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INVESTIGATION OF THE MECHANICAL PROPERTIES OF ALUMINIUM ALLOY (LM6) REINFORCED WITH HEMATITE METAL MATRIX COMPOSITES.

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Abstract

Aluminium LM6 alloy reinforced through Hematite particulate matter composite were advanced by stirrer casting process with dissimilar weightiness proportions of Hematite particulate matter from 0 to 12 wt.% in stages of 3 wt.%. The stirrer casting method is used to fabricate the metal matrix composites based on aluminium alloy and then investigate the microstructure of the prepared specimen and find out the Hardness strength, Compressive strength and Tensile strength of the mechanical properties. In the present study a modest attempt has been made using a hematite reinforcing material to manufacturing an aluminium based metal matrix composite, with an objective to make aluminium metal matrix composites by using low conventional casting technique and to obtain the delivery of reinforced material uniformly. To achieve this objective, stirrer casting process has been implemented. Aluminium (LM6) alloy and reinforcing material hematite has been chosen as matrix respectively. The result exposed that increased the reinforcing material hematite both heat treated and un heat treated specimens increases the Hardness Strength, Compressive Strength, Tensile Strength of the specimen and percentage of Elongation is decreases.

Keywords: Al LM6, Hematite, Stir Casting, SEM.

1. Introduction

In a composite materials aluminium alloy is a main matrix element. In Engineering applications, the composite materials play a significant role due to its increase the mechanical properties, specific strength and stiffness of the material [1]. In a metal matrix alloy reinforced with a hard ceramic particulate such as titanium oxide, boron carbide, aluminium oxide, silicon carbide to increases the wear resistance and evaluate the effect on cutting forces of certain cutting variables under a dry cutting condition of aluminium metal matrix composites. [2]. The most commonly used method for manufacture of aluminium metal matrix composite is stirrer casting technique [3]. The previous studies of Huseyin sevik et al. reported that aluminium–silicon-based alloy (LM6) and hematite particles using pressure die-casting technique The Particle volume fraction increases with decreasing the composite wear rate and with particle size decreases with increased proportionally to the applied load [4]. P. Vijian et al. reported to analyse the influence of the process parameters on surface roughness in squeeze casting of LM6 aluminium alloy using

Taguchi method.[5]. S. Sulaima et al. reported Tensile and hardness tests and scanning electron microscopic studies were conducted to determine the maximum load, tensile strength and modulus of elasticity. To increases in addition of quartz particulate the tensile strength decreases of the composite. [6]. Lim Ying Pio et al. presented that the mechanical properties of LM6 sand casting can be optimally improved by grain refinement of 0.5 wt.% AL5Ti1B [7]. Thomas. A et al. Metal matrix composites through stir casting is taken in to focus manufacturing of (LM6)- aluminium alloy Hematite particulate matter reinforced metal matrix composites by stirrer casting is the objective. They are frequently used in Aeronautical and Automotive applications and so it is given the prime importance. From the earlier studies it was initiate that no work takes remained carried out on Al LM6 -hematite particulate matter compositions. In the existing paper we report an examination of the Microstructure and the Mechanical properties the effect of Heat treated and un heat treated specimens in aluminium alloy LM6 Metal matrix composite.

2. Experimental Technique

2.1 Material Collection

Aluminum alloy LM6 is used in various industrial applications like Aerospace, Marine and automobile. In the material system they exhibit the poor tribological properties are very poor that is one of the foremost draws back. To develop the better tribological properties with good wear resistance the design in the engineering community to advance a new material led to development of matrix material without compromising on the strength to weight ratio.

Table 1: Chemical Configuration of Aluminum LM6 Alloy in wt.%

Cu	Fe	Mg	Mn	Ni	Pb	Si	Al
0.10	0.60	0.10	0.50	0.10	0.10	10-13	Balance

2.2 Reinforcement Material

The reinforcement material was used as hematite is a rich iron ore with size of the particle is 100-140µm. Table 2 shows the chemical configuration of Hematite particle matter as reinforcement used in current study.

Table 2: Chemical Configuration of Hematite in wt.%

Fe_2O_3	FeO	SiO_2	Al_2O_3	MnO	TiO_2	ZnO	CuO	MgO	S	Al
92.6	0.44	0.28	1.35	0.01	0.07	0.01	0.01	0.11	0.001	Balance

2.3 Specimen Preparation

The matrix alloy used as aluminium LM6 alloy and the reinforcement are chosen as hematite particle matter by using stirrer casting process used for the preparation of composite as shown in Fig.1 and 2. The particulate size of the hematite is 100-140µm. the tensile samples were prepared as per ASTM E8M-15a test standard as shown in Fig.3. The universal testing machine as used for tested the specimen as shown in Fig.7. The Brinell hardness equipment as used for the hardness

test as per ASTM standard E10-95 as shown in Fig.10. The process of hardness test conducted was carried out HB500 tester with a load of 500 kg-f with 10 mm diameter ball indenter. The universal testing machine used as testing the compression test specimens and machining a size of 20 mm as per ASTM standard with a load interval up to 200 tons. For obtaining the SEM analysis the specimens polished roughly by using silicon carbide paper of 100-1000 grit size. Samples were prepared for microscopic inspections by standard metallographic procedures, engraved with Keller's substance and inspected under visual microscope; the microstructures are shown in Fig.4 with different weight percentages.

Fig 1: Electrical Furnace

Fig 2: Cylindrical and Rectangular Die

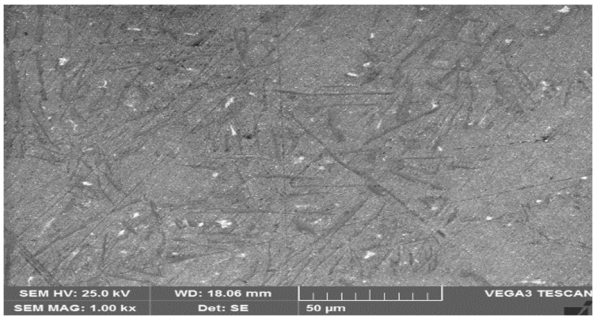
Fig 3: Composite Specimens Before Machining

3. Results and Discussion

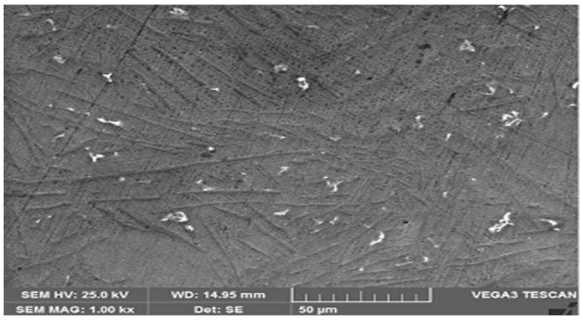
3.1 SEM Analysis

The Scanning Electron Microscope (SEM) examination was conducted for Aluminium LM6-Hematite particulate composite using stir casting method. The specimens were refined and etched with killer's agent. Fig.4 clearly reveals the distribution of Hematite particulates uniformly and good interfacial bonding strength in the composite with minimum permeability as shown in above Fig.3.

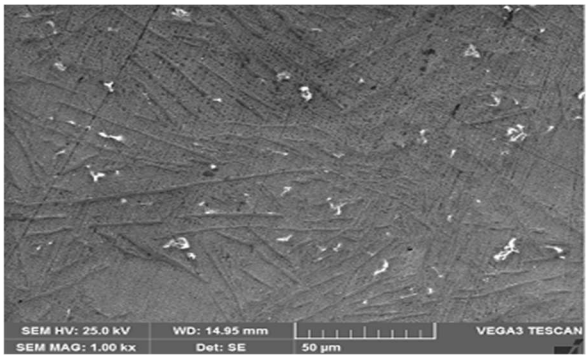
Fig 4: Scanning Electron Microscope Specimens



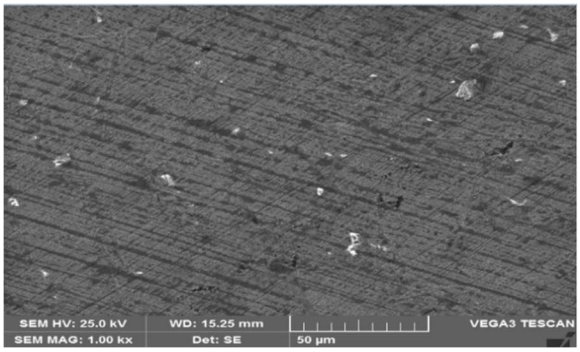
Al LM6+0% Composite



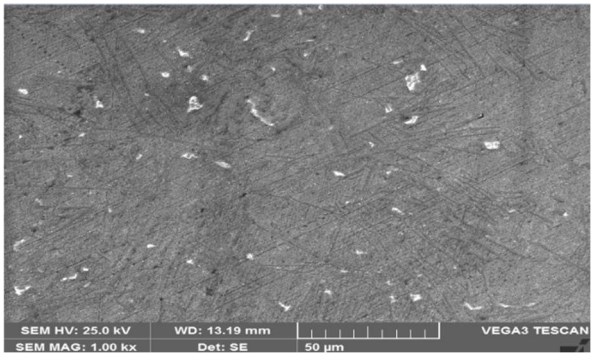
Al LM6+3% Composite



Al LM6+6% Composite



Al LM6+9% Composite



Al LM6+12% Composite

Fig.5. SEM Investigation of Al LM6 Alloy and Hematite Reinforcement Composition.

3.2 Tensile Test

Fig. 8 shows the results of Tensile strength. The tensile strength increases with increase in weight percentage of Hematite particulates, the tensile strength is increases due bonding between matrix and particulates, the reinforcing and the tensile strength of the heat-treated specimen much stronger than the un heat treated specimens.

The Tensile test was conducted using Tension Test Machine. The specimens for tension test were prepared as per the ASTM-E8M 15a standards. The Ultimate Tensile Strength (UTS) and Elongation were evaluated for all the combinations of reinforcements. The tensile strength has increases with increases in the percentage of the reinforcement while the elongation has decreased with increases in hematite percentage. It is due to the fact that the hematite is a brittle material & property of brittle nature has been imparted to the metal matrix material. The UTS gradually increased from 0 to 12% of the reinforcement added and a maximum of 20% was observed after the experimental work at 12% of the reinforcement.

(a) Before test (b) After test (c) After test

Fig. 6. Tensile Test Specimens: a) Before Test and b)&c) After Test.

Fig. 7. Photograph of Tensile Test Machine

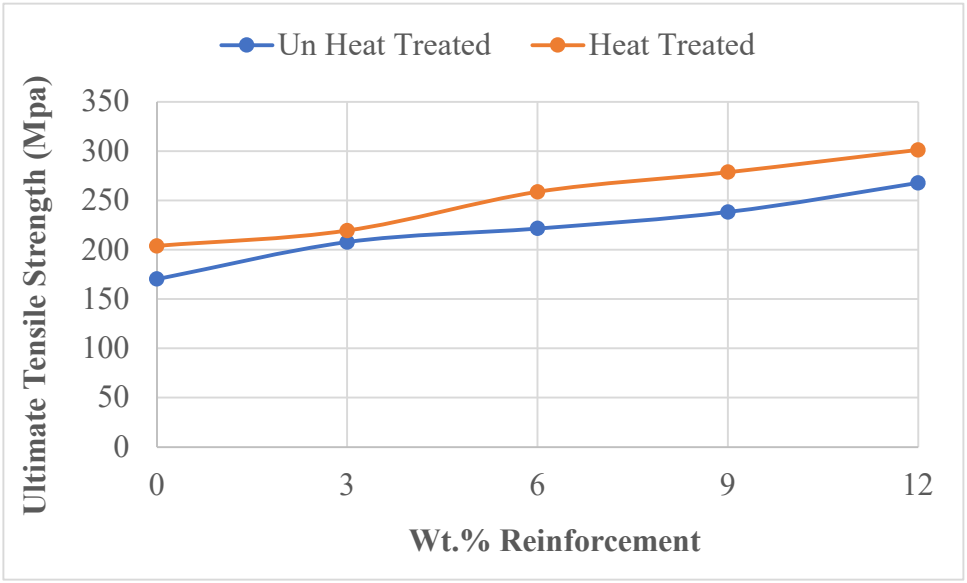


Fig. 8. Requirement of Tensile Strength on Hematite wt.% in Al LM6 Alloy with Un Heat Treated and Heat-Treated Specimen.

3.3 Compression Test

Fig. 9 shows the weight percentage of reinforcement increases with increases the compression strength of both heat treated and un heat treated specimens. The effective transmission of applied compressive load through the fine bonding with the reinforcement. The Heat-treated specimen's compression strength is better due to enhanced bonding as compared to un heat treated specimens.

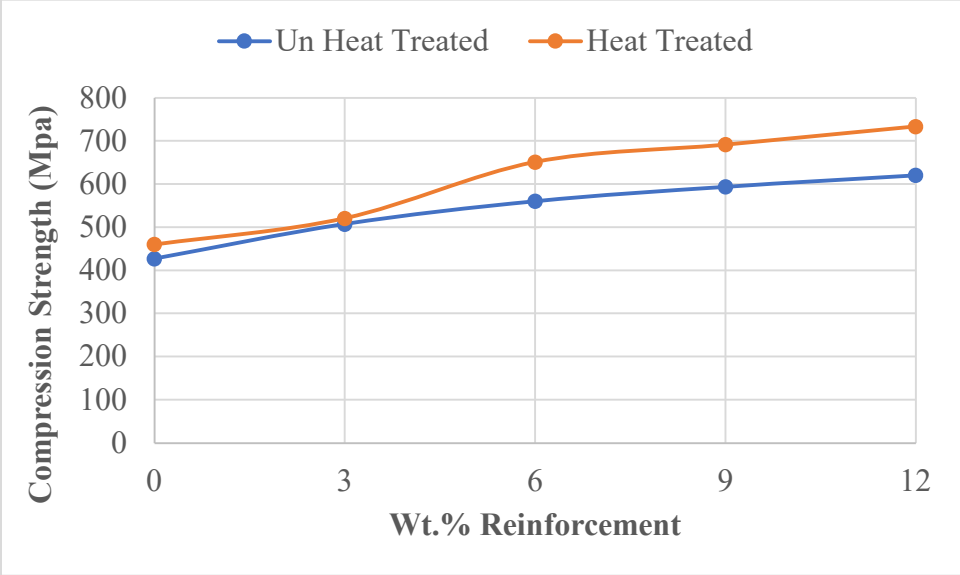


Fig. 9. Compression Strength Distinction with Hematite wt.% in Al LM6 Alloy with Un Heat Treated and Heat-Treated Specimens

3.4 Hardness Test

Brinell hardness testing apparatus was used for conduction of hardness test. As per ASTM E-10 standard the samples were prepared. The values of the hardness are depending up on the bonding among the matrix material and the reinforcement used in a metal matrix composite. The hardness is increases with increases weight percentage of the reinforcement. It is observed that increase the hardness of the heat-treated specimen as compared un heat treated specimen.

Figure 10: Hardness Test Samples Before and After Indentation.

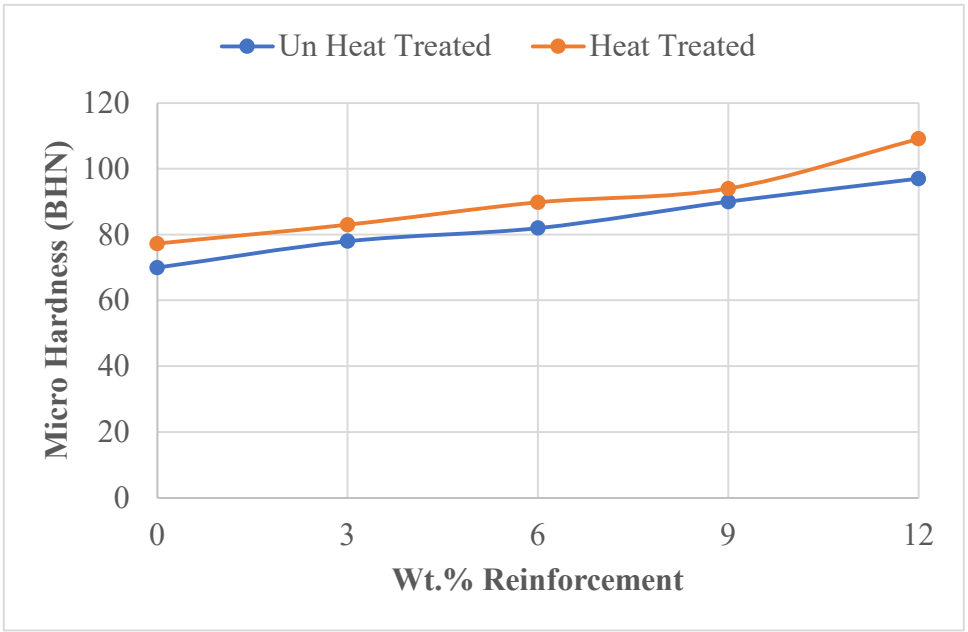


Fig. 11. Hardness Dependency of Composition on Hematite wt.% in Al LM6 Alloy, Heat treated and Un Heat treated Specimen.

Conclusion

1. Al LM6 reinforced through Hematite particulate composite was successfully fabricated by using stir casting method.
2. The distribution of Hematite particulates uniformly in Al LM6 matrix alloy is clearly visible in microstructural analysis.
3. The experiments conducted for Mechanical properties reveal that, there is a substantial increase in Ultimate Tensile Strength, Compression strength and hardness of the composite due to the adding of Hematite as reinforcement.
4. The accumulation of Hematite particulates in terms of percentage increases the mechanical properties of heat-treated specimens as compared to un heat treated specimens.

References

1. L. Bolzuni, M. Nwak, N. Haribabu, "Assessment of the influence of Al-2Nb-2B master alloy on the grain reinforcement and properties of LM6 (A413) alloy" Materials science and engineering A628(2015) 230-237.
2. H. Joardar, N.S. Das, G. Sutradhar, "Application of response surface methodology for determining cutting force model in turning of LM6/Sic metal matrix composite" Measurement 47 (2014) 452-464.
3. M. Singh, D.P. Mondal, A.K. Jaw, "preparation and properties of cast aluminum alloy-sillimanite particle composite" Composite: part A 32 (2001) 787-795
4. Huseyin Sevik, S. Can Kurnaz, "properties of alumina particulate reinforced aluminum alloy produced by pressure die casting. Materials and Design 27(2006) 676-683
5. P. Vijayan, V.P. Arunachalam "optimization of squeeze cast parameters of Al LM6 aluminum alloy for surface roughness using Taguchi method" Journal of material processing technology 180 (2006) 161-166.
6. S. Sulaiman, M. Sayuthi. R. Samin "Mechanical properties of the as cast quartz particulate reinforced LM6 alloy matrix composite." Journal material processing technology 201 (2008) 731-735
7. Lim Ying Pio, Sham Suddin Sulaiman, "Grainence and Refinement of LM6 Al-Si alloy sand castings to enhance mechanical properties" Journal materials processing technology 162-163 (2005) 435-441.
8. S. Das, S.V. Prasad, T.R. Rama Chandran "Tribology of Al-Si alloy graphite composites: Triboinduced graphite films and the role of silicon morphology." Materials science and engineering A 138 (1991) 123-132.
9. Tony, Thomas A, Parameswaran R, "Development of feeding and stirring mechanisms for stir casting of aluminum matrix composites" procedia materials 5 (2014) 1182-1191
10. M. Singh, B.K. Prasad, D.P. Mandal "dry Sliding wear behavior of aluminum alloy-garnet particle composite" Tribology International 34 (2001) 557-567
11. K. Srinivasa Reddy, D. Sreedhara, "Effect of CNTs on hardness and Thermogravimetric properties of LM6 nano particulate composite" Materials today proceedings 2 (2015) 3629-3626