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Examination of Microstructural and Mechanical Characteristics of Fabricated AA LM25 Reinforced with SiC and Waste Ceramic Nano Particles

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ABSTRACT: Aluminium-based composites are extensively and commonly used in the aircraft and automotive sector. They intend to improve hardness, corrosion resistance, flexibility, fatigue strength, and impact resistance. Stir Casting Process had been effectively used to fabricate aluminium alloy LM25 reinforced with various proportions of SiC (0.5%, 1.0%, and 1.5%) and Ceramic (fixed 1.0%) dual nanoparticles. Microstructural, micro hardness and tensile strength of the fabricated specimen were examined. SiC and Ceramic Nanoparticles in the composite matrix has been almost evenly scattered, according to microstructural analysis. The greater tensile strength is provided by the combination of SiC vol. 1.0%and Ceramic vol. 1.0%with AA LM25. Hardness value AA LM25 composites at combination of SiC vol. 1.0% and ceramic 1% has been rapidly increased.

KEYWORDS: Microstructure, LM25, Dual reinforcement, Stir casting, and Tensile strength.

I.INTRODUCTION

Composites materials matrix are made up of two main elements: a metal and a ceramic or organic material. Because of cheap price, less weight, and strong mechanical properties, metal matrix composites are used in a variety of disciplines. To enhance the mechanical characteristics of composite materials [1] particulate fibres were added. Engineers in various sectors such as aerospace, automobiles, electronics manufacturing, and electrical equipment have shown growing interest in lightweight composites. Aluminium-based composite materials seem to be the major player in this sector. Due to various improved properties, the need for Aluminum-based composites is growing. These composites can be prepared by stir casting process [2]. Thermal treatment will change its material characteristics, and it casts effectively [3]. AA LM25 is widely used in manufacturing sector for moderate cast iron that need great form or complexity, as well as cast adequacy. It's found in engine components and wheels in the automotive sector. And it is utilized in a variety of several other sectors, including pharmaceutical, and electromagnetic, marine and aviation [4]. To improve corrosion protection, the AA LM25 could be oxidised. It even has great durability to ocean water pressure, improved machining properties, and the potential to be welded [5]. Manufacturing process of AA LM25-based composite materials can be done in a variety of ways. Stir casting, blow moulding, and other methods have been the most common used [6]. Metal matrix composite manufacturing processes are usually complex and expensive. Some drawbacks should be acknowledged in order to completely optimise the ability of metal matrix composites [7]. It is crucial to create and incorporate the safest and also most

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cost-effective production solution possible. P. Suresh et al. [8] used the AA LM25 reinforced with carbon in this article. The mechanical characteristics of an AA LM25 enriched with carbon are enhanced. They investigated at the mechanical characteristics of the AA LM25 with carbon, with and without thermal treatment. It offers greater performance in a variety of conditions. By mixing silicon and chromium Nano particles with an AA LM25, toughness, compressive strength, and ultimate tensile are increased. The mechanical characteristics of aluminium enhanced with boron carbide particles was proposed by J. Onoro et al. [9]. Metal matrix composites were made using a heat extrusion technique. At low and elevated temperatures, they investigated the fracture behavior and strength strain. The use of boron carbide as reinforcing strengthened the mechanical characteristics of the Al 6061 and 7015. The mechanical strength and microstructural evaluation of fly ash impurities intensified with AA 6061 composite materials formed by the compo-casting method were examined by J. David raja selvam, et al., [10]. The fly ash impurities were applied at varying concentrations. The microstructure of matrix composites were studied using scanning electron microscopy. The hardness and tensile properties of the samples were improved by adding fly ash impurities. The research on Aluminum matrix content was carried out by Pradeep Kumarkrishnan et al. [11] using scrap wheels of Aluminum material. Scrap aluminium wheels have been used as the metal matrix, and alumina catalyst is being used as reinforcement. Compressive and toughness measurements have been carried out. The properties of aluminium containing carbon is a fascinating subject of investigation. Mehul. G This article by Mehul. G. Mehta, et al., [12] shows how varying amount of Fe3O4 impact various essential characteristics of AA LM25 produced with such a reduced traditional casting technique. The tensile and toughness qualities of three distinct variations of Fe3O4 particle with AA LM25 are studied. Poovazhagan et al. [13] produced aluminium hybrid Nano composites containing SiC and B4C. Elevated ultrasonic cavitation method was used to produce the samples. When an aluminium was reinforced with 1% SiC and 0.5 percent B4C, the material characteristics are enhanced.

Investigation on mechanical behaviour and microstructure of AA 2024 intensified with Mos2 was studied by Bhargavi Rebba [13]. Stir casting was used to create the samples by varying MoS2 proportions (1, 2, 3, 4, and 5% wt.). The mechanical characteristics of the samples were tested, including strength and hardness. B. Vijaya Ramnath, et. al., [14] evaluated the mechanical behavior of a matrix composite enriched of alumina and B4C. Aluminum reinforcement particles was established by Yashpal et al. [15]. The strength and hardness behaviour of composite materials have strengthen as the particle size is reduced andthe wt. % of reinforcement increases.

II.MATERIALS AND METHOD

a. Selection of Materials

For the fabrication of composite samples, the AA LM25 was used as the metal matrix. It consists of alloying element such as Si (7.2%), Fe (0.5%) is next to Al (90.95%) which results in resistance to corrosion and good weldability. Table 1 shows the chemical content of the aluminium alloy LM25.

Table 1. Chemical content of AA LM25

Zn	Ni	Cu	Ti	Mn	Mg	Fe	Si	Al
0.10%	0.10%	0.20%	0.20%	0.30%	0.45%	0.50%	0.072	0.9095

The reinforcing substance had been a combination of SiC and waste ceramic Nano particles. Average Nano size of SiC and Ceramic materials are 60 µm and 45 µm respectively is produced by ball milling process. For sample preparation, AA LM25 was used to incorporate reinforcing of varying of SiC (0.5, 1.0, and 1.5 vol. %) and ceramic waste (1.0 vol. %) Nano particles. Reinforcement mixing content of samples are shown in Table 2.

Table 2. Reinforcement mixing content

Sample	Reinforcement Mixing content
S1	AA LM25 + 0.5% SiC + 1.0 % Ceramic Dual reinforcement
S2	AA LM25 + 1.0% SiC + 1.0 % Ceramic Dual reinforcement
S3	AA LM25 + 1.5 SiC + 1.0 % Ceramic Dual reinforcement

b. Fabrication of Composite Specimen

Stir casting machine was utilized to fabricate the composites samples. From table 2 the samplesare fabricated with different proportions of reinforcement weights are added with AA LM25. First the mould is preheated to prevent the porosity. The reinforcements of Sic and Ceramic waste Nano particles are preheated up to 500º C for 40 minutes to removes moisture and gas presented in the materials. AA LM25 material is cut into small pieces to feed into the crucible. After the metals melts the reinforcements are added at the same time stirrer mixes the matrix material and reinforcement materials for 5 minutes. Then the liquid metal is poured into the mould. Then the mould is allowed to cooling of casting. Figure 1 shows three composite samples prepared by stir casting method.

Fig 1. Fabricated samples

III. TESTING

The following tests was performed on samples to examine the microstructural and mechanical characteristics of fabricated AA LM25 reinforced by SiC and Ceramic Nano particles.

3.1 Micro structure

Microstructural examination shows the homogeneous scattering of reinforcement SiC and ceramic Nano particles in the AA LM25. The samples of AA LM25 dual reinforced composites are cut into small pieces of 15mm dimension for examination under optical microscope.

3.2 Tensile test

Mechanical property testing is very important for evaluating the properties of newly produced composite materials and controlling performance

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consistency. The tensile evaluation is carried out in this research using a universal measuring unit. The specimens were prepared in compliance with ASTM-E8 guidelines. Tensile measurements are used to assess the material stress strain curve and overall tensile strength, and also the mechanical characteristics of the composite material such as elongation percentage, yield strength, and breaking strength.Figure 2 shows AA LM25 of SiC and Ceramic Dual Reinforced Composites samples for tensile property evaluation.

Fig. 2. Tensile test specimen

3.3 Hardness test

Hardness is a mechanical characteristics of any sample that assists in the prevention of deformation caused by penetration. Vickers hardness measuring system was used to assess the hardness of this research. In hardness examination, a diamond indenter makes an indentation on the sample by applying a load P, as seen in fig. 3. With the guidance of a standardized microscope, the size d of a resulting indentation is estimated, and the hardness is determined by the stress distribution imposed just below the indenter. Vickers hardness test were conducted to see how the percentage of Dual Nano particles in the composite sample affected the hardness. The load weighed 150 kg, and the indenter was 1/16' were used. Figure 4 shows AA LM25 Dual reinforced Composite samples of SiC and Ceramic Nano particles for hardness testing.

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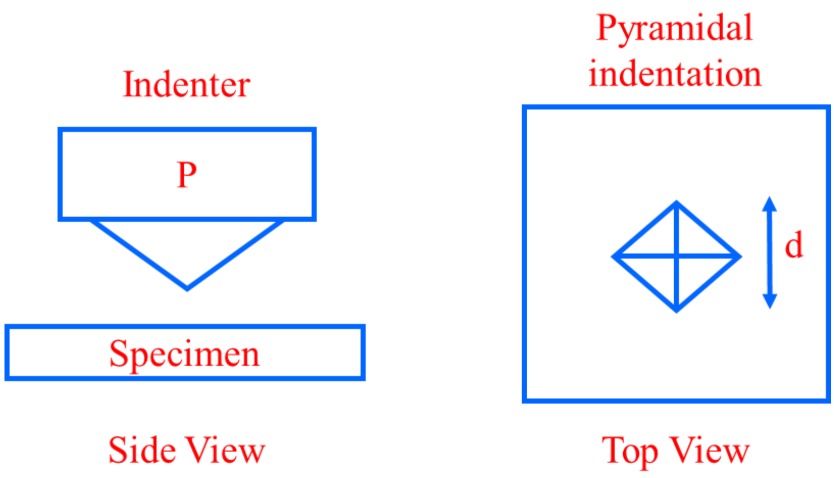

Fig. 3. Representation of indentation

Fig. 4. Hardness specimen

IV.RESULT AND DISCUSSION

4.1 Microstructure

The microstructure of the fabricated samples was studied under a microscope at magnifications of X100 and X150, as seen in fig 5. The deposition of reinforcing Nano particles, its isolation, and indeed proportion of non-defects throughout the examination were detected using an optical microscope, suggesting that reinforcing Nano particles and alloy content are completely combined. The scattering of reinforced Nano particles in the AA LM25 substance is almost homogeneous, as seen in fig. 5. It's also proof that the AA LM25 matrix has a minimal level of porosity. It has been show that interaction binding between the reinforcing nano particles and the AA LM25 alloy is strong. The lack of dendritic formation in all samples is easily seen in the microstructure, that accounts for effective stir casting production of composite materials.

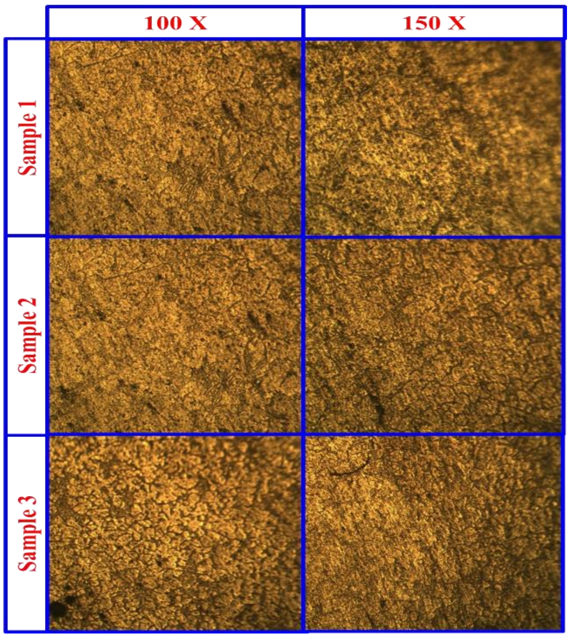

Fig 5. Microstructure comparison of Samples

4.1 Tensile Properties

The fabricated samples are subjected to tensile properties examination. The samples are inserted into universal testing machine load is applied to examine the tensile properties. Fig. 6represents the sample after subjected to tensile load. Figure 7 shows the stress strain diagram of the AA LM25 reinforced dual Nanoparticle samples. Figure 7 shows that the tensile strength values of fig. 7b are greater than those of figs.7a and 7c in their stress-strain curve.

Yield, Tensile, and Breaking strength of AA LM25 with SiC (0.5, 1.0 and 1.5 vol. % testing machine is graphically visualized in fig. 8.From the fig. 8 it is discovered that, Tensile properties of the fabricated samples, such as tensile, yield, and breaking strength, steadily improved with increasing the vol. % of SiC Nano particles embedded in the AA LM25 up to 1.0 % vol. and then gradually decreased with morereinforcement, i.e. 1.5 percent vol.

Fig 6. Tensile test specimen after testing

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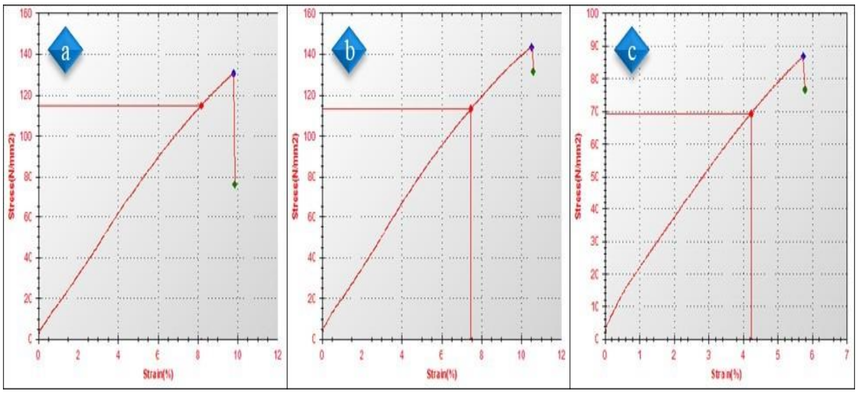

Fig 7. Stress vs strain curve of sample (a) S1 (b) S2 (c) S3

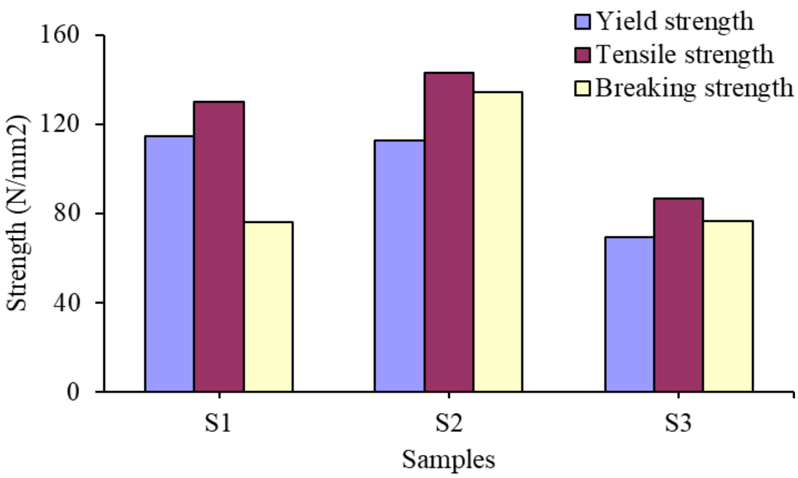

Fig. 8. Results of Tensile properties

4.3 Hardness

Vickers hardness test was performed at three different location on sample their diamond indention is captured using optical microscope. The comparison of diamond indentation at different location of different fabricated samples are visualized in fig. 9

Hardness value is measured at three different location on fabricated sample. The average value and standard deviation of hardness value of three values obtained at different location are graphical represented in Fig 10.

From fig. 10 it is detected that, the hardness value of the fabricated specimen improved steadily as vol. % of SiC and ceramic Nano particles incorporated in the AA LM25 raises. The reinforced materials, SiC generates a significant improvement in hardness, from 308.26 to 591.53HV for the AA LM25.

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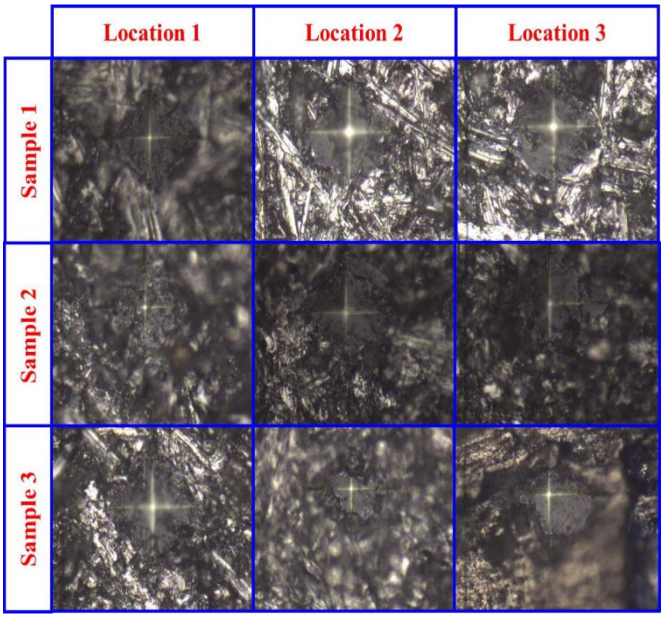

Fig 9. Comparison of micro hardness Diamond indentation

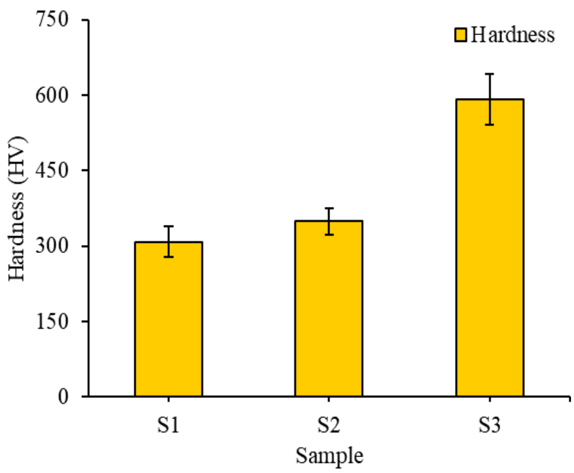

Fig. 10. Results of Hardness

V.CONCLUSION

Microstructural and Mechanical characteristics of fabricated AA LM25 reinforced with SiC and Ceramic Nano particles has been successfully examined. The below is a summary of the main findings:

- The AA LM25 + SiC + Ceramic Nano materials had a uniform scattering of structure and a lower level of porosity in three samples, according to microstructurestudy.
- Among the fabricated three samples the highest hardness (591.53 HV) was obtainedfor the AA LM25 + 1.5% SiC + 1.0 % Ceramic Dual reinforcement composites followed by the AA LM25 + 1.0% SiC + 1.0 % Ceramic Dual reinforcement composites (349.5667 HV).
- The AA LM25 + 1.0 % SiC + 1.0 % Ceramic Dual reinforcement composites had the maximum tensile strength (142.952 N/mm2). The AA LM25 +

% SiC +1.0% Ceramic Dual reinforcing composites (130.168 N/mm2) had the 2nd greatest strength (130.168 N/mm2). The development of the reinforcing combined with the eutectic Si process possessing morphology shapes is primarily responsible for the considerably maximum tensile strength values in the prepared samples.

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CONFLICT OF INTEREST:

Authors declared that there are no conflicts of interest.

REFERENCES

[1]Vijaya Ramnath, B., Elanchezhian, C., Jaivignesh, M., Rajesh, S., Parswajinan, C., & Siddique Ahmed Ghias, A, *Mater and Des*, *58* (2014) 332–338.

[2]Hossain, S., Mamunur Rahman, M. D., Chawla, D., Kumar, A., Seth, P. P., Gupta, P., Kumar, D., Agrawal, R., & Jamwal, A, *Mater Today*, 21(2020) 1458–1461.

[3]Mazahery, A., Shabani, M. O., Salahi, E., Rahimipour, M. R., Tofigh, A. A., & Razavi,M, *Mater Sci and Tec*, *28*(5) (2012) 634–638.

[4]Kataria, M., & Mangal, S. K, *Indian J Eng and Mater Sci*, *27*(2) (2020) 234–245.

[5]Maurya, N. K., Maurya, M., Srivastava, A. K., Dwivedi, S. P., Kumar, A., & Chauhan, S,*Mater Today*, *25* (2019) 755–758.

[6]Bolcu, D., & Stănescu, M. M, *Poly*, *12*(8) (2020) 1–20.

[7]Coyal, A., Yuvaraj, N., Butola, R., & Tyagi, L, *SN App Sci*, *2*(5) (2020) 1–10.

[8]Suresh, P., Arunagiri, P., & Arun Pravin, A. P, *Mater Today*, *33* (2020) 7–12.

[9]Oñoro, J., Salvador, M. D., & Cambronero, L. E. G, *Mater Sci and Eng*, 499 (2009) 421–426.

[10]David Raja Selvam, J., Robinson Smart, D. S., & Dinaharan, I, *Mater and Des*, *49* (2013)28–34.

[11]Krishnan, P. K., Christy, J. V., Arunachalam, R., Mourad, A. H. I., Muraliraja, R., Al-Maharbi, M., Murali, V., & Chandra, M. M, *J Alloys and Comp*, 784 (2019) 1047–1061.

[12]Mehta, M. G., & Vadher, J. A, *Mater Today*, (2021)

[13]Rebba, B., & Ramanaiah, N, *Procedia Mater Sci*, *6* (2014) 1161–1169.

[14]Vijaya Ramnath, B., Elanchezhian, C., Jaivignesh, M., Rajesh, S., Parswajinan, C., & Siddique Ahmed Ghias, A, *Mater and Des*, *58* (2014) 332–338.

[15]Yashpal, Sumankant, Jawalkar, C. S., Verma, A. S., & Suri, N. M, *Mater Today*, *4*(2) (2017) 2927–2936.