [8] have taken Aluminium Alloy LM25 as matrix material and Silicon Carbide SiC, E Glass and Red Mud as reinforcement. The composition of reinforcement in the composite material as sample 1 contains SiC 3%, E Glass 1% and Red Mud 3, 6, 9%; sample 2 contains SiC 3%, E Glass 1, 2, 3% and Red Mud 3%; sample 3 contains SiC 3, 6, 9%, E Glass 1% and Red Mud 3%. The tests shows that there is Improvement in Tensile Strength, Impact Strength and reduce in the % Elongation. Addition of E Glass minimizes the Hardness and there is nearly uniform distribution of reinforcement in the composite.

J. Jebeen Moses et al. (2014) [9] done an experiment in which he takes Aluminium alloy AA6061 as matrix material and silicon carbide SiC in different composition as reinforcement. Fabrication is done through stir casting. The periphery of vortex of the composite is added by silicon carbide and then solidified in permanent mould. It is found that fairly homogeneous distribution of silicon carbide particle in the Aluminium matrix. There is enhanced microhardness and ultimate tensile strength of the composite.

CHAPTER 3
EXPERIMENTAL DETAILS

3.1 Introduction

In this present work, an effort is made to synthesize Aluminium Alloy AA5083(O) as a base matrix material reinforced with recycled fuse carrier ceramic particulates by exploiting traditional stir casting procedure. Different weight percentage of reinforcement was used and the manufactured composite material was experimented with divergent mechanical and tribological tests. The main motive of this research is to establish a peculiar aluminium metal matrix composite material that could serve for military and defence equipment's that are subjected to extreme environmental condition. Mechanical properties like hardness, tensile strength were scrutinized. The proposed composite material was subjected to wear and tribological studies and evaluated.

3.2 Selection of materials

3.2.1 Matrix Material

Aluminium Alloy AA5083(O) was chosen as the base matrix material with magnesium as the primary alloying element as demonstrated in Table 3.1. The mechanical and physical characteristics of AA5083(O) matrix material is delineated in Table 3.2. Alloys in this series avail excellent welding characteristics and high resistance to corrosion in marine atmosphere. AA5083 aluminum alloy has highest strength of the non-heat treatable alloy, one of the major drawback of the AA5083(O) that it is not reusable and cannot be used above 650°C temperature.

Table 3.1: Chemical composition (wt%) of 5083 aluminium alloy

Element	Mn	Fe	Cu	Mg	Si	Zn	Cr	Ti	Al
Min	0.4	0.4	0.1	4	0.4	0.25	0.05	0.15	Balance
Max	1.0			4.9			0.25		

Table- 3.2: Physical and Mechanical Properties of AA5083 aluminium alloy

S.No	Properties	Units	Values
1	Density	g/cm3	2.80
2	Melting Point	°C	635
3	UTS	MPa	317
4	YS	MPa	229
5	Shear Strength	MPa	190
6	% Elongation	-	16
7	Poisson's Ratio	-	0.33
8	Crystal Structure	-	FCC

Fig. 3.1. Pure AA5083(O)

3.2.2 Particulate Material

One of the important functions of reinforcement in a composite material is to improve the mechanical property. In this work we are using recycled fuse carrier ceramic material, is an inorganic, non-metallic oxide, nitride, or carbide material. Some elements, such as carbon or silicon, may be considered ceramics. Ceramic materials are brittle, hard, strong in compression, and weak in shearing and tension. And also ceramic is any of the various hard, brittle, heat-resistant and corrosion-resistant materials made by shaping and then firing an inorganic, nonmetallic material, such as clay, at a high temperature. The properties of ceramics are high hardness, high elastic modulus, low ductility, high dimensional stability, good wear resistance, high resistance to corrosion and chemical attack, High weather resistance, high melting point. Hard ceramic particles are normally used as reinforcements in the metal matrix. However, these materials have some disadvantages, such as low ductility, poor wettability, particle matrix debonding, presence of porosity or particle clusters.

Fig. 3.2. Before Recycling Fuse Carrier Ceramic materials

3.2.3 Ball Milling

A ball mill also known as pebble mill or tumbling mill is a milling machine that consists of a hallow cylinder containing balls; mounted on a metallic frame such that it can be rotated along its longitudinal axis. The balls which could be of different diameter occupy 30 – 50 % of the mill volume and its size depends on the feed and mill size. The large balls tend to break down the coarse feed materials and the smaller balls help to form fine product by reducing void spaces between the balls. Ball mills grind material by impact and attrition. Ball milling is a grinding method that grinds nanotubes into extremely fine powders. During the ball milling process, the collision between the tiny rigid balls in a concealed container will generate localized high pressure. Usually, ceramic, flint pebbles and stainless steel are used.

Fig. 3.3. Ball Mill Grinder

Table- 3.3: Ball Mill Specifications

Model	BST/BM-1
Speed	80 rpm
Motor	FHP Geared Motor
Material feed size	< 10 mm
Final fineness	< 10 µm, for colloidal grinding < 1 µm

3.2.4 Cut-Off Machine

All cut off machines use an abrasive blade which allows it to cut through very hard materials and that blade can be powered by either a gasoline engine or electric motor.

Fig. 3.4. Cut-off Machine

Table. 3.4. Cut-off Machine Specifications

Model	BS-355K
Size	355 mm
Rated Power	2000 W
Usage	Metal Cutting
Speed	3800

3.2.5 Electric Furnace

Furnaces employing combustion produce a hot gas which transfers heat to the material by radiation and convection. Solids are heated by direct contact, but fluids are usually heated indirectly, being carried inside pipes within the furnace.

Fig. 3.5. Electric Furnace

Table. 3.5. Furnace Specifications

Furnace Type	Fix
Power Source	Electric
Max Temperature	0 – 1250 Degree Celsius
Usage	Gold, Silver, Copper, and All Non-Ferrous Metals
Max Product Size	4 kg

3.2.6 Portable Pneumatic Hand Held Stirrer

In stir processing, a rotating tool is used with a pin and a shoulder to a single piece of material to make specific property enhancement, such as improving the material's toughness or flexibility, in a specific area in the micro-structure of the material via fine grain of a second material with properties that improve the first.

Fig. 3.6. Hand Held Stirrer

Table. 3.6. Hand Held Stirrer Specifications

Model	DPS-APGST-4441
Rated Voltage	220 V
Rated Power	2100 W
Rated Speed	0-800 rpm
Rated Frequency	50/60 Hz
Adjustable Speed	6 Level

3.2.7 Moulding

A mold or mould is a hollowed-out block that is filled with a liquid or pliable material such as plastic, glass, metal, or ceramic raw material. The liquid hardens or sets inside the mold, adopting its shape. A mold is a counterpart to a cast. The very common bi-valve molding process uses two molds, one for each half of the object. Mould Size: 15×15 cm.

Fig. 3.7. Mould

3.2.8 Wire Cut Electric Discharge Machine

Wire cut EDM is a machining process that uses electrical discharges to cut metal. It is a versatile and precise method that can be used to create complex shapes. Wire cut EDM is typically used for hard metals, such as stainless steel or titanium, but can also be used on softer metals.

Fig. 3.8. Wire Cut EDM

Table. 3.7. Wire Cut EDM Specifications

Work Electrode Diameter	0.05-0.3 mm
Workpiece Weight	1500 kg or less
Taper Angle	± 25°/50 mm or more
Job Admit	275 or more

3.2.9 Pin-on-disc wear test

Simple wear tests usually involve a sample of one material being pressed against the flat, moving face of another. For example, in the pin-on-disc test, wear is created in a flat-ended pin by pressing it against a rotating disc. The amount of wear is most conveniently measured by weighing the pin periodically.

Fig. 3.9. Pin on Disc Machine (DUCOM – TR 20-LE)

3.2.10 Hardness Test

A hardness test is a method employed to measure the hardness of a material. Hardness refers to a material’s resistance to permanent indentation.

There are numerous techniques to measure hardness and each of these tests can identify varying hardness values for a single material under testing. Hence, hardness test as a method can be dependent and each test's outcome needs to be labeled to determine the kind of hardness test used.

Fig. 3.10. Hardness Testing Machine

3.2.11 Ultimate Tensile Strength

The ultimate tensile strength (UTS) is a material's maximum resistance to fracture. It is equivalent to the maximum load that can be carried by one square inch of cross-sectional area when the load is applied as simple tension. The UTS is the maximum engineering stress in a uniaxial stress-strain test.

Fig. 3.11. The Universal Testing Machine

3.3 METHODOLOGY

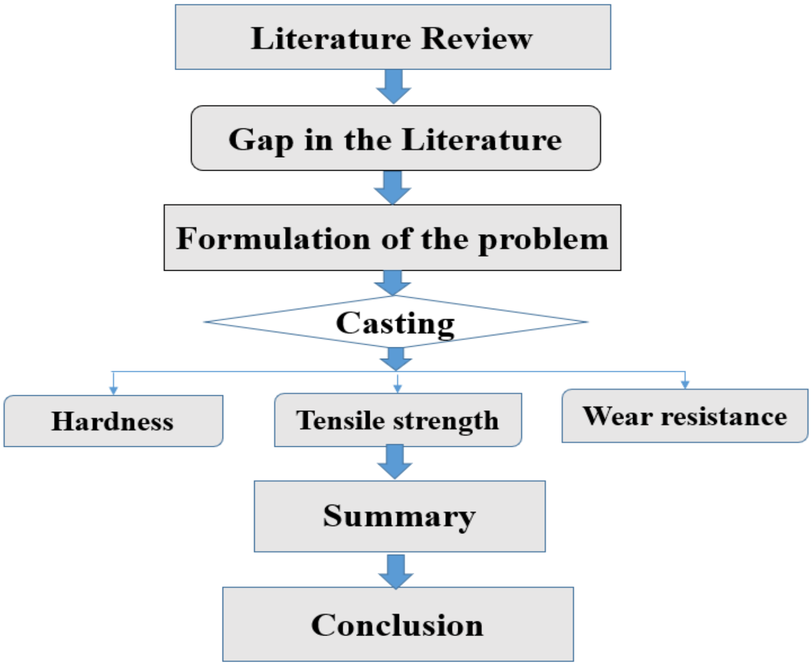


Fig. 3.12. Methodology

3.3.1 Fabrication Process

Owing to its cost effectiveness and simplicity, Conventional stir casting method was preferred to develop the aluminium MMCs. The AA5083 alloy as exposed in the Figure 3.1 were blended inside the crucible with its melting temperature inside the stir casting furnace as demonstrated in the Figure 3.15. Fuse Carrier Ceramic of 99.5% purity with particle size less than 20μm was preheated before mixing with aluminium melt. Legitimate stirring is obligatory to accomplish orderly distribution of reinforcement in the matrix material. The melt is stirred with the guidance of mechanical stirrer in order to develop a vortex. Meanwhile, Fuse Carrier Ceramic particulates with 4, 8 & 12 wt% were preheated and fed in to the aluminium melt at constant feed rate.

Fig.3.13. Pure AA5083(O)

Fig.3.14. Recycled Fuse Carrier Ceramic Particles

The various process parameters used to contrive the aluminium metal matrix composite material is displayed in Table 3.8. After continuous stirring of the molten mixture, it was discharged in to the preheated permanent mould at room temperature, which is previously adopted for required dimensions for accomplishing specimens. After cooling, the samples were taken out from the mould and the required specimens were cut using Wire Cut EDM machine for further testing and analysis.

Fig.3.15. Stir Casting Process

Fig.3.16. Moulding

Table.3.8. Testing Specification for Stir Casting

S.No	Process Parameters	Value
1	Stirring Time	5 mins
2	Stirring Speed	200 rpm
3	Melting Temperature	600°C
4	Crucible Size	4 (Bell Crucible)
5	Furnace	Electric muffle furnace
6	Preheating Temperature	500°C
7	Maximum Temperature of furnace	1100°C

3.3.2 Composition of Specimens

In this experiment, the fabrication is done by Stir casting. For fabrication matrix material is taken as aluminium alloy AA5083 and reinforcement as recycled fuse carrier ceramic. These materials are taken in different composition which are listed below table 3.9

Table. 3.9. Compositions of Specimens

Elements	Specimen 1		Specimen 2		Specimen 3	
	In gms	In (%)	In gms	In (%)	In gms	In (%)
AA5083	960	96	920	92	880	88
Reinforcement (Fuse carrier ceramic particulates)	40	4	80	8	120	12

Specimen 1

Specimen 2

Specimen 3

Fig. 3.17. Specimens

3.3.3 Mechanical Characteristics of Composites

The mechanical properties specifically microhardness of the cast specimens and Ultimate Tensile Strength (UTS) were explored. Tensile test was implemented out to assess the mechanical behaviour of developed AA5083/Ceramic aluminium metal matrix composite material. Figure 3.18 shows the tensile specimen in consonance with ASTM E8M04 standard. Tensile strength was regulated by employing digitalized universal testing machine alongside maximum load about 50 kN.

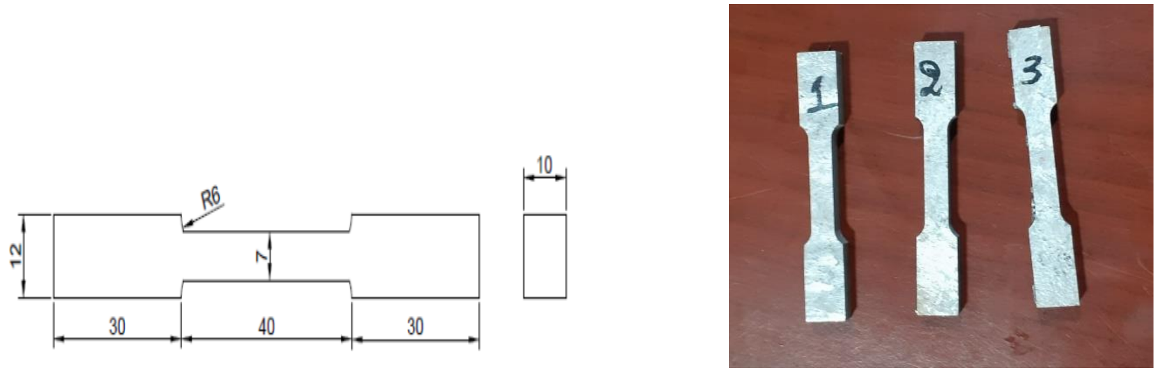


Fig. 3.18. ASTM E8 Standard Tensile Strength

The microhardness was retrieved using Vickers microhardness tester according to ASTM E92 standard specimen as shown in Figure 3.19. Each sample is polished using emery papers before micro-hardness test is conducted. 15 N load was enforced at the same time as the indentation for every test with an interminable dwell time of 5 seconds. At 10 disparate spots the microhardness of the advanced composite material was resolved to furnish repeatability of the secured results.

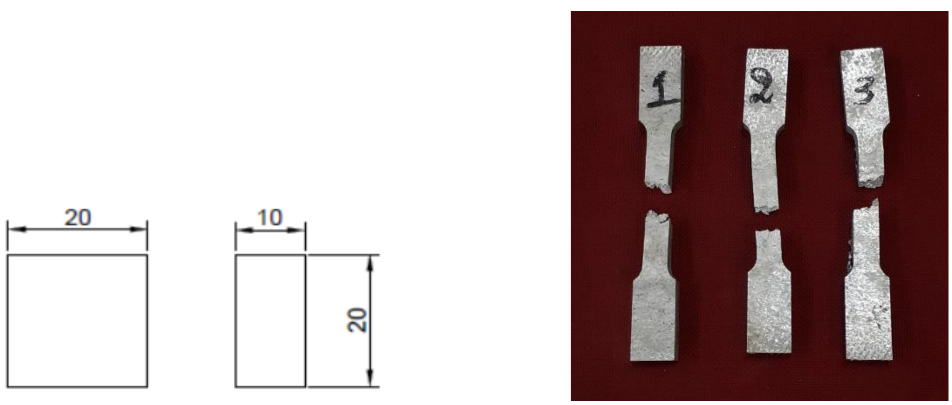


Fig.3.19. ASTM E92 Standard hardness specimen

3.3.4 Wear Behaviour of Composites

A computer unified pin on disc machine (DUCOM – TR 20-LE) as shown in the Figure 3.9 was employed for the investigation of wear rate at room temperature. The machine consists of a fixed arm with pulley at one end and a stationary pin at other end. Before each attempt, the specimens were gleamed using recognizable SiC emery sheets to persuade homogeneous surface roughness (Ra value of 0.03 μm). In line with typical ASTM G99 30 mm height & 8 mm diameter wear samples were flourished over wire EDM method and the surface was gleamed metallographically. Every analysis was bolstered 3 times & a balance data was depicted. Experiment was conducted at loading condition of 15 N at a sliding distance of 2000 m, 1 m/s and track diameter of 80 mm.

3.3.5 Scanning Electron Microscopy (SEM)

The scanning electron microscope (SEM) is a sort of electron magnifying instrument that pictures the example surface by examining it with high-energy beams of electron emission in a raster sweep design. The electrons connect with the atoms that make up the example delivering signals that contain data about the specimen's surface geology, compositions and different properties, for example, electrical conductivity. An extensive variety of amplifications is conceivable, from around 10 times (about proportionate to that of an intense hand-lens) to more than 500,000 times, around 250 times the amplification furthest reaches of the best light magnifying lens.

Fig.3.20. Scanning Electron Microscopy

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Tensile Strength

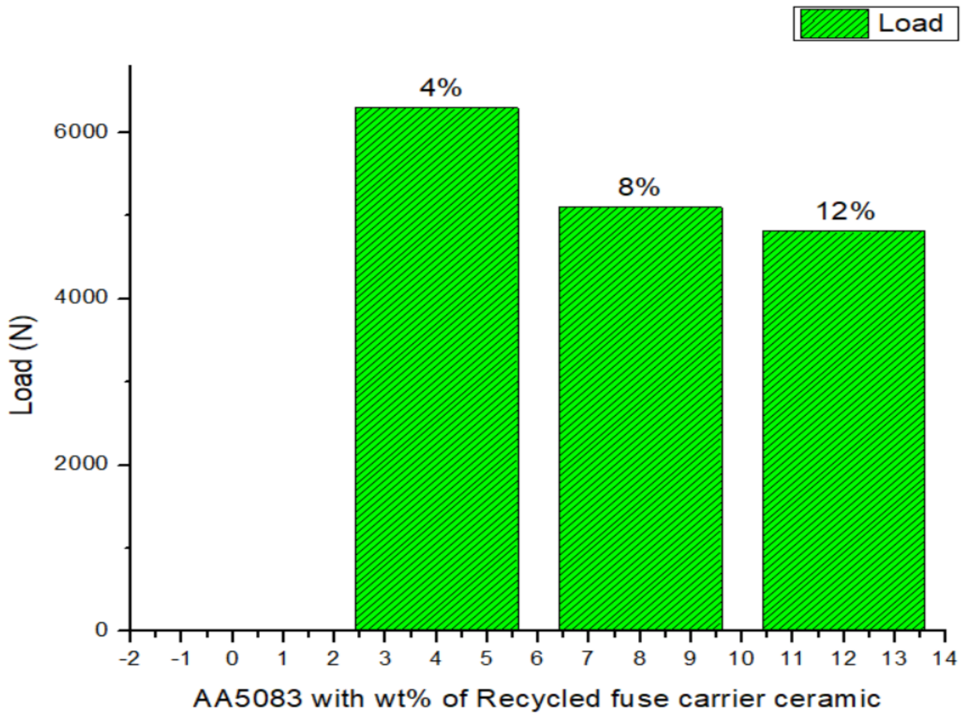


Fig.4.1. Load vs AA5083 with wt% of Recycled fuse carrier ceramic

Tensile tests were conducted to estimate the yield strength, ultimate tensile strength and various properties. The empirical testing authorized the stress-strain curves for AA5083 augmented 4, 8 and 12 wt% Ceramic particulates. It is observed that the yield strength decreases with upturn in wt% of reinforcement in the composite material. It is not necessary that the graph between percentages of reinforcement versus yield strength should have to be a linear one. Figure 4.1 depends on the elastic nature of the composite under consideration, and the stress at which the material begins to deform plastically.

4.2 Microhardness

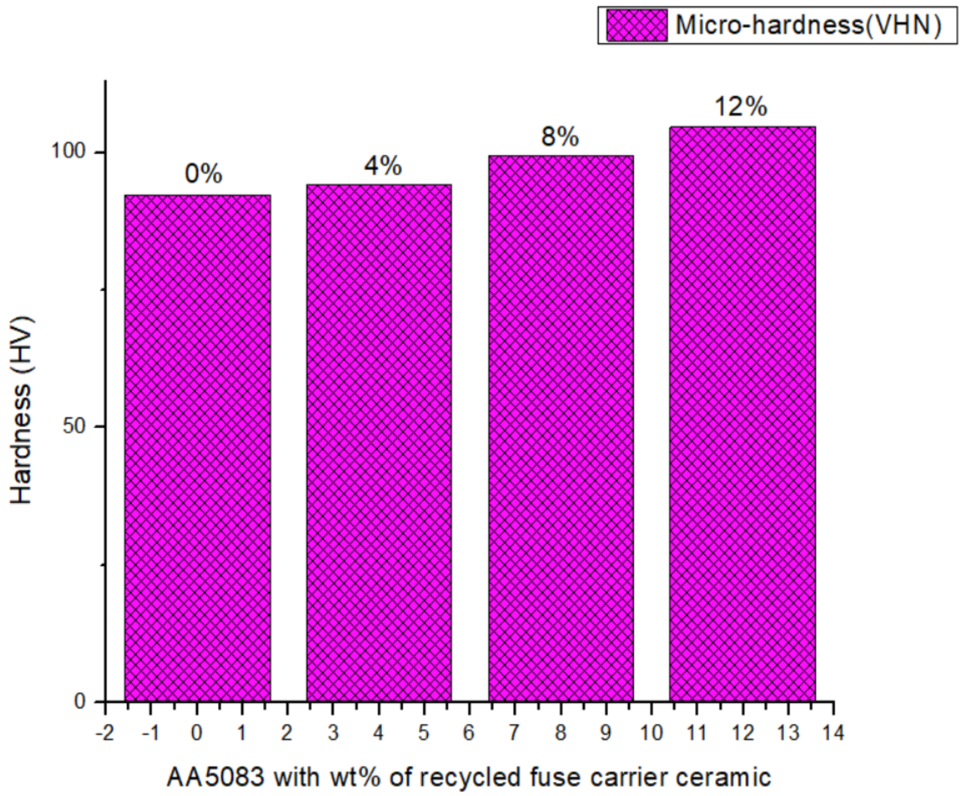


Fig.4.2. Hardness of AA5083/Ceramic particulates with respect to wt% of reinforcement

From Table 4.1, it can be analysed that the hardness increases marginally with raise in weight percentage of ceramic. This steady increase in hardness can partially prove the dispersion of Recycled fuse carrier ceramic particulates in AA5083 metal matrix. The superior value of hardness of composites illustrates that the continuation of ceramic particulates in the matrix. The presence of ceramic reinforcement starts to the increase in deprive to plastic deformation of the matrix during the hardness test. From Figure 4.2, the appreciable hardness difference between samples can be studied.

Table.4.1. Microhardness with varying wt% of ceramic

S.No	wt% of Recycled fuse carrier ceramic	Microhardness(VHN)
1	0	92.3
2	4	94.0
3	8	99.5
4	12	104.6

4.3 Wear characteristics

Tribological observations were implemented to understand the wear behaviour of AA5083(O)/Ceramic composite employing a pin-on-disk wear tester. Wear experiments were supervised adopting a 'pin-on-disc wear tester' for 4, 8 & 12 wt% Ceramic. The experimental wear data's achieved from verifying 4 specimens is delineated in Table 4.2.

Table.4.2. Experimental Wear Results

S.No	Time (sec)	Wear of AA5083(O)	Wear in μm when Ceramic is 4%	Wear in μm when Ceramic is 8%	Wear in μm when Ceramic is 12%
1	0.98	0	0	0	0
2	150.902	53.65	19.28	112.63	20.07
3	300.872	88.99	20.8	115.56	19.31
4	450.848	101.18	32.66	111.81	27.37
5	600.814	127.41	32.27	116.43	31.11
6	750.778	164.18	39.81	103.37	34.12
7	900.74	166.09	49.08	109.31	34.3
8	1050.702	172.06	58.33	110.86	33.54
9	1200.665	183.31	58.14	120.8	36.18
10	1350.63	194.24	58.17	116.43	36.21
11	1500.594	183.88	58.72	125.68	38.62

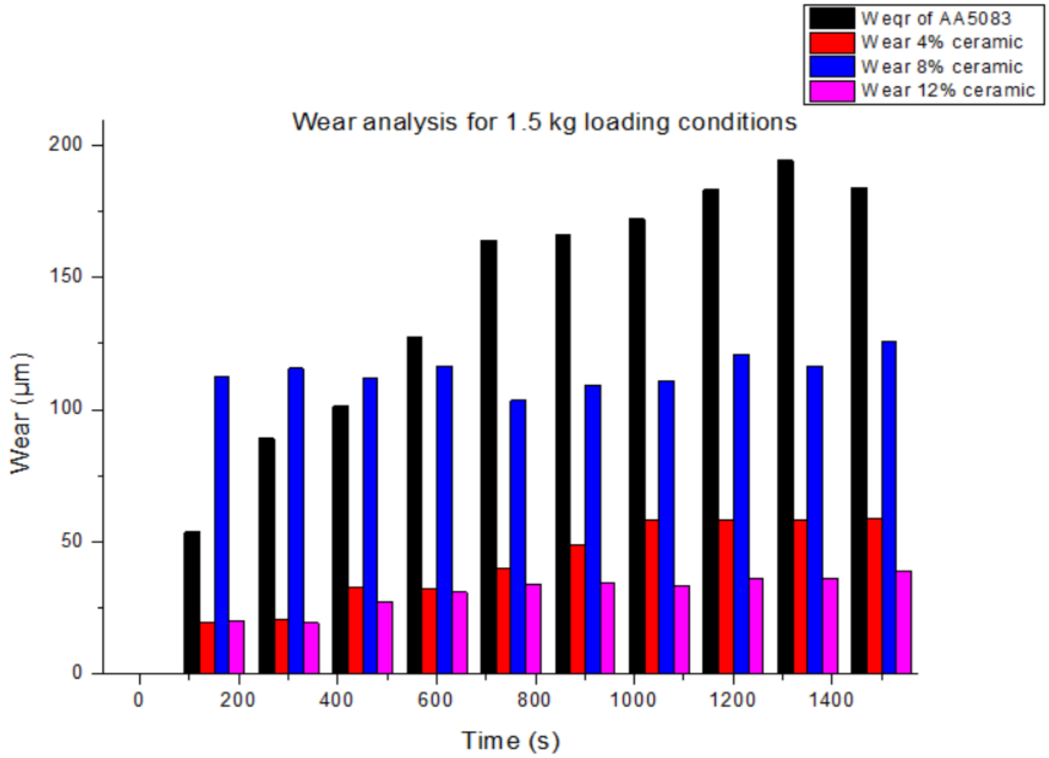


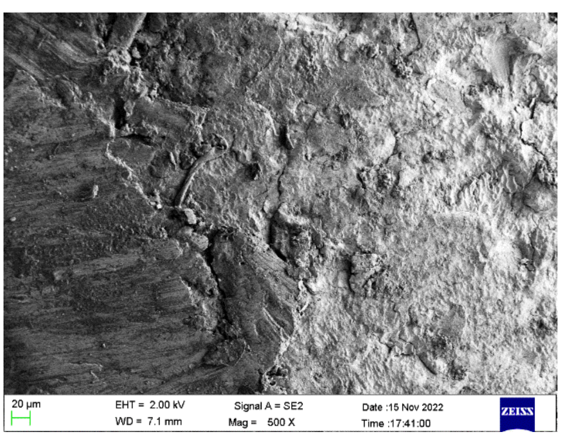
Fig.4.3. Wear with respect to time (1.5 Kg loading condition)

The Figure 4.3 represents wear of the samples with respect to time. From the Figure 4.3 it can be analysed that the sample with higher Ceramic content has lesser wear rate that all other samples with lesser percentages of Ceramic. The wear rate for the samples with 4 & 12 wt% ceramic has very low difference in wear comparing with 8 wt% of Ceramic at 1350 seconds. The test reveals that the sample with 8 wt. % Ceramic has a wear of 109.31 µm which is significantly higher than the base metal sample with 58.17 µm. The samples with 4 and 12 weight percentage of Ceramic also show substantial reduction in wear compared to the base metal alloy.

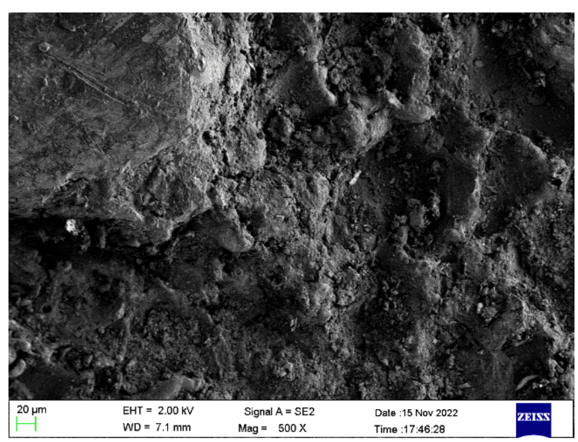
4.4 Surface Morphology

The scanning electron microscope (SEM) is a sort of electron magnifying instrument that pictures the example surface by examining it with high-energy beams of electron emission in a raster sweep design

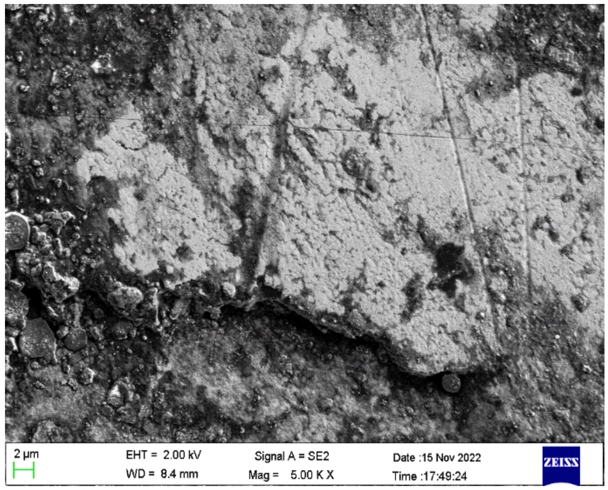
Fig.4.4 Before SEM analysis of wear and fractured specimens



Specimen 1



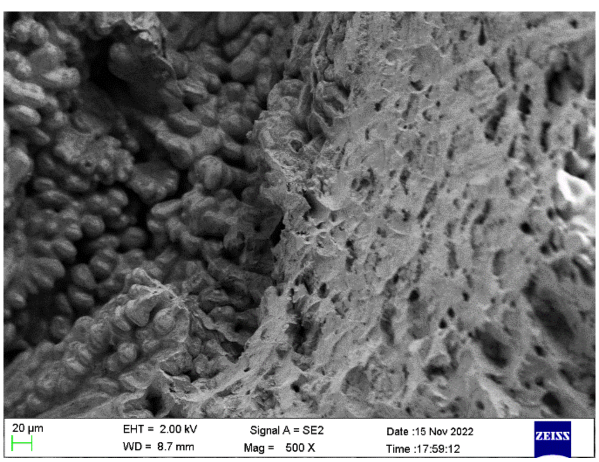
Specimen 2



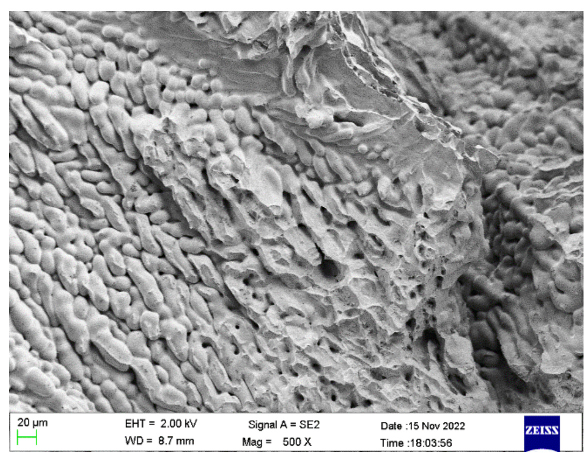
Specimen 3

Fig.4.5. SEM of wear specimens

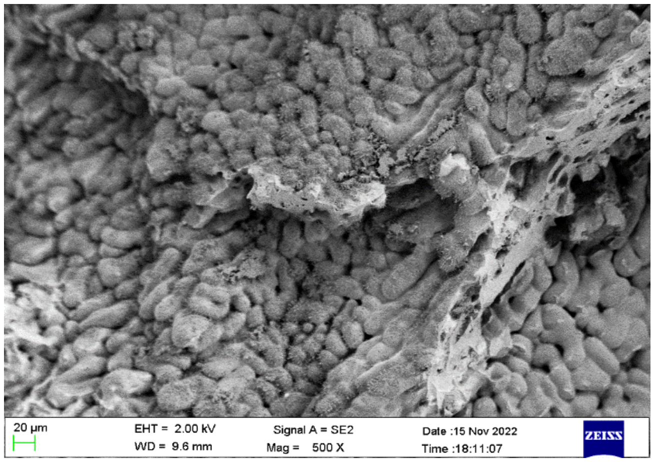
After wear testing surface of the samples see through Scanning Electron Microscopy (SEM) in SITRA Meditech, Coimbatore. Fig clearly shows the wear surface of the particulate filled AA5083 composites.



Specimen 1



Specimen 2



Specimen 3

Fig.4.6. SEM of fractured specimens

After tensile testing fractured of the samples see through Scanning Electron Microscopy (SEM) in SITRA Meditech, Coimbatore. Fig clearly shows the fractured area of the particulate filled AA5083 composites.

Figure clearly shows the homogeneous distribution of reinforcement particles. SEM images also reveal that no agglomeration of particles in the composite.

CHAPTER 5

CONCLUSION

1) In this work, AA5083(O) alloy was successfully reinforced with varying weight percentage reinforcement of recycled by in-situ stir casting process.
2) From the micro hardness test it was recognized that the surface hardness of the material surge with upturn in reinforcement, a trend which could be associated to the increase in presence of magnesium which increases the surface hardness of the composite and improves the wettability of ceramic in the matrix.
3) The wear test conclusions further prove that wear resistance of the samples further escalates unquestionably as the percentage of reinforcement increases. This is due to the evolution of a thin ceramic layer which brings about self-lubricity to the material. This thin ceramic layer formation was realised at the interfaces.
4) From the tensile testing outcomes, it was discovered that the tensile strength of the material reduces with increment in reinforcements by a factor of approximately 14% for every 2% addition of Ceramic and the material seemed to fail in a more ductile manner with increase in reinforcements which may be attributed to the decrease in the base material.

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