Optimization of Engineering Properties in Al-7175/SiC/B4C Alloy

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Abstract. The growth of the industrial sector has resulted in a higher use of Aluminium Metal Matrix Composites (AMMCs). These composites are well-known for their exceptional mechanical and tribological qualities, attracting worldwide attention, especially in the automotive, architectural, and aerospace industries. Advanced Metal Matrix Composites (AMMCs) exhibit increased specific strength, improved strength-to-weight ratio at increasing temperatures, and better wear resistance when compared to the basic matrix without any additional components. SiC and B4C particle reinforcements are used to enhance the metallurgical and mechanical characteristics of the base matrix. Authors have used several production methods such as Powder Metallurgy for solid-state procedures and Stir Casting, Compo-casting, Squeeze Casting, and in-situ casting for liquid-state processes to create AMMCs. Stir casting is the most cost-effective and easy process for producing AMMC. This article provides an in-depth explanation of the procedure for producing Aluminium Matrix Metal Composites (AMMCs) utilising AL-7175 as the matrix material, together with B4C and SiC as reinforcements, with the stir casting technique.

1 Introduction

MMCs are classified according to the alloy designation of the metal matrix, material type, volume percentage, and shape of the ceramic reinforcement. These lightweight structural materials are often used in aeroplanes, helicopters, and spacecraft. They are composed of a metal matrix phase that contains embedded hard reinforcing particles. The matrix often consists of lightweight metal alloys such as aluminium, magnesium, or titanium, commonly

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used in aircraft constructions (e.g., 2024 Al, 7075 Al, Ti-6Al-4V). Nickel superalloys may act as the matrix phase in Metal Matrix Composites (MMCs) used in high-temperature applications.

The metal matrix is reinforced by adding ceramic or metal oxide in different forms including continuous fibres, whiskers, or particles. Continuous fibre reinforcements such as boron, carbon, and silicon carbide are often used and dispersed inside the matrix. Commonly used particle reinforcements include silicon carbide, alumina (Al_2O_3), and boron carbide (B_4C). In Metal Matrix Composites (MMCs), the volume proportion of reinforcement is usually kept around 30%, which is less than the fibre content in aerospace carbon-epoxy composites (55-65% by volume). Reinforcement contents above 30% are often avoided because of the processing, forming, and machining difficulties arising from their high hardness and poor ductility. Metal matrix composites (MMCs) have unique features when contrasted with other types of composite materials.

The Al-7075/Al_2O_3&SiC metal matrix composite was successfully fabricated using a liquid-state approach with varying weight percentages (2%, 4%, 6%, and 8% wt). The cost-effective stir casting method proved efficient in producing this composite, resulting in enhanced hardness compared to non-reinforced Al-7075[1]. Another successful application of the stir casting technique involved the creation of a metal matrix compound using Al7075, grey cast iron, and ash dust, demonstrating its classic and economically viable nature. Notably, the rigidity number of the Al-7075 compound with ash dust and grey cast iron was higher when compared to non-reinforced Al-7075 with ash dust and grey cast iron compound materials[2]. The increasing need for lightweight materials has driven the use of aluminium metal matrix composites (AMMCs) to attain higher material performance, establishing them as highly promising materials for structural and functional applications. These composites are used in several sectors such as marine, defence, automotive, aerospace, and high-temperature settings. Stir casting is a famous and cost-effective technology used for mass manufacture of metal matrix composites (MMCs). The review paper thoroughly examines the stir casting method, including mechanical characteristics, the impact of different reinforcements, obstacles faced, and possible research paths in composite development [3].

Composite materials include unique characteristics not often present in traditional materials, including a greater volume-to-weight ratio, which makes them very important for sectors including aircraft, automotive, home appliances, and electronics. Yet, creating these composites is difficult because of the many phases included in the matrix and reinforcing components. Three aluminum-based metal matrix composites were analysed in a research by adjusting the amount of matrix (Al6063) and reinforcement (fly ash and Al_2O_3) elements by the stir casting technique. Al_2O_3 particles were found to greatly enhance the hardness of the composite material based on the assessment of hardness and toughness[4]. Progress in material science has allowed for the identification and creation of new materials that might potentially replace current ones in various uses. The study focused on comparing the characteristics of Al 6061 and Al 2024 metal matrix composites (MMCs) with certain reinforcing elements. These reinforcements encompassed B_4C, SiCp, and graphite in particle form, aiming to enhance the mechanical and tribological properties of the composites when added to the Al matrix. The MMCs were produced by the stir casting method and their mechanical characteristics were compared to those of pure Al6061 and Al 2024, following ASTM E10/2018 guidelines. The inquiry examined the tensile strength, hardness, and wear resistance of aluminium metal matrix composites[5].Aluminium 7075 alloy composites were created by adding 4%, 8%, and 12% silicon nitride (Si_3N_4)

reinforcement using the stir casting process in a separate research project. Heat treatment was used to remove porosity, and porosity was measured using X-ray computed tomography and image analyzer methods. Chemical composition analysis was conducted utilising Spectro analysis, combined with micro-images and micro-hardness tests, on the casted specimens. The distribution of Si3N4 in the aluminium alloy was examined using a scanning electron microscope [6]. The Metal Matrix Composite (MMC) is a composite material made up of at least two components, one of which is a metal and the other might be a ceramic or organic composition. Aluminum-based Metal Matrix Composites (MMCs) have become widespread in several engineering and technical domains because of their outstanding features. The solidification behaviour of these cast MMCs considerably influences their desired features. This study intended to analyse and predict the best results in experimental electromagnetic stir casting techniques for composite materials. The research revealed significant impacts on the mechanical characteristics, including as hardness and tensile strength, and conducted a microstructure examination of A359/Al2O3 composites [7]. Aluminium composites are widely used in fields such as medicine, dentistry, and engineering for applications including piston rings and cylinder blocks. These composites usually show outstanding mechanical characteristics when enhanced with microparticles, however ductility tends to diminish as the reinforcement fraction increases. Composites with a reduced amount of microparticles may enhance the strength of the matrix without compromising its ductility. The mechanical qualities are significantly improved by adding ceramic reinforcements like Al2O3 and SiC. This work focuses on investigating the wear characteristics of aluminium alloys (Al-6061/Al-2024/Al-7075) that have undergone stir casting with ceramic reinforcements such as Al2O3 and SiC [8]. The study focused on creating Al 8011-SiC composites by the stir casting method, utilising three different sizes of SiC particles and varying weight percentages (2%, 4%, and 6%). The work examines the mechanical characteristics of Al8011-SiC composites, investigating the influence of particle size and SiC weight percentage. Anova and the Taguchi approach were used to determine the best parameters for producing excellent mechanical qualities like as hardness, tensile strength, elongation, and toughness. Confirmation tests confirmed that reducing particle size and increasing SiC weight percent improved mechanical characteristics. The 63μm SiC particles exhibited higher hardness, tensile strength, elongation, and toughness compared to the 76μm and 89μm particles. Al 8011-6wt.%SiC showed higher hardness and tensile strength, but Al8011-2wt.%SiC showed better elongation and toughness. Particle size was identified as the primary element impacting mechanical characteristics, with reinforcing quantity being the next most significant component [9]. The review article examines the wide range of uses of Aluminium (Al) or Aluminium alloy Metal Matrix Composites (MMCs) in sectors such as aerospace and automotive because of its lightweight nature, high tensile strength, and resistance to wear. The review focuses on SiC particulate-reinforced Al MMCs. Silicon carbide particles are incorporated into aluminium or aluminium alloy using liquid-state and solid-state manufacturing techniques. Stir casting is often used by researchers for liquid processing due to its simplicity and cost-effectiveness. Adding a tiny quantity of magnesium is common practice to improve the capacity of silicon carbide to spread on the surface of molten aluminium or aluminium alloy when used as reinforcement. Adding silicon carbide to aluminium or aluminium alloy greatly improves its mechanical and tribological characteristics. The review article thoroughly discusses how the size and weight or volume fraction of SiC particles impact various properties of Al or Al alloy MMCs, such as density, porosity, hardness, impact toughness, tensile strength, ductility, sliding wear resistance, slurry erosion resistance, erosion-corrosion resistance, corrosion resistance, and fatigue strength. The paper also explores how extrusion and machinability affect silicon carbide particulate-reinforced aluminium metal matrix composites. The research offers vital

information on the improved characteristics of aluminium or aluminium alloy metal matrix composites (MMCs) and highlights the significance of silicon carbide (SiC) reinforcement in the development of these composite materials[10]. Recent years have seen significant study on aluminium metal matrix composites (AMMCs) to achieve superior mechanical characteristics for high-end applications. This paper provides a summary of the elements that affect the mechanical characteristics of aluminium 6061 MMCs manufactured using the stir casting technique, emphasising the progress made in this area. The mechanical characteristics are affected by the weight % of reinforcing particles, preheat temperature, and melting temperature. Challenges in creating novel materials with specific mechanical characteristics exist, but the increasing interest in AMMCs is driven by their potential advantages in precise applications[11]. Open-celled A360 aluminum-B4C composite foams with evenly sized pores were produced using a novel method that combined stir casting and space holder methods. Different weight ratios of reinforcing particles (0.5%, 1%, 1.5%, and 2%) were used to study their impact on microstructure and mechanical properties. Microstructural study, performed using an optical microscope (OM) and scanning electron microscope (SEM), showed enhanced compression strength and hardness in the composite foams reinforced with ceramics. Plastic strength decreased after achieving a specified reinforcement ratio of 0.5 wt.%, and the energy absorption qualities followed a similar pattern to compressive strength properties[12]. Researchers used a hybrid method to optimise stir casting settings, considering the influence of several factors and their interactions on the uniform distribution of reinforcing particles. While some positive results have been obtained in some situations, more research is required to apply these findings more broadly and enhance stirrer design for improved mixing efficiency. Researchers used a variety of methodologies such as theoretical, experimental, statistical, and numerical simulation techniques, including Design of Experiments (DOE), Taguchi, ANOVA, and regression, to improve accuracy and dependability. Recent advancements in modelling stir casting have matched experimental or analogue model data using sophisticated numerical software and analytical analysis. The study's findings and suggestions were organised and improved to provide a thorough guide on suitable stirrer design, phases, and location, which sets the publication apart[13].

2 Materials and Methods

2.1. Preheating

The experimental setup used Al-7175/B4C&SiC composite materials as the workpiece. Preheating is crucial to avoid agglomeration, moisture, and gases from forming in the reinforcement. Both silicon carbide (SiC) and boron carbide (B4C) are preheated in a muffle furnace at 300°C before use.

2.2. Stir Casting

An amount of Aluminium 7175, between 800gm and 1000gm, is added to the vessel to match die-casting standards, as shown in the figure. Once the vessel lid is sealed, we melt the base material and add reinforcements, which make about 1% to 2% of the weight of the Al-7175 in the chamber. Stir casting is a liquid-state process used to create composite materials by blending dispersed particles with a molten metal matrix by mechanical stirring. This approach offers significant benefits because of its simplicity, cost efficiency, and adaptability in producing metal matrix composites with different combinations of ceramics and metals. Its simplicity and cost-effectiveness have resulted in its extensive use in several sectors.

2.3. Crucible

A crucible plays a crucial function in metallurgical and casting operations by containing metal while it melts into a molten state before being poured into moulds to form different forms. Choosing the right crucible material is essential for ensuring the efficacy and efficiency of melting and casting processes. Crucibles may be made from several materials such as silicon carbide (SiC), solid steel, and graphite. Every substance has its own unique benefits and drawbacks. We have selected a graphite vessel for its remarkable qualities that suit our special requirements. Graphite, with a melting point of 2700°C, is an excellent option for our high-temperature applications since it exceeds the operating temperature requirements.

2.4. Stirrer

Uniformly blending ceramic particles, such as SiC, throughout the liquid metal is crucial in the manufacturing of Metal Matrix Composites (MMC). A stirrer is used to evenly distribute the composite, engineered to withstand high temperatures without compromising its integrity. This stirrer is comprised of a stainless-steel rod connected to a nuclear grade 6 fan. The stirrer operates with a ½ H.P. AC motor, rotating at a speed of 400 revolutions per minute. The ceramic particles are placed into the container to a depth of roughly one-third of their height during the introduction process. External agents may be used for mixing by attaching them to the chamber via the top at any location. The precise blending procedure is crucial for improving the characteristics and functionality of the Metal Matrix Composites produced.

2.5. Casting on Molten Aluminium

The liquid metal was poured into the mould cavity from a container once the mould was prepared, and then left to harden. After the casting process was completed, the final product was removed from the mould, as shown in Figure 1.

Table 1: Chemical Compositions of Aluminum7075.

Constituent	Cu	Cr	Ti	Mg	Zn	Fe	Mn	Si	Al
Percentage in Wt.	1.8	0.2	0.15	1.9	3.25	0.5	0.4	0.5	Balance

Fig. 1. Squeeze casting setup for MMC processing
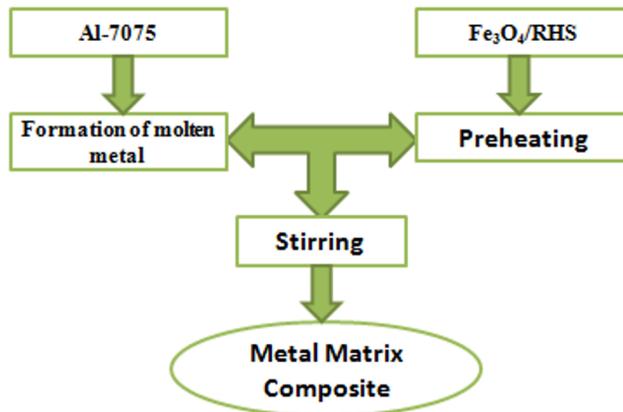
Fig. 2. Flow chart for proposed fabricated process.

- ✓ In order to achieve the desired temperature of 660 degrees Celsius, the crucible containing the weighed aluminium alloy 7075 was heated. The crucible was held in the furnace at the same temperature.
- ✓ Based on the weighted proportion of iron oxide and RHS particles, which were 3%, 6%, and 9% respectively.
- ✓ In addition, the moulding dies were heated beforehand.
- ✓ To prevent blowholes and to decrease porosity, it is necessary to include degasifying chemicals.
- ✓ When the temperature reaches the necessary amount, add the determined proportion of iron oxide (Fe_3O_4) and RHS to the molten metal and mix it well at a speed of 400 revolutions per minute throughout the process.
- ✓ Take out the slag.
- ✓ Let the molten metal pour into the die, and then wait for it to cool down.

Using a universal testing equipment manufactured by Instron and a displacement control mode rate of 0.1 mm/min for testing, tensile and compression work pieces are machined from rough castings with dimensions of 9 millimetres in diameter and 45 millimetres in gauge length in accordance with ASTM requirements. Several other kinds of testing were carried out, and the greatest results were averaged. We examined a number of different tensile characteristics and percentage elongation for Al-7075 alloy, Al-7075- 3, 6, and 9 weight percent Fe_3O_4/RHS composites. In addition, a compression test was carried out on the same machine in accordance with the criteria of ASTM. Scanning electron microscopy was used in order to do the micro structural examination on the composites that had earlier been created. After being cut from the castings and given a thorough polish, the test sample has a diameter of between 10 and 12 millimetres.

3 Findings and Analysis

3.1. Maximum pull-out force when conduct a tensile test

Figure 3 illustrates the ultimate tensile strength (UTS) of the material in comparison to various percentages of Fe_3O_4/RHS. In the presence of a 0–9% weight addition of

Fe_3O_4/RHS, there is a discernible increase in UTS, which may range from 190 MPa to 348 MPa across the board.
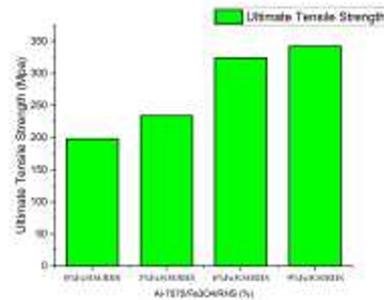
Fig.3. Composite Al7075 + Fe3O4/PKSA 0–9% composite ultimate tensile strength.

This consistent rise highlights the significant role that Fe_3O_4/RHS particulates play in determining the mechanical characteristics of the composite, notably in terms of increasing the tensile strength of the material of the composite. Incorporating different amounts of Fe_3O_4/RHS into the material has a favourable influence on the overall mechanical performance of the material, as shown by the observed intensification in tensile strength.

3.2. Strength for yielding

Figure 4 illustrates the composition of the ratio of yield strength to weight %. As the weight percentage of Fe_3O_4/RHS grows from 0% to 9%, the graph clearly demonstrates a significant improvement in yield strength, which goes from 103.6 MPa to 262.16 MPa. This improvement is a clear indication of the increase in yield strength. This trend highlights the good impact that Fe_3O_4/RHS has, demonstrating a considerable increase in the material's yield strength. Therefore, it is important to note that this trend. The fact that the yield strength of the Al7075 metal matrix composite increased as a result of the gradual addition of Fe_3O_4/RHS demonstrates that this reinforcement is effective in improving the overall mechanical characteristics of the composite material.
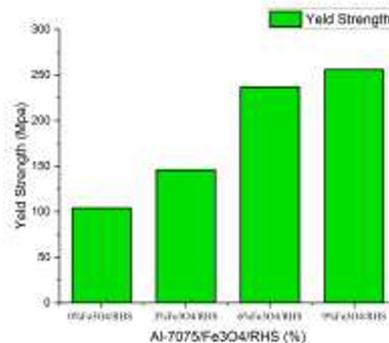
Fig. 4. Composite strength - Al-7075/Fe_3O_4/PKSA 0 to 9 weight percent.

In addition to contributing to the composite's better mechanical characteristics, the tight arrangement of Fe_3O_4/RHS particles is responsible for the increased yield strength. This arrangement also helps to reinforce the molecular strength inside the aluminium lattice for the composite.

3.3. Measurement of the percentage of elongation

Figure 5 is a graph that illustrates the effect that Fe_3O_4/RHS has on the malleability of the composite material. The graph shows a downward trend when Fe_3O_4/RHS particles are added, with the percentages ranging from 0 to 9 weight percent. The integration of Fe_3O_4/RHS into the composite product resulted in an increase in the composite's strength, which is the cause of this reduction. The reduction in malleability that was found highlights the trade-off that exists between strength and malleability, indicating the significant influence that different percentages of Fe_3O_4/RHS have on the mechanical behaviour of the material.
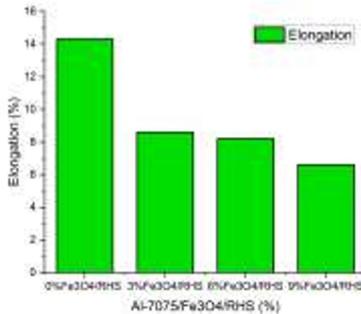
Fig. 5. Elongation proportion of Al7075/Fe_3O_4/PKSA 0–9 weight percent composite.

3.4. Examination of compression

A representation of the compression strength of Al-7075 in the presence of Fe_3O_4/RHS composites ranging from 0 to 9 weight percent is shown in Figure 6. Beginning at 629.5 MPa and continuing all the way up to 787.52 MPa, the compression strength shows a progressive rise. This increased trend demonstrates the good influence that the gradual addition of Fe_3O_4/RHS has had, confirming the function that it plays in increasing the compression strength of the composite. Elucidating the possibilities for customising the material's characteristics by controlled compositional alterations in Al-7075 metal matrix composites, the observed variations give useful insights into the link between the content of Fe_3O_4 and RHS and the compression strength that ensues as a consequence of this relationship.
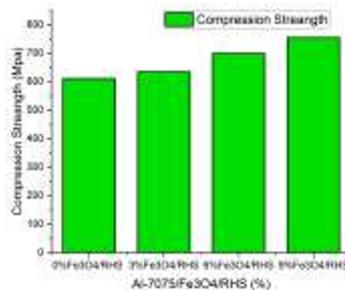
Fig. 6. 0 to 9 weight percent composite material with a compression strength of Al7075/ Fe_3O_4/PKSA

3.5. An examination of the hardness

Using a Brinell hardness tester, indentation tests were performed on the composite material that the suggested Al matrix alloy was made of. We created specimens of aluminium 7075 alloy with Fe_3O_4/RHS reinforcement at 3%, 6%, and 9% in accordance with the usual procedures for metallographic analysis. There was a load of 250 kilogrammes of force, a ball with a diameter of 5 millimetres, and a dwell duration of thirty seconds. Recording the indentation load depth readings allowed for the determination of the material's hardness. In order to conduct the indentation test, each specimen was subjected to three iterations of the procedure, and the average data was collected. Hard Iron oxide Fe_3O_4/RHS is included into the mixture, which results in a progressive rise in the hardness values, which range from 65.7 to 108.75 BHN, as shown in Figure 7. The results of this study emphasise the proportionate increase in hardness that occurs with increasing Fe_3O_4/RHS particle reinforcement in the Al7075 metal matrix composite.
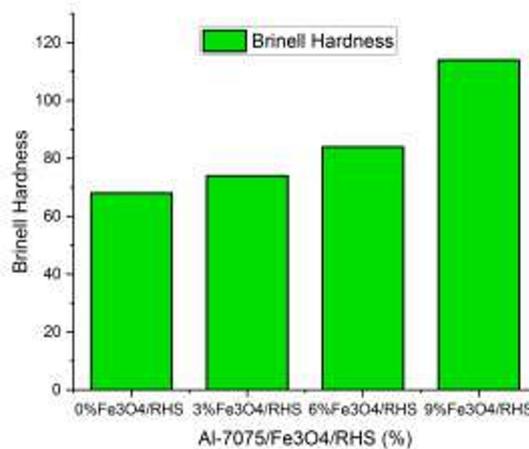
Fig. 7. The composite material Al7075/ Fe_3O_44/PKSA has a hardness ranging from 0 to 9 weight percent.

3.6. Visual Structure under a Microscope

The Tescan Vega Scanning Electron Microscope was used during the process of conducting a microstructural evaluation of the composites that were manufactured. Cutting test samples with a diameter of 10 to 12 millimetres was done from the castings, and then they were polished with great care. The Al7075/ Fe_3O_4/RHS particulate composites are shown in the scanning electron micrographs (SEM) shown in Figure 8 (a-3% Fe_3O_4/RHS, b- 6% Fe_3O_4/RHS, and c- 9% Fe_3O_4/RHS). Particularly noteworthy is the fact that the photos show a uniform distribution of Fe3O4/RHS particles with a restricted amount of aggregation, segregation, and porosity. It is essential to note that there is no sign of casting faults like as fractures, slag inclusions, or shrinkages, which substantiates the sound quality of the casting. The microstructural study highlights the effective incorporation of Fe_3O_44/RHS particles into the Al-7075 matrix. It also highlights the uniform distribution of the composite material and the lack of any casting irregularities that might be harmful to its performance.
Figure 8 a-c displays optical micrographs of hybrid composites of varied proportions that are based on Al-7075 and include Fe_3O_4 and rice husks ash. These composites are based on

Al-7075. Based on the figures, it seems that the distribution of the overall reinforcement appears to be distributed in a way that is distributed evenly. When looking at the Al-7075 alloy, it is able to see the reinforcement that is present not only at the grain boundaries but also inside the grains themselves. Among the matrix alloy and the reinforcements, there is a remarkable metallurgical connection that exists. Furthermore, each and every one of the micrographs demonstrates that there is no damage that can be identified. All of the combinations that were investigated did not exhibit any clustering of reinforcements inside the matrix, and there was a great dispersion of reinforcements as they moved across the matrix. The existence of porosity or cracks in a composite material is a reliable indicator of the substance's overall quality. In the case of the matrix material and the reinforcements, an optical micrograph indicates that there is a strong relationship between the two. In addition to this, data has been produced that serves to indicate the presence of particles in the border region. Gaps and discontinuities are not present inside the reinforced particles; they are completely absent. Expanding the quantity of reinforcing material that is present in the base matrix might result in a reduction in the grain size.
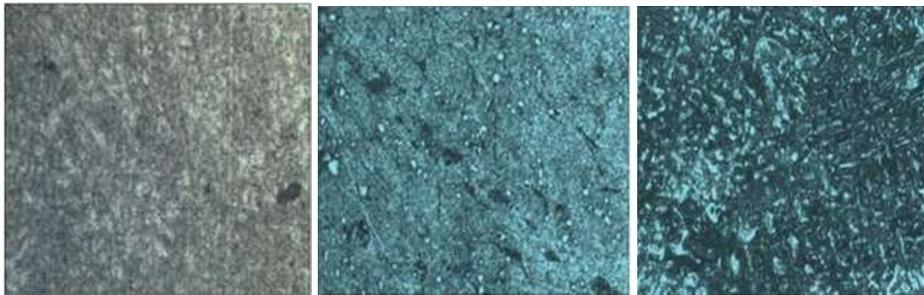
Fig. 8. a) 3%RHS/ Fe_3O_4.   b) 6%RHS/ Fe_3O_4.   c) 9%RHS/ Fe_3O_4.

Figures 8 a–c show optical micrographs of the sample. In every instance of hybrid composites, the primary phase of the microstructure was determined to be a-Al, and it was accompanied by nucleation of Mg Zn2 and Al2 Cu Mg precipitates. It was discovered that both kinds of precipitates could be found in the intervals between the dendrites, while some Mg Zn2 precipitates could also be detected in the inside of the dendrites arms. It is important to keep in mind that the morphology has a significant role in determining whether substances are classified as intermetallics or precipitates.

3.7. Surface morphology

For the purpose of identifying material characteristics, scanning electron microscopes (SEMs) that are both highly efficient and versatile are required. The samples are first air-dried using acetone. Figure 9(a-c) shows several microstructures of Al-7075 and a combination of nano-composites. Elongated grains and irregular, acicular particles are seen in Figure 7's structure. When macro-cracks occur in Al-7075, it seems that many globular apatite particles play a role. The matrix retains the microstructure that integrates reinforcing particles because these particles are uniformly dispersed throughout it.

The inclusion of Fe_3O_4 and rice husks particles reduces the impact of apatite nucleation, which causes alloy holes and cracks to form (Figure 9b). The uniform dispersion of silica fume particles, as shown in the exterior morphology, proves that the rice husks particles were successfully mixed in. Using a 9% hybrid nano-composite normally results in smaller surface grain sizes for apatite particles. Achieving a consistent distribution of basic

elements and distinct subdivisions is the main goal in metallurgy. Figure 9c shows that the refined microstructure, with tiny grains originating from the 9% hybrid nanocomposite, helps to reduce surface fractures and holes. This is because the sector is more resilient and has an equalised morphology.
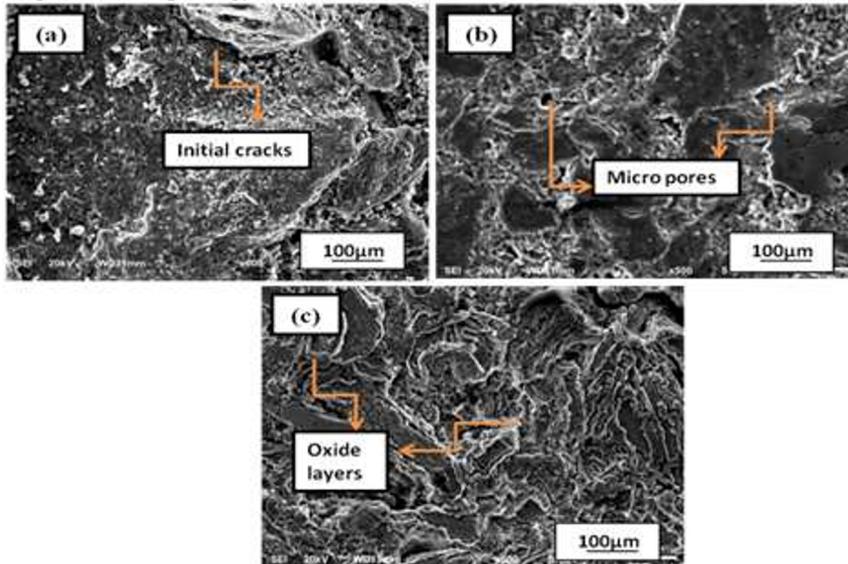
Fig. 9. Surface Morphology with[a]Al-7075/3%RHS/ Fe_3O_4, [b] Al-7075/6%RHS/ Fe_3O_4,[c] Al-7075/9%RHS/ Fe_3O_4.

3.8. XRD analysis

To examine crystalline materials, scientists use non-destructive X-ray diffraction. Figure 10 (a-c) shows the results of analysing the samples using XRD to determine the amount of Fe_3O_4 and rice husks produced at different weight percentages. The important aluminium segments in Figure 10-a of Al-7075 correspond to the direction statistics of JCPDS card 89-4184 [22] and are located at $2\theta = 23°$, $31°$, and $39°$ orientations. Adding a 3–9 weight percent mixture composite causes crisp segments and strong signals, suggesting an increase in the Si phase [23], while the matrix's restricted reflection strength gives a qualitative evaluation of the sample crystallinity.

Figure 10-b shows that there are significant XRD reflections when the material becomes very crystalline (with more than 3% Fe_3O_4). The 6% mixed composite in Figure 10-c shows strong signs with additional peaks at $2\theta= 20°$, $30°$, and $68°$, which are a result of the increased concentration of rice husks and lower density, which improves the material strength. The dominating C and O peaks clearly show the presence of Fe3O4 and particles from rice husks. The availability of reinforcements in a 9% mixed composite may reduce the Si and C phases while further enhancing the aluminium segment.
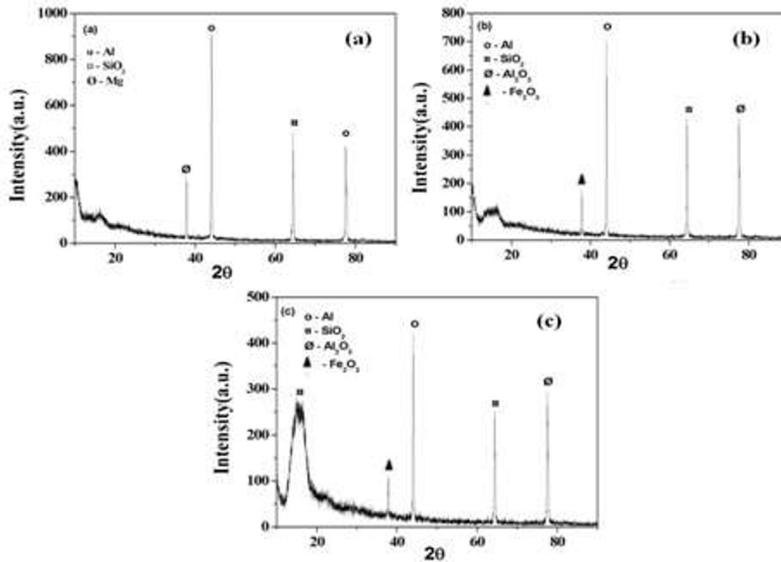
Fig. 10. XRD analysis with[a]Al-7075/3%RHS/Fe$_3$O$_4$,[b] Al- 7075/6%RHS/Fe$_3$O$_4$,[c] Al 7075/9%RHS/Fe$_3$O$_4$.

4 Findings derived from the current investigation:

The results are arrived at with an average of three values, for the tensile, compression, and Hardness studies.

✓ Al-7075 reinforced with 3%, 6%, and 9 %wt Fe$_3$O$_4$/RHS Metal Matrix composites fabricated using stir-casting technique with fairly even distribution of particulates in the matrix were effectively produced.

✓ The addition of Fe$_3$O$_4$/RHS Particulates to the Al-7075 matrix has resulted in enhanced properties in mechanical when related to the Al matrix alone.

✓ Corresponding to the result BHN value was dominating the percentage of 9% of Fe$_3$O$_4$/RHS. In this process, while the percentage of Fe$_3$O$_4$4/RHS increases, the higher the value of BHN is noticed.

✓ Further, wt. % addition of Fe$_3$O$_4$/RHS density and hardness of the composite increases in such a line of attach that retaining the properties of base metal would be the challenging.

✓ Corresponding to the surface morphology and XRD Analysis shown the % of reinforcements incremental represents oxide layers.

✓ From the SEM images, it can be observed that the distributions of reinforcement are fairly uniform.

Lastly, this study concluded that the stirring process also accountable for the fabrication of composites.

References

1. F.Q. Tian, N.K. Li, J.Z. Cui, Development process and direction of strengthening and toughening of ultra-high strength aluminum alloy [J], Light Alloy Process. Technol. 33 (12) (2005) 1–9.

2. A. Seshappa, B. Anjaneya Prasad Characterization and Investigation of Mechanical Properties of Aluminium Hybrid Nano-composites: Novel Approach of Utilizing Silicon Carbide and Waste Particles to Reduce Cost of Material. ISSN Silicon, 1876-990X, 2020, https://doi.org/10.1007/s12633-020-00748-z

3. B. Zhou, S. Lu, K.-l. Xu, C. Xu, Z.-Y. Wang, B.-J. Wang, Hot cracking tendency test and simulation of 7075 semi-solid aluminium alloy [J], Trans. Nonferrous Metals Soc. China 30 (2) (2020) 318–332.

4. J. Ren, R.C. Wang, Y. Feng, C.Q. Peng, Z.Y. Cai, Microstructure evolution and mechanical properties of an ultrahigh strength Al Zn Mg Cu Zr Sc (7075) alloy processed by modified powder hot extrusion with post aging [J], Vacuum 161 (2019) 434–442.

5. J.M. García-Infanta, A.P. Zhilyaev, A. Sharafutdinov, O.A. Ruano, F. Carreño, An evidence of high strain rate superplasticity at intermediate homologous temperatures in an Al Zn Mg Cu alloy processed by high-pressure torsion [J], J. Alloy. Compd. 473 (1-2) (2009) 163–166.

6. Z. Horita, T. Fujinami, M. Nemoto, T.G. Langdon, Improvement of mechanical properties for Al alloys using equal-channel angular pressing [J], J. Mater. Process. Technol. 117 (3) (2001) 288–292.

7. A. Javdani, A.H. Daeisorkhabi, Microstructural and mechanical behavior of blended powder semisolid formed Al7075/B 4 C composites under different experimental conditions, Trans. Nonferrous Metals Soc. China 28 (7) (2018) 1298–1310.

8. J. Hashim, L. Looney, M.S.J. Hashmi, Particle distribution in cast metal matrix composites - part II, J. Mater. Process. Technol. 123 (2) (2002) 258–263, https://doi.org/10.1016/S0924-0136(02)00099-7.

9. S.K. Pradhan, S. Chatterjee, A.B. Mallick, D. Das, A simple stir casting technique for the preparation of in situ Fe-aluminides reinforced Al-matrix composites, Perspect. Sci. 8 (2016) 529–532, https://doi.org/10.1016/j.pisc.2016.06.011.

10. E. Bayraktar, D. Katundi, Development of A New Aluminium Matrix Composite Reinforced with Iron Oxide (Fe3O4)Journal of Achievements in Materials and Manufacturing Engineering.

11. J. Liu, Y.-S. Cheng, S.W.N. Chan, D. Sung, Microstructure and mechanical properties of 7075 aluminum alloy during complex this extrusion, Trans. Nonferrous Metals Soc. China 30 (12) (2020) 3173–3182, https://doi.org/ 10.1016/S1003-6326(20)65452-8.

12. C.M. Anand Partheeban, M. Rajendran, S.C. Vettivel, S. Suresh, N.S.V. Moorthi, Mechanical behavior and failure analysis using online acoustic emission on nano-graphite reinforced Al6061–10TiB2 hybrid composite using powder metallurgy, Mater. Sci. Eng.: A 632 (2015) 1–13.

13. Trishul M.A, Virupaxayya Hiremath, Shreyas P, Production and Testing of Al- Fe2O3 Particulate Composite. Journal of Achievements In Materials And Manufacturing Engineering.

14. [13] Essam R. I. Mahmoud andMahmoud M. Tash, Characterization of Aluminum-Based-Surface Matrix Composites with Iron and Iron Oxide Fabricated by Friction Stir Processing. Journal of Achievements in Materials And Manufacturing Engineering.

15. EminBayraktar, FayzaAyari, Ming Jen Tan, Ayse Tosun-Bayraktar, And DHURATA KATUNDI, Manufacturing Of Aluminum Matrix Composites Reinforced With Iron Oxide (Fe3O4) Nanoparticles: Microstructural And Mechanical Properties. Journal Of Achievements In Materials And Manufacturing Engineering.

16. F. AyariA, B, D. KatundiB, And E. Bayraktar B, Damage Of Aluminium Matrix Composite Reinforced With Iron Oxide (Fe3O4): Experimental And Numerical Study. Journal Of Achievements In Materials And Manufacturing Engineering.

17. Yi Wang1,2, XiaoLan Song3, Wei Jiang1, Guo-Dong Deng1, Xiao-De Guo1, Hong-Ying LIU1, FengSheng LI1, Mechanism For Thermite Reactions Of Aluminum/Iron-Oxide Nanocomposites Based On Residue Analysis.Journal Of Achievements In Materials And Manufacturing Engineering.

18. Emin Bayraktar, FayzaAyari, Ming Jen Tan, AyseTosun-Bayraktar, And Dhurata Katundi, Manufacturing Of Aluminium Matrix Composites Reinforced With Iron Oxide (Fe3O4) Nanoparticles: Microstructure And Mechanical Properties. Journal Of Achievements In Materials And Manufacturing Engineering.

19. Palani swamy Shanmugha sundaram1, Of Iron Oxide On Tribological Behaviour Of Al- Si Alloy – Iron Oxide Composites – Taguchi Approach. Journal Of Achievements In Materials And Manufacturing Engineering.

20. E. Bayraktar, M.-H. Robert, I. Miskioglu, And A. Tosun Bayraktar, Mechanical And Tribological Performance Of Aluminium Matrix, Composite Reinforced With Nano Iron Oxide (Fe3O4). Journal Of Achievements In Materials And Manufacturing Engineering.

21. Kumar GP, Keshavamurthy R, Tambrallimath V, Biswas R, Andhale YS (2018) Mechanical Properties of Al7075-SiC-TiO_2 Hybrid Metal Matrix Composite. In AdvManuf and Mater Sci 1:301-307

22. Sambathkumar M, Navaneethakrishnan P, Ponappa KS, Sasikumar KS (2017) Mechanical and corrosion behavior of Al7075 (hybrid) metal matrix composites by two step stir casting process. Latin Amer J of Solids and Struct 14:243-55

23. Murali M, Sambathkumar M, Saravanan MS (2014) Micro structural and mechanical properties of AA 7075/TiO_2 in situ composites. Univer J of Mater Sci 2:49-53