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CHARACTERIZATION OF ALUMINIUM 6061 MATRIX REINFORCED WITH RED MUD WITH DIFFERENT WEIGHT FRACTIONS

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***Abstract*— Aluminium matrix composites (AMCs) are potential light weight engineering materials with excellent properties. The present investigation aims to evaluate the properties of red mud particulate reinforced with aluminium 6061 metal matrix composites. Red mud particulates in different weight fractions are under dry condition. Composites are prepared by Stir casting method. The main objective of this study is to develop red mud reinforced aluminum composites using stir casting and the powder metallurgy process. Red mud is a material which is obtained as industrial waste during the production of alumina by Bayer's process. Red mud could be used as reinforcement for the production of aluminum composites. Using varying wt. % of reinforcement, the aluminium composites are fabricated by stir casting method. Due to technological advancements, it is possible to use Nano sized reinforcement in Al matrix. Nano sized reinforcements enhance the properties of Al matrix compared to micro sized reinforcements. With increasing volume fraction, more loads are transferred to the reinforcement which results in a higher yield strength, ultimate tensile strength and bending force and ductility to the Al-alloy/Red mud composites. This project is focused on overview of development in the field of Al based metal matrix with Nano aluminium based composites.**

***Keywords*— Red mud, stir casting, reinforcement etc**

I. INTRODUCTION

Composite materials play an important role in the field of science and engineering as well as advance manufacturing in response to unprecedented demands from technology due to rapidly advancing activities in aircrafts, aerospace, sporting goods, marine and automotive industries. These materials have low specific gravity that makes their properties, particularly superior in strength and modulus of many traditional engineering materials such as metals. As a result of intensive studies into the fundamental nature of materials and better understanding of their structure property relationship, it has become possible to develop new composite materials with improved physical and mechanical properties. These new materials include high performance composites such as reinforced composites. Continuous advancements have led to the use of composite materials in more and more diversified applications.

In a composite material, the matrix is a primary phase and having a continuous character. The matrix is usually more ductile and less hard phase that completely surrounds the reinforcement phase. Aluminum is the most popular matrix for the metal matrix composites. The Al alloys are quite attractive due to their low density, their capability to be strengthened by precipitation, their good corrosion resistance, high thermal and electrical conductivity, and their high damping capacity

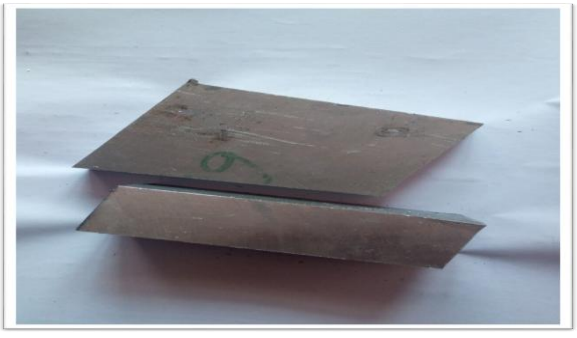

Figure 1: Aluminum 6061-T6

The other constituent of composite materials is reinforcement. It increases the strength, stiffness and the temperature resistance capacity and lowers the density of MMC. In order to achieve these properties, the selection depends on the type of reinforcement, its method of production and chemical compatibility with the matrix and the following aspects must be considered while selecting the reinforcement material. Reinforcements are characterized by their chemical composition, shape, dimensions and properties as in gradient material and their volume fraction and spatial distribution in the matrix. In this project we selected redmud as the reinforcement. Red Mud (RM) is the industrial waste or insoluble residue generated by the Bayer process which is used to extract Aluminum from bauxite. Typical red mud may contain as much as 30-60% Fe_2O_3, 10-20% $A1_20_3$, 350% Sic, 2-10% Na_2O, 2-8% CaO and 24% TiO_2 depending upon chemical and mineralogical make up of bauxite and bauxite treatment technology. About 0.5-2 tons of red mud is generated for each ton of Aluminum produced. The Indian bauxite processing industries contribute over 1.9 million tons of red mud in about 40 million tons/year of red mud produced globally.

Figure 2: Red Mud

II. OBJECTIVES

1. Analyze the effect of Red mud % on tensile strength, Hardness of Al6061-Redmud composite.
2. For improving mechanical properties of Aluminum – Red mud composites by stir casting method.
3. To fabricate red mud reinforced Aluminum 6061 alloy metal matrix composites using stir casting method.
4. To investigate the addition of red mud on its mechanical properties such as, hardness and tensile strength of the red mud reinforced Aluminum composites fabricated by stir casting method.
5. Increase in yield strength and tensile strength at room temperature and above while maintaining the minimum ductility or rather toughness
6. Increase in creep resistance at higher temperatures compared to conventional alloys
7. Increase in fatigue strength, especially at higher temperatures
8. Improvement of thermal shock resistance
9. Improvement of corrosion resistance
10. Increase in Young's modulus
11. Reduction of thermal elongation

III. STEPS FOR EXPERIMENTAL METHODOLOGY PREPARE

Step 1: Preparation of mould : Preheating of mould at a temperature of 300℃ in a electric oven.

Step2: Preparation of Specimen of various compositions: The alloying element Red mud is mixed proportionately by weight in the ratio of 5%, and 7% The percentage of alloying element to be used is determined by literature review and history for development of this work.

Step3: Stir casting Technique: Proper weight fraction of al-6061 and RMp are mixed thoroughly for 300 seconds until it is in liquid form ready to pour into the mould

Step 4: solidification: The molten metal is poured into the die cavity for solidification

Step 5: Machining: Machining of test specimen according to ASTM Standards

Step 6: Testing: Testing of tensile specimen and hardness specimen.

Step 7: Study the Mechanical Properties: Mechanical Properties are studied from previous papers

Step 8: Analysis of results: Various Experiments were conducted on fabricated MMCs samples by varying weight fraction of Red Mud (5%, 7%) and size of Red Mud particles (150-micron grain size) to analyze the casting performance characteristics of Al/Red Mud

IV. DATA COLLECTION AND EXPERIMENTATION

Data collection is the process of gathering and measuring information on targeted variables in an established systematic fashion, which then enables to evaluate outcomes.

The following calculation gives the quantity of Aluminum, Red mud and Magnesium to be used for preparing the specimen for testing of mechanical properties.

Base Metal Calculation:

Mass of each specimen of Al, $M = \rho \times V$

Where ρ is density of Aluminum =2.7 gm/cm^3

$\rho = M/V$

V=Volume of specimen= $\pi r^2 h$

Here r = 0.75cm, radius of specimen

h = 12cm, height of specimen

$M = \rho \times V$

$= \rho \times \pi r^2 h$

$= 2.7 \times \pi \times (0.75)^2 \times 12$

M= 57.25gms ≈ 60gms

14 % Shrinkage Allowance + 6 % Slag = 20% Total Allowance

$(60 \times 20)/100 = 12$gms

Mass of Aluminum = 60 + 12

= 72 ≈ 75gms

For a die, two specimens =150 gms × 10 Specimens

Reinforcement Calculation:

As mentioned earlier, Red mud is added as reinforcement

The calculations are as follows:

Mass of reinforcement, 5% = (150 × 5)/100

= **7.5gms**

For a die, Two specimen = 7.5 *2=**15 gms**

Mass of reinforcement, 7 % = (150 × 7)/100

= **11gms**

For a die, Two specimen = 11 *2=**22 gms**

V. MECHANICAL CHARATERIZATION

1. HARDNESS TEST

First the cylindrical specimens are cut to the required dimensions of 1.2 cm length,1.5 cm diameter. The samples are polished by 600, 800, and 1000 grit emery papers, to get fine surface before testing their hardness. The hardness of prepared composite is measured by Brinell hardness test and Figure 5.6 shows the Brinell Hardness Tester. 1/16-inch steel ball is used as indenter and 100Kgf pressure is exerted for dwell period of 20secs. The hardness values are measured in 3 different locations over the surface of the samples, average values are calculated

FIGURE 3: BRINELL HARDNESS TESTER

2. TENSILE TEST

The prepared cylindrical specimens are brought down to final dimensions as per ASTM E8M-15a Standard by machining the specimens using conventional lathe machine. Then Tensile test is carried out using Universal Testing Machine. The Tensile load is applied gradually from initial value of 0.5 KN till failure load.

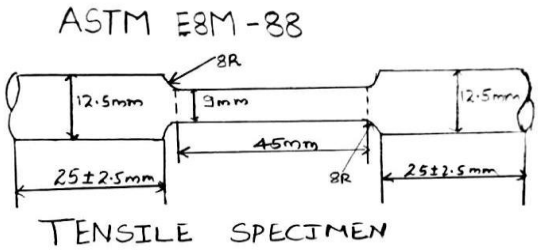

Figure 4: Specification of ASTM tensile test specimen

VI. RESULT AMND DISCUSSION

1. **Hardness Test Result**

The values given in Table 5.4 reveal that hardness of the composite increases proportionately with increase in the weight % of Red mud particles in composite.

Table 1: hardness test result

Material	Load in kgf	indentation	scale	Indentation time in sec	1	2	3	Avg Value
Base metal AL-6061	100	1/16" ball	B	20 sec	45	43	46	45
Al+5% red mud 150 micron	100	1/16" ball	B	20 sec	56.8	56.8	56.3	56.6

2. **Tensile Test Result**

The tensile test results furnished in Table 2 show an increasing trend in the values of ultimate tensile strength with increase in reinforcing Red mud % by weight.

Table 2: Tensile test results

SL NO	Composition	Tensile strength (MPa)			% Elongation		
		1	2	Average	1	2	Average
1	Aluminum- 6061(Base metal)	61.03	72.08	66.55	12.66	13.83	13.24
2	Base metal+5% Red Mud	94.786	72.71	83.74	2.44	1.98	2.21
3	Base metal +7% RedMud	118.935	74.374	96.65	1.73	2.73	2.23

VII. CONCLUSION

The fabrication of red mud reinforced aluminum metal matrix composites using stir casting. The effect of addition of the reinforcement on the aluminum alloy is studied with the changes in the physical, mechanical properties. In addition to that study on the fabricated composites by stir casting method is also analyzed. These analyses included the Tensile test and Hardness test.

It is found that the yield strength of Aluminum is 66.55 N/mm2 and it increased to 83.74 N/mm2 for 5% addition of RMp and on further increase of RMp to 7% we found out it increased to 96.65 N/mm2. Therefore, we conclude that with the addition of RMp there is an increase in Yield Strength of base metal by 25.83%for 5% addition of RMp and for 7% the increase was 45.22% which is as per our assumption.

From the Hardness Test point of view, we can say that the hardness of base metal is 45BHN and for 5% addition of RMp we found out that the hardness is 56.6 BHN and for 7% it was found that the hardness value is 62.2 BHN. therefore the increase of weight fraction increases the hardness of a base metal by 25.77% for 5% addition and 38.22% for 7% addition. Which is as per our assumption that with increase in wt. Fraction the hardness of base metal increases

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