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Study on Microstructure and Mechanical Properties of Al7068 Reinforced with Silicon Carbide and Channa Husk Ash by Powder Metallurgy

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ABSTRACT

This paper presents a comprehensive investigation into the microstructure and mechanical properties of aluminum 7068 reinforced with channa husk ash and silicon carbide through the application of powder metallurgy. The aluminum 7068, silicon carbide, and channa husk ash were utilized in powdered form, with their sizes tailored to meet the required specifications. These powders were then mixed together in varying proportions and compacted under a pressure of 400MPa using a hydraulic press to fabricate samples. Subsequently, the samples were subjected to a sintering process at a temperature of 600°C for a duration of 2 hours. The resulting samples were evaluated for density, compressive strength, hardness, and their microstructure was examined using a scanning electron microscope. Additionally, an energy dispersive x-ray analysis was conducted to confirm the presence of silicon carbide and channa husk ash within the aluminum matrix.

Keywords: **Al7068, Channa Husk Ash, Silicon Carbide, Powder Metallurgy, Mechanical Properties.**

I. INTRODUCTION

Metal alloys, ceramics, and polymers can only provide so many desirable features for so many applications, but many of today's technologies need for materials with novel combinations of characteristics. Those materials used in aircraft, undersea, and transportation applications are in particularly high demand. Aircraft designers, for instance, are always on the lookout for new structural materials that can withstand extreme conditions without succumbing to corrosion, rust, or other damage. This is a potent potentia, to say the least. Density tends to be higher for strong materials, while increasing strength or stiffness often decreases impact strength.

The evolution of composites has allowed for the expansion of the possible combinations and ranges of material properties. To use a broad definition, a composite is any multiphase material that displays appreciable amounts of the qualities of both component phases, resulting in an improved combination of features. Using this concept of combined action, you may create materials with enhanced properties by skillfully blending two or more types of constituents. Many composites also include property trade-offs.

Over the last forty years, synthetic composite manufacturing has skyrocketed, with the industry being dominated by composites made from fine fibers incorporated into different polymers (Polymer). According to forecasts, the demand for composites would rise gradually, with metal and ceramic-based composites playing a disproportionate role.

II. LITERATURE REVIEW

1. Yashwant Kumar T, et al. (2016)

The properties of a composite material consisting of aluminum 7075 and boron carbide, prepared using the powder metallurgy method, were investigated in this study. The composite, with varying weight percentages of boron carbide (0%, 5%, 10%, and 15%), was produced through the powder metallurgy technique. Specimens were prepared by adjusting the content of boron carbide and the sintering temperature. Wear analysis demonstrated that the inclusion of boron carbide enhanced the wear resistance of the composite. Additionally, the hardness and compressive strength of the composite were found to increase.

2. "Characterization of par particulate reinforced Aluminium 7075 / TiB2 Composites"
Author Name: P. Pradeep, P. S. Samuel Ratna Kumar, Daniel Lawrence I, Jayabal S
Has looked at the possibility of using composites with an aluminum matrix in aerospace applications. There is a thorough examination of the material's hardness, microstructure, and wear. We use a stir casting process to make Al7075/TiB2 composite specimens with reinforcement. Composites' hardness increases linearly with reinforcement content in the base alloy, reaching a peak at 8 Wt.% of the TiB2 reinforced Aluminum matrix. Microscopically, an 8 Wt.% reinforced composite containing uniformly dispersed aluminum particles exhibits the lowest wear rate, while an 8 Wt.% reinforced composite containing TiB2 exhibits the greatest speed and the shortest sliding distance under the lightest loads. Due to work hardening of the specimen surface, the specific wear rate reduces with increasing sliding speed up to the transition speed (1.6 m/s) and load. Experimental validation of the generated response surface model shows that it has a low amount of error (up to 7 percent).

3. "Mechanical Properties and Microstructure Studies of Aluminium (7075) Alloy Matrix Composite Reinforced with Short Basalt Fibre"
Author Name: R. Karthigeyan, G. Ranganath, S. Sankaranarayanan
Has investigated the current experimental findings are listed below:
Al (7075) alloy and their composites have been successfully developed through the stir casting based liquid processing route with fairly uniform dispersion of basalt fibre.
The hardness of Al7075/basalt fibre composite increases as the addition of basalt fibre particles and the increment in hardness attributes to fibre particles dispersion in soft aluminium alloy matrix.
The addition of short basalt fibre significantly improves the yield strength and the ultimate tensile strength of Al7075, when compared with that of unreinforced matrix. The ultimate tensile strength of Al 7075/Basalt fibre composite when reinforced with 6 vol. % is increased by 65.51%.
The improvement in strength values under tensile loading occurs without affecting the tensile ductility. Fractured surfaces under tensile loading of the cast Al (7075) alloy and their composites shows the presence of equi-axed and shallow dimples in all the samples. The strength calculation involving the random distribution of basalt fibres best fits the experimental values.

4. "Aluminium (AA7075) Metal Matrix Composite Reinforced with B4C Nano Particles and Effect of Individual Alloying Elements in Al Fabricated by Powder Metallurgy Techniques".
Author Name: G Manohar, K M Pandey, S R Maity
The Nano B4C particles used in this study were created using ball milling procedures, and the AA7075/B4C Nano composite was fabricated through the Powder Metallurgy (PM) technique.
Instead of using pure Al powder, we construct two composites, composite-1 and composite-2 (alloyed composite), to study the impact of adding alloying materials to Al to meet AA7075 standard composition.
Composite-2 outperforms composite-1 in terms of mechanical qualities thanks to precipitates created during the sintering process as a result of the interaction between the alloy powders and reinforcements.
Composite-1 had higher hardness. This is because the generated intermetallics are resistant to the deformations caused by indentations, and because the manner of failure during the compression test demonstrates the ductile nature of composite-2.
Composites get their ductile properties through the addition of other alloying elements to Al, rather than from the use of AA7075 alloy powder as the matrix phase.

5. "Evaluation of Mechanical Properties of Graphite Powder and Bagasse Ash Reinforced Al 7075 Hybrid Metal Matrix Composites"
Author Name: Madhu M G, H K Shivanand, Maibusab, Sumana B G
Experimental research on newly produced hybrid composites has shown promise as a potential material for use in the challenging contexts that current technology must operate in. There is a lot of interest in MMCs among the different composites. The compositional differences between the ceramic and metal surfaces of MMCs provide the unique benefits of a continuous reduction in thermal stress throughout the material's thickness and a reduction in stress concentration at the interface between the two materials. As a consequence, these composites are finding increasing use in components for high-stress machines and places with extreme temperature differences, such as

turbines and rocket nozzles.
Mechanical characteristics such as Ultimate Tensile Strength, Yield Strength, Youngs modulus, ductility, Compression Strength, etc., of Aluminum 7075 hybrid composites, and the impact of added particles and fibers on them.

6. "Processing of Carbon fiber reinforced Aluminium (7075) metal matrix composite".
Author Name: Prof. Madhuri Deshpande, Prof.Dr. Rahul Waikar, Mr. Ramesh Gondil, Dr. S.V.S Narayan Murty & Dr. T. S. Mahata
Determined that Powder Metallurgy (PM) is an effective method for producing carbon fiber reinforced Al matrix composites.
Even at a high volume % of reinforcement, the carbon fibers in the composites demonstrate excellent adhesion to the Aluminum alloy matrix during fabrication.
Electro less nickel coating on the fiber surface improves interfacial bonding, leading to greater composite hardness.

The development of Al4C3, which is harmful to the composite's mechanical and thermal characteristics, may be avoided during fabrication by using the PM method.

When densifying a composite, double action hot pressing yields the best results with no density gradient.

Thus, PM method has enormous promise for making short/milled carbon fiber reinforced Aluminum matrix composites.

III. PROBLEM STATEMENT

3.1 PROBLEM STATEMENT

Reviewing the available literature led us to identify the following knowledge gaps for aluminum metal matrix composites.

- Powder metallurgy has seen just a small amount of research into metal matrix composites made from aluminum.
- To yet, powder metallurgical research on the combination of Al7068, Channa Husk ash, and silicon carbide has shown no results.

The literature review revealed several omissions, and the current effort seeks to address those gaps by developing a more robust aluminum composite.

IV. MATERIAL SELECTION

4.1 ALUMINIUM 7068

The mechanical strength of an Aluminum 7068 alloy exceeds that of any other aluminum alloy and is comparable to that of certain steels. This remarkable alloy has a yield strength of up to 400 MPa, which is up to 30% higher than that of 7075 alloy, and strong ductility, as well as corrosion resistance equivalent to 7075 alloy. In the mid-1990s, Kaiser Aluminium developed 7068 alloy as a stronger alternative to 7075 for emerging uses; now, Advanced Metals International is the exclusive distributor of this material in Europe. 7068's mechanical properties (retained at elevated temperatures better than 7075) and other important characteristics have led to the alloy's widespread specification to significantly reduce the weight/cross section or significantly increase the strength of critical components across a variety of market sectors.

The US Aluminium Association recognizes Al-7068 alloy as a 7000 series aluminum-zinc alloy that conforms to AMS 4331 (chemical composition and mechanical qualities) and AMS 2772 (heat treatment). The tensile data and fatigue characteristics of 7068 alloy A and B have been approved for inclusion in MIL

Handbook 5 / MMPDS. It is important to note that while the aforementioned specifications serve as a foundation for 7068 alloy supply, Kaiser Aluminium is the only company capable of supplying a consistent, optimized property combination thanks to their targeting of a much narrower composition window and their proprietary knowledge of the heat treatment regime and metal processing techniques.

APPLICATION & PROPERTIES

Common applications for the aluminum 7068 alloy include connecting rods, actuators for gearboxes, shock absorbers for automobiles, and fuel pumps for high-performance engines. Race car components: rocker arms Motorcycle chain tensioners, Motorcycle gears, Seals for high-performance engines' bearings, Wheels and rims for racing cars, artificial limbs, Ordnance, Sabot, 25mm Stress gauges, Materials for hydraulic valves, Strong solenoid pressure, Tools for scaling mountains, Backpacking poles, ski poles, tent poles, Battle rifles, Coupling for bending shafts, Driveshaft for a snowmobile, Fluid-transporting devices with quick-disconnect fittings.

Properties of Al-7068 alloy

- ✓ Strong in tension, compression, bearing, and shear, and capable of making aluminum alloy composites lighter or stronger.
- ✓ Useful up to 200 °C due to excellent strength retention at high temperatures
- ✓ Appropriate for cyclic loads, as in IC engines, with good fatigue strength
- ✓ Al-7068 is easily interchangeable with the more stronger 7075.
- ✓ Excellent machinability and high thermal conductivity
- ✓ The 7068 alloy is amenable to all the common anodizing processes, and although its behavior is comparable to that of the 7075 alloy, the hard anodized surface of the 7068 alloy is more resistant to abrasion.

CHEMICAL COMPOSITION OF AL-7068

Table 1. Chemical composition of Al7068 alloy (weight percentage)

Weight (%)	**Si**	**Fe**	**Cu**	**Mn**	**Mg**	**Cr**	**Zn**	**Ti**	**Zr**	**others**
MIN			1.6		2.2		7.3		0.05	
MAX	0.12	0.15	2.4	0.10	3.0	0.05	8.3	0.10	0.15	0.05

4.2 SILICON CARBIDE

Silicon carbide, a compound of silicon and carbon with the chemical formula SiC, was first created by a high-temperature Electrochemical reaction of sand and carbon. The material has improved to become a ceramic of technical grade with exceptional mechanical characteristics. It finds widespread usage in high-performance contexts such as abrasives, refractories, ceramics, and many others. There is no other carbon- and silicon-based chemical compound than silicon carbide. The name "Carborundum" refers to a kind of silicon carbide. The silicon carbide employed in the study has a particle size between 50 and 100 millimeters.

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Figure 1: Silicon Carbide

4.3 CHANNA HUSK ASH

Ash from burning channa husks is a heterogeneous byproduct of the coal combustion process in thermal power plants. The glassy spheres in the thin grey powder ascend with the exhaust fumes. Ash from Channa Husks varies in chemical composition depending on the kind of coal burned and the combustion process.

Figure 2: Channa Husk Ash

4.4 PROCESSING STAGES OF POWDER METALLURGY

a. The raw materials are first ground into a fine powder and separated into many tiny particles.
b. It is possible to create a homogenous mixture by combining two or more metals and/or nonmetals.
c. Pressing the combined ingredients in a mold or die creates a green compact, a weakly cohesive aggregate.
d. After the green compact has been heated and compressed for a certain amount of time, it will have hardened into a solid.

4.5 STEPS INVOLVED IN PM TECHNIQUE

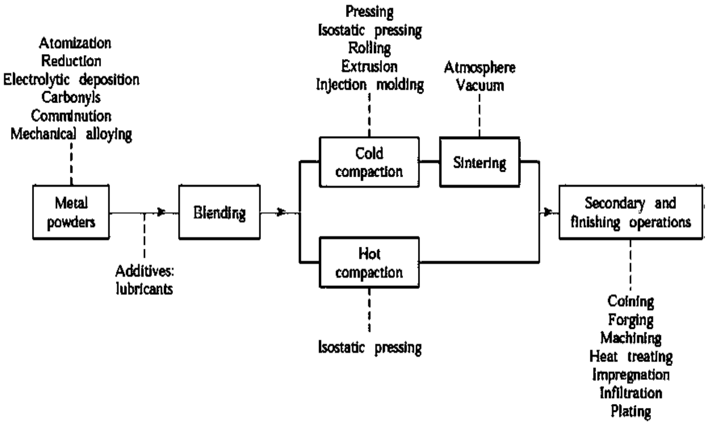

Figure 3: Steps involved in PM technique

- **Preparation of powders:** Very fine powders are obtained using various techniques.

- **Blending of powders:** The fine powders are mixed along with a lubricant. Thelubricant helps in imparting good fluidity to the powders.

- **Compacting:** The blended powders are compacted in a mold or die.
- **Sintering:** The compacted mass is sintered at a high temperature in a furnace in a controlled atmosphere.
- **Sizing:** The sintered component is passed in a mold or dies to trim the component and have high dimensional accuracy.
- **Machining:** If required final machining is done on some specific locationsincluding drilling very small holes.
- **Treatment:** Parts are subjected to deburring and tumbling to remove any smallprojections and other treatments like oil impregnation tec., are given.
- **Inspection:** Finally parts are inspected to check the quality

V. METHODOLOGY

The equipment/ instruments used for powder metallurgy operation and testing ofcomposites is given below.

1. Weighing machine.
2. Pot mill.
3. Polypropylene bottles.
4. Hydraulic Press.
5. Die mould.
6. Raising hearth furnace.

5.1 MILLING AND BLENDING

Figure 4: Pot mill used for milling and mixing of powders

Powders of varying or identical compositions may be extensively mixed together via the process of blending or mixing. The goal of the blending procedure is to achieve a homogeneous powder dispersion. Here, a ball mill serves as a mixer. Aluminum 7068 metal powder, Chana husk ash, silicon carbide, and stearic acid are mixed together to form the binder.

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Figure 5: Polypropylene bottles used for milling and mixing of powders

We ordered 1000 kilos of 30 micron-sized Aluminium 7068 powder from Parshwamani Metals in Mumbai. In a milled 500 ml polypropylene container, Aluminium 7068 powder was produced. For this milling process, we employ alumina balls in two diameters, 10mm and 3mm, as the grinding medium. Half of the grinding media is 10 mm alumina balls, and the other half is 3 mm alumina balls; the powder to grinding media ratio is 1:4. The quantity of powder to utilize with the grinding medium and the size of the container or jar used for milling might affect the grinding ratio.

By listening to the jars spin and listening to the alumina balls hit, we were able to determine the optimal rotational speed for milling the grinding medium. The observed critical speed is somewhere between 230 and 250 revolutions per minute. With the dimensions of our polypropylene container, we found that 240 revolutions per minute provided the most effective milling of the powder. In a 500 ml polypropylene container, we milled a sample size of 50 grams of Al7068, Channa Husk ash, and silicon carbide mixed powder.

Ash from Channa husks and Silicon Carbide powder in the size range of 30 microns were employed to strengthen the aluminum 7068 used as the foundation material. After every hour of milling, the samples were rest for 15 minutes. The total milling time was 10 hours.

5.2 DIE COMPACTION

We developed a die and punch to achieve cold die compaction of ball milled powders. Tooling steel was high carbon high chromium steel. After machining, we hardened and ground the die and the punch. The table below details the die and punch dimensions. A measured quantity of the hybrid composite powder mixture was pressed into the mold. Using a hydraulic press, we compacted the die and punch at a pressure of 400 MPa for 60 seconds. Fig. depicts compositionally diverse samples after die compaction but before sintering. In this step, the powder is compressed into a green, cylinder-shaped compact and removed from the die cavity.

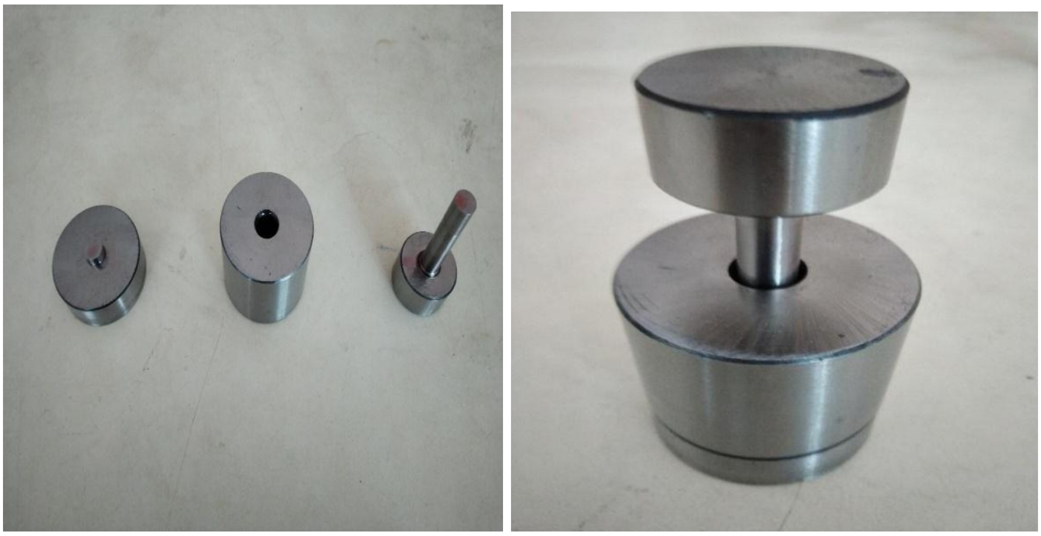

Figure 6: Punch and die used for compression of powder

Using a digital hydraulic press machine, we compressed powdered samples with a diameter of 10 mm (around 2 to 2.5 grams). It was common practice to use machine oil to lubricate the punch and die throughout the pressing process..

Table 2. The dimensions of the punch and die used for compaction

Sl.No.	Parameters of Punch and Die	Dimensions in mm
1.	Outer diameter of die	40 mm
2.	Inner diameter of die	10 mm
3.	Length of the die	40 mm
4.	Diameter of punch	10 mm
5.	Length of the punch	50 mm

Figure 7: Digital hydraulic press used for compaction of powders

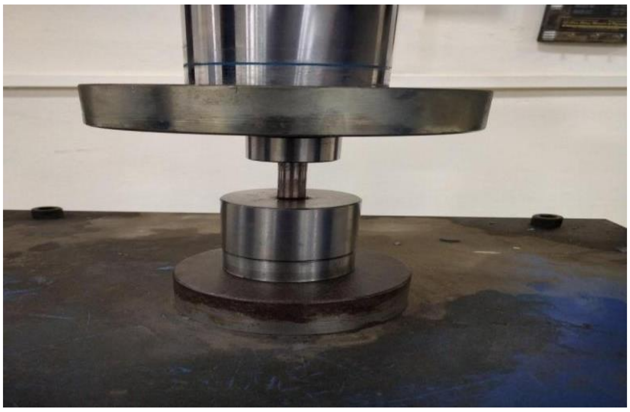

Figure 8: Placement of die between upper and lower punch

Figure 9: Green sample size of 10mm diameter

5.3 SINTERING

Sintering refers to the process of applying heat to a powder or compact, often at a temperature lower than the melting point of the major ingredient, in order to increase the strength of the material by gluing together the particles. Sintering temperatures are typically between a third and a half of the melting point of the material's primary component in Powder Metallurgy. For this study, we solid-state sintered AL-7068 green compacts with varying reinforcement weight percentages in a Raising Hearth Furnace at 600 °C for 120 minutes at a heating rate of 5 °C, and we cooled the samples off in the furnace at a slower rate to prevent cross-contamination. The aggregate powder particles fuse together during the sintering process. To prevent oxidation, the samples were put in ceramic crucibles containing tur husk ash and heated in a rising hearth furnace.

Figure 10: Raising Hearth Furnace

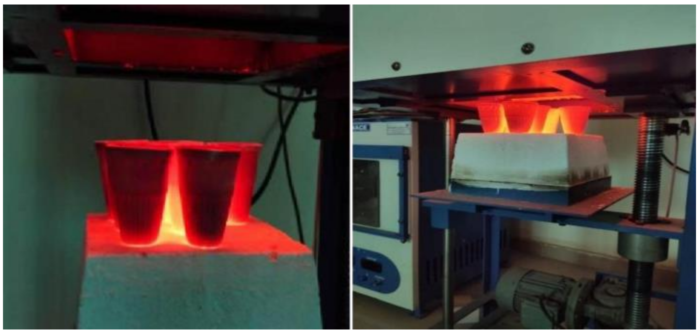

Figure 11: Ceramic crucible

Figure 12: Sintered cylindrical specimens with different weight percentage ofreinforcements

Table 3. The sample specification

Sample No.	Composition
1	Al7068 Pure
2	Al7068 + 0% channa husk + 4%SIC
3	Al7068 + 0% channa husk + 6%SIC
4	Al7068 + 4% channa husk + 0%SIC
5	Al7068 + 4% channa husk + 4%SIC
6	Al7068 + 4% channa husk + 6%SIC
7	Al7068 + 6% channa husk + 0%SIC
8	Al7068 + 6% channa husk + 4%SIC

9	Al7068 + 6% channa husk + 6%SIC
10	Al7068 + 8% channa husk + 0%SIC
11	Al7068 + 8% channa husk + 4%SIC
12	Al7068 + 8% channa husk + 6%SIC

5.4 MICRO STRUCTURAL ANALYSIS

One form of electron microscope, known as a scanning electron microscope (SEM), creates pictures by moving a focussed beam of electrons over the surface of a subject. Electrons collide with sample atoms, triggering a wide range of signals that provide details about the surface's topology and chemical make-up. A quicker scan pattern is used to move the electron beam, and a picture is formed by combining the beam's location with the detected signal's intensity. The most typical SEM mode makes use of an Everhart-Thornley detector to pick up secondary electrons generated by atoms that have been stimulated by the electron beam. Specimen topography is a major factor in the detectability of secondary electrons and, by extension, the strength of the signal. Resolutions greater than 1 nm are possible using SEM.
Standard SEM uses a high vacuum, but specialized equipment may monitor specimens in low vacuum or wet environments, under varying pressure or climatic conditions, and at cryogenic or higher temperatures.

Specimens were made using typical metallographic techniques, including sectioning, mounting, and polishing a piece from the center of the squeeze disk. Using a scanning electron microscope (SEM) with a maximum resolution of 100 nm in a backscattered model in X-ray diffraction mapping mode and a maximum usable magnification of 30,000, we were able to analyze the finer characteristics of the microstructure. See an example of a scanning electron microscope in Figure 5.10 below. It was necessary to apply an etchant to the polished specimens before microscopic analysis by energy dispersive spectroscopy (EDS) to get an accurate assessment of their composition.At Nishaka Labs in Hyderabad, they use a scanning electron microscope (SEM). Specimens S1 (90% Al7068, 4% channa husk, 6% silicon) and S2 (92% Al7068, 0% channa husk, 8% silicon carbide) are examined for their wettability and bonding using SEM images. Darker regions of SiC and alumina particles in the image below indicate increased soaking of reinforcements into the matrix. The deagglomeration of reinforcements, which occurs as a consequence of the enhanced wettability, improves the composite's tribological properties. Carbon fiber enhances the composite by filling up any air pockets, which improves the bonding and strength of the matrix and reinforcement.

Figure 13: SEM used for microstructure study

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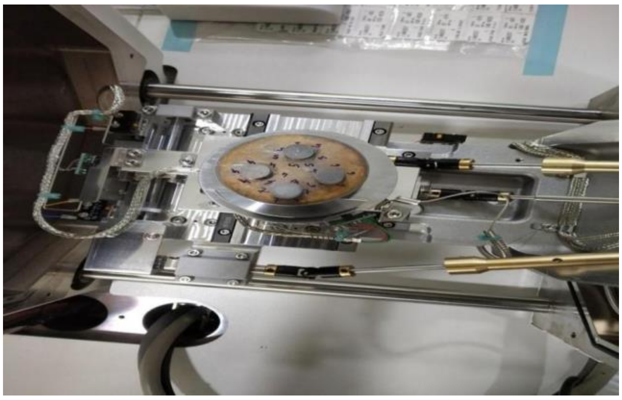


Figure 14: Placement of samples in the machine for SEM and EDX study

Each sample was assigned a unique reference number before being placed on the disk to prevent any potential mix-ups. In this instrument, we were able to acquire SEM and EDS pictures at magnifications of 500x and 1500x, respectively. The photos shown here accurately depicted the materials, from particle size to porosity.

As with SEM, EDS relied on a flat surface. Surface findings and point-shoot outcomes were also included in the EDX analysis.

5.5 COMPRESSION TEST

The digital hydraulic press was previously used for die compaction, and this is what was put through the compression test. Hydraulic pressing of test samples yielded findings expressed in kilograms per millimeter squared (kg/mm2). The samples used in the compression test were just 10 mm in diameter and 12 mm in height, thus the 15-ton capability of the hydraulic press was sufficient..

Figure 15: Digital hydraulic press used for compression test

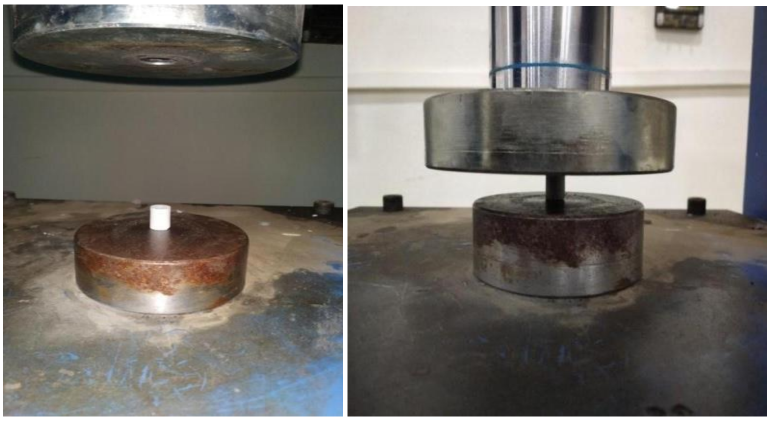


Figure 16: Pallet location between upper punch and lower punch compression of sample in hydraulic press

Different concentrations of tur husk ash and silicon carbide were sintered into aluminum alloy (Al7068) samples at 600 oC, and the results were compared using a compression test.

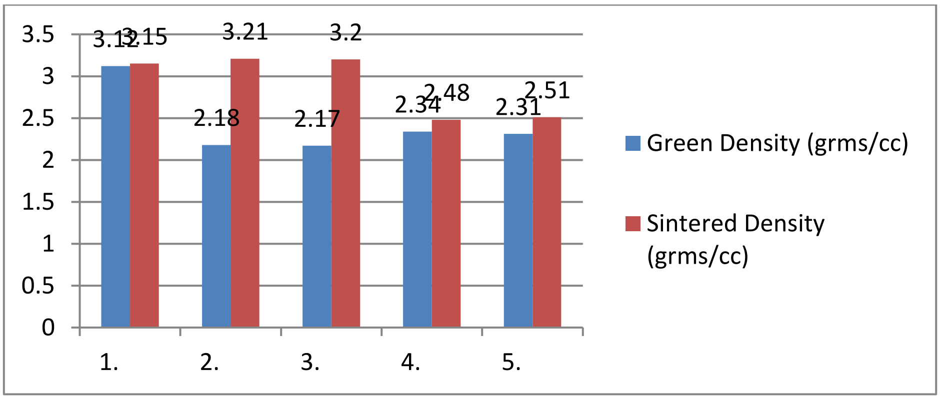
VI. RESULTS AND DISCUSSION

DENSITY

The density of samples is determined by measuring the weight and volume of the specimens

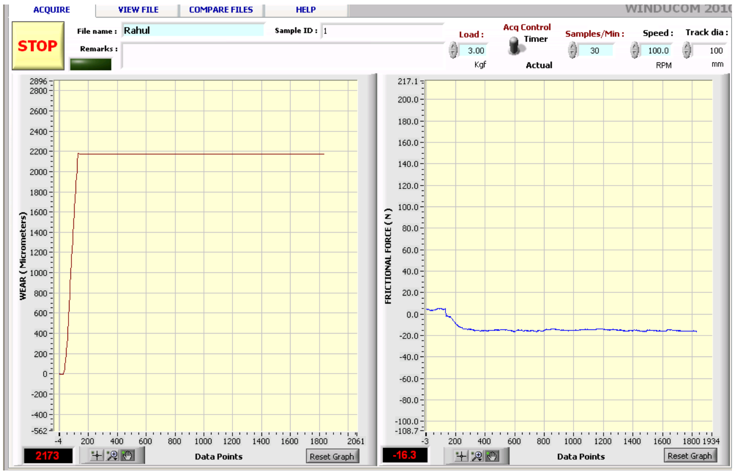
Table 4: Density of samples

Sample No.	Green Density (grms/cc)	Sintered Density (grms/cc)
1.	3.12	3.15
2.	2.18	3.21
3.	2.17	3.20
4.	2.34	2.48
5.	2.31	2.51

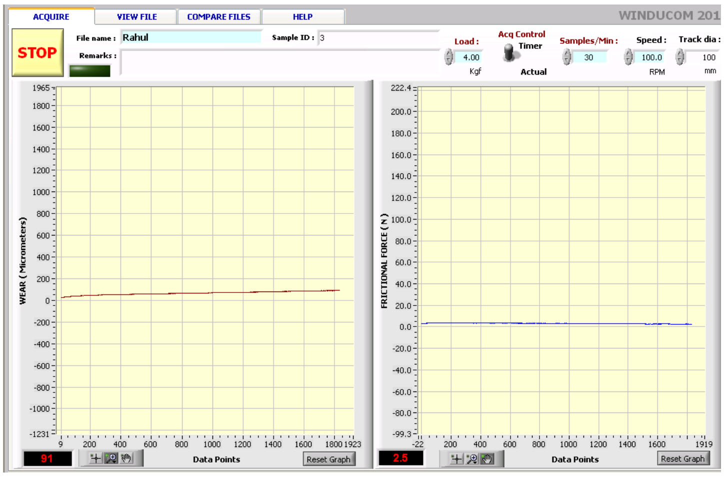


Graph 1: Graphical representation of Green and Sintered density in grms/cc.

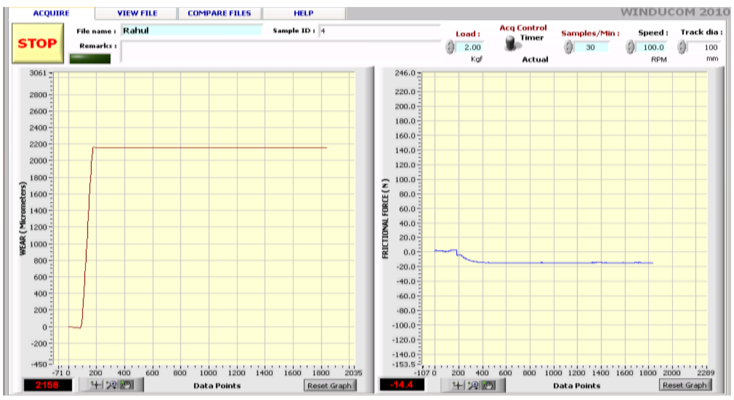
Variations in SCHA and SiC reinforcement percentages resulted in a wide range of green density & sintered density values throughout the samples. Sintered samples have higher density values in density calculations compared to green samples. The following graph visually displays the data.



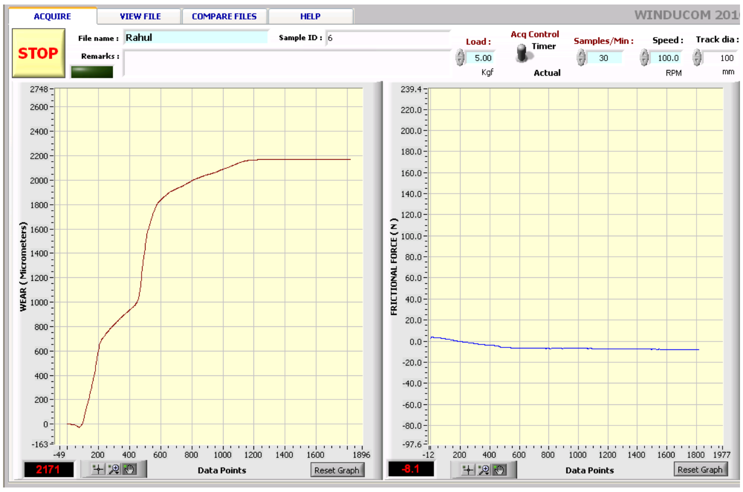
Graph 2: Specimen S1 90% of Al7068 +4% channa husk + 6% of Silicon carbide



Graph 3: Specimen S2 92% of AI7068 + 0% channa husk + 8% silicon carbide



Graph 4: Specimen S3 91% of AI7068 + channa husk 7% + silicon carbide 2%



Graph 5: Specimen S4 90% of AI7068 + channa husk 2% + silicon carbide 8%

Table 5: Results of wear test

SL NO	Particulars	Specimen	Load (N)	Sliding Speed (RPM)	Sliding Time (Sec)	Wear Rate (µm)
1	**90% of Al7068 +4% channa husk + 6% of Silicon carbide**	**S1**	3 kg	100	1800	2150
2	**92% of AI7068 + 0% channa husk + 8% silicon carbide**	**S2**	4 kg	100	1800	120
3	**91% of AI7068 + channa husk 7% + silicon carbide 2%**	**S3**	2 kg	100	1800	2170
4	**90% of AI7068 + channa husk 2% + silicon carbide 8%**	**S4**	5 kg	100	1800	2185

This takes place at Kalaburagi, at the PDA College of Engineering's Mechanical Laboratory. Wear is a phenomenon involving the progressive loss of material. When two surfaces are moving at an angle to one another, friction causes a gradual wearing away of both surfaces. We used a dry sliding wear testing system to submit the specimens to wear against a revolving EN-32 pin on disc. No lubrication was used throughout the 1800 seconds of testing, which took place at room temperature with the following parameters held constant: track Dia = 60mm, test duration = 1800 seconds. The outcomes serve as the basis for defining the features. Wear is greatest (2185) on the 90% Al-7068 + 2% channa husk + 8% silicon carbide specimen S4, whereas the 92% Al-7068 + 0% channa husk + 8% silicon carbide specimen S2 wears the least (120m) at 100rpm with a 5kg load.

Wear varies somewhat among samples due to the incorporation of CHANNA HUSK and SILICON CARBIDE, with S3 and S4 showing much higher levels of deterioration. All of the samples showed very low levels of friction force. When compared to other samples, S4 performs better.

6.1 SCANNING ELECTRON MICROSCOPY (SEM)

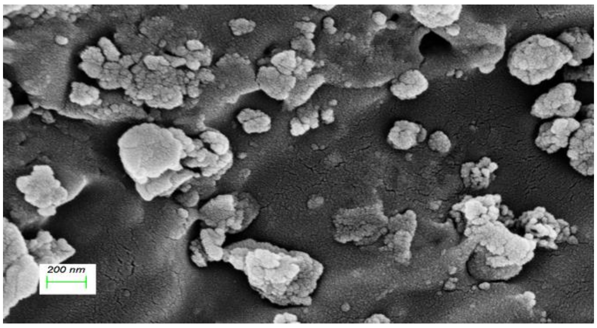


Figure 17: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 200nm

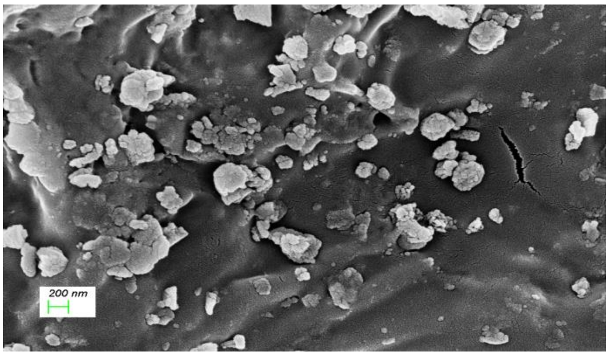


Figure 18: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 200nm

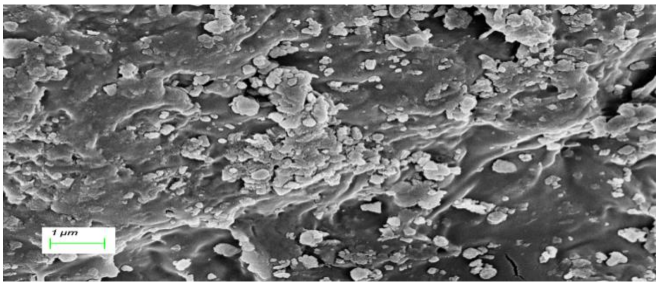


Figure 19: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 1µm

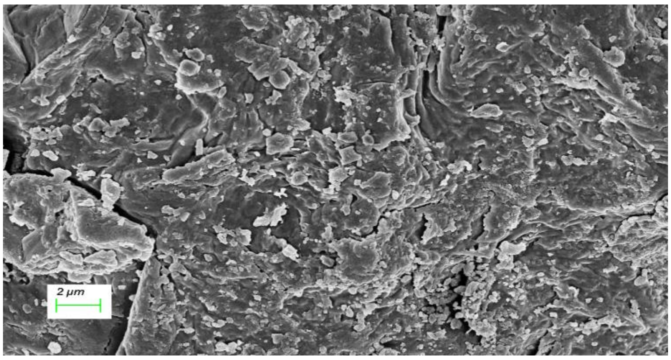


Figure 20: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 2µm

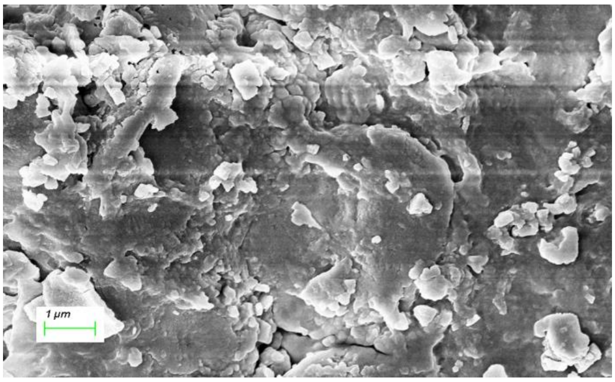


Figure 21: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 1µm

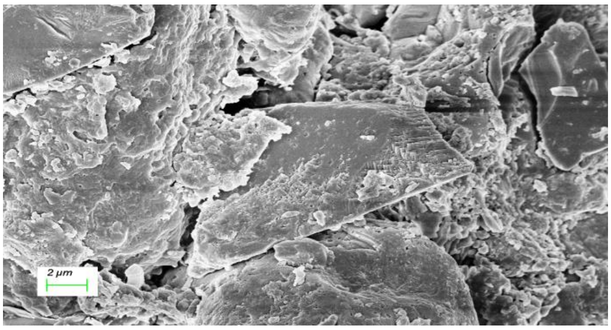


Figure 22: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 2µm

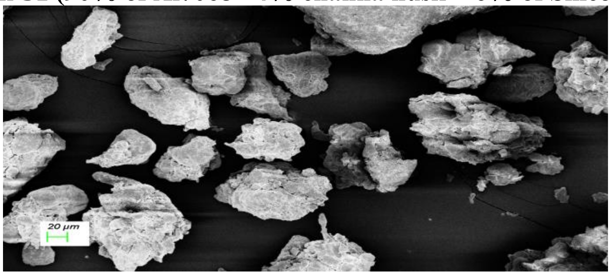


Figure 23: SEM of specimen S1 (90% of Al7068 +4% channa husk + 6% of Silicon carbide) with size of 20µm

Scanning Electron Microscopy (SEM)

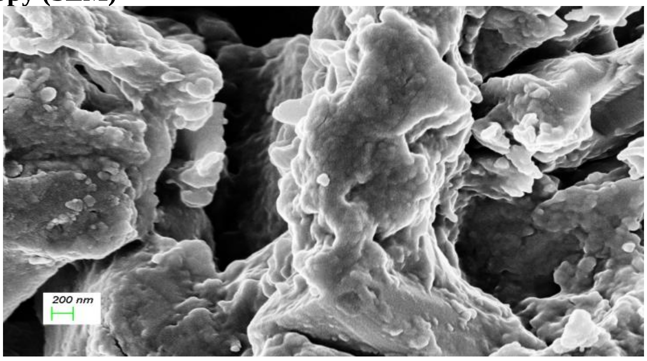


Figure 24: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 200nm

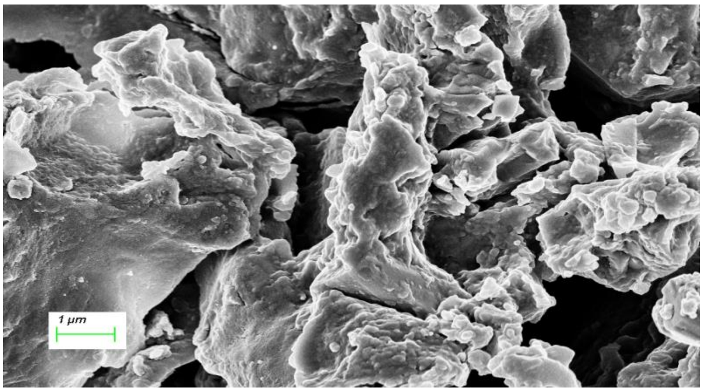


Figure 25: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 1 µm

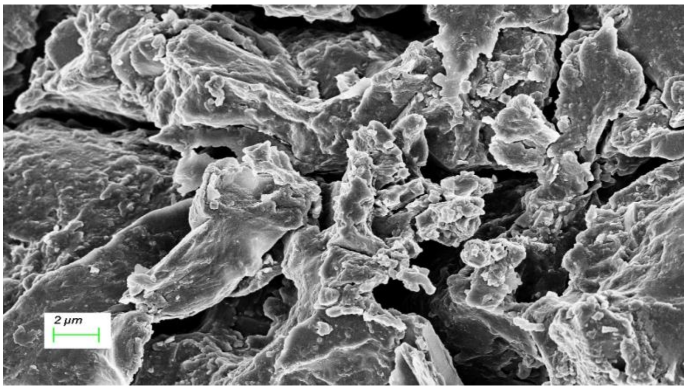


Figure 26: SEM of specimen S2 92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 2 µm

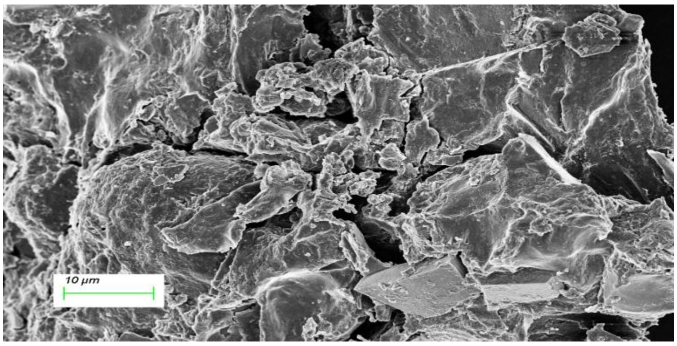


Figure 27: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 10 µm

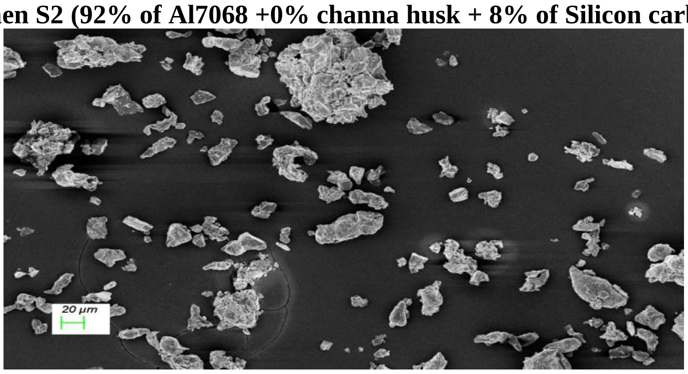


Figure 28: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 20 µm

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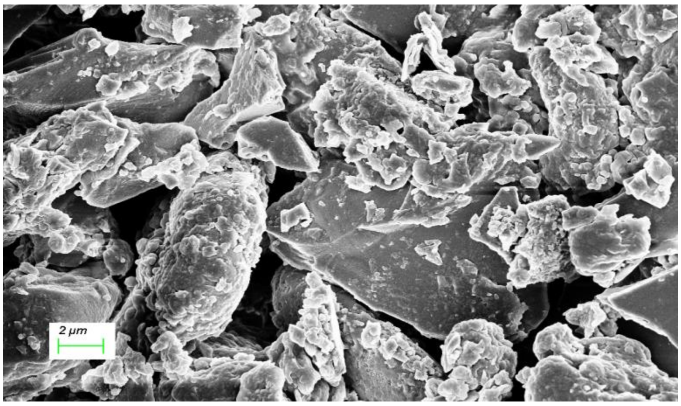

Figure 29: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 2 µm

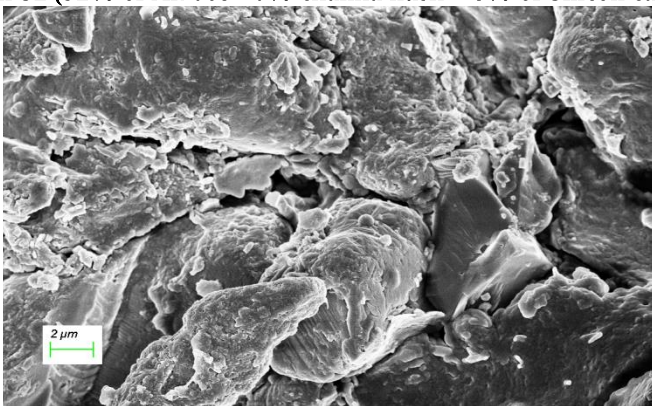

Figure 30: SEM of specimen S2 (92% of Al7068 +0% channa husk + 8% of Silicon carbide) with size of 2 µm

The above illustration is a scanning electron micrograph (SEM) of a sintered sample that has SCHA reinforcement. Despite the fact that the sample seems to have less porosity in the 500x picture, it is still not completely sintered since the particles are only weakly bonded and there are no grain boundaries visible.

VII. CONCLUSION

From the present work on the aluminum based hybrid MMC the following conclusions have been derived:

- • Sintering was shown to result in a rise in density, which was assessed before and after the process.
- • The microstructure examination (SEM) of sintered MMC revealed that the samples were blended extremely well but were only half sintered.

SCOPE FOR FUTURE WORK

The aforementioned task has been accomplished with the help of the existing literature. Design of experiments (Taguchi Technique) allows for the optimization of sample size, leading to more accurate findings. In this study, we took samples at random (based on the existing literature) and reported our findings. Future research into the mechanical characteristics of hybrid composites may benefit greatly from the use of Design of Experiments techniques. Raising the compacting load has the effect of enhancing the material's mechanical characteristics. Analyses of other tests, such as tensile and wear tests, are also possible. The mechanical characteristics of MMCs may be studied in relation to the reinforcement employed in the composites' fabrication, which can range from ZrO2 and TiO2 through B4C and TiC..

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