

A Study on Synthesis and Characterization of AL 7075 Reinforced with Nano Sic and Red Mud

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Abstract— This paper investigates the experimental results of the mechanical properties of nano SiC, and Red mud reinforced aluminium alloy (7075) composites samples, processed by stir casting route are reported and analyzed. Two sets of composites with constant weight fraction of one reinforcements and varying one reinforcement (3 Sets) and a base metal specimen. The main mechanical properties studied were the tensile strength, ductility impact strength & wear strength. Unreinforced Al7075 samples were also tested for the same properties. In our study we varied the reinforcing material in smaller quantity to avoid the mixing problem. And from the results what we got shows the addition of reinforcing materials like Red mud and nano SiC improves tensile strength, Impact strength and reduces % Elongation.

Key words: Aluminum 7075 Alloy, Nano Silicon carbide, Red mud and Al7075 Mechanical properties and tribological properties

I. INTRODUCTION

Metal matrix composites (MMCs) reinforced with nano-particles, also called Metal Matrix nano-Composites (MMnCs), are being investigated worldwide in recent years, owing to their promising properties suitable for a large number of functional and structural applications. The reduced size of the reinforcement phase down to the nano- scale is such that interaction of particles with dislocations becomes of significant importance and, when added to other strengthening effects typically found in conventional MMCs, results in a remarkable improvement of mechanical properties. Aluminum alloys for its light weight, has been in the net of researchers for enhancing the technology. The broad use of aluminum alloys is dictated by a very desirable combination of properties, combined with the ease with which they may be produced in a great variety of forms and shapes. while the reinforcement phase improves the overall mechanical properties of the matrix. Nowadays, nanoparticles have been gaining growing attention and have been applied in many fields to fabricate new construction materials with novel functions owing to their unique physical and chemical properties.

Silicon Carbide (SiC) is highly wear resistant and also has good mechanical properties with low density, including high temperature strength and thermal shock resistance.

Red mud emerges as the waste material during the production of alumina from bauxite in Bayer's process. The red color is caused by the oxidized iron present, which can make up to 60% of the mass of the red mud. It comprises oxides of iron, aluminium, titanium and silica along with some other minor constituents. The addition of reinforcing phase significantly improves the tribological properties of aluminium and its alloy system. The thinking behind the development of hybrid metal matrix composites is to combine

the desirable properties of aluminium, silicon carbide and fly ash. Aluminium have useful properties such as high strength, ductility, high thermal and electrical conductivity but have low stiffness whereas silicon carbide and fly ash are stiffer and stronger and have excellent high temperature resistance but they are brittle in nature.

In this study an attempt has been made to fabricate a Hybrid Composite from commercial silicon carbide and red mud. Aluminium alloy (7075) is used as matrix material for the fabrication of Al7075-SiC-red mud hybrid composite material. Methods available for the production of Hybrid Composites are powder metallurgy, spray deposition, liquid metal infiltration, squeeze-casting, stir-casting. Though various processing techniques available for particulate or discontinuous reinforced metal matrix composites, stir casting is the technique, which is in use for large quantity commercial production. This technique is most suitable due to its simplicity, flexibility and ease of production for large sized components. Hence stir casting method is used in this study.

II. MATERIALS AND METHOD

A. Material Preparation:

The materials used to prepare specimens are Al6063, SiC, fly ash and Red mud. The specimens are prepared by machining the stir casted parts. For stir casting induction furnace is used. First the base metal is taken in a furnace and heated to 600°C. When base metal melts at that temperature the reinforcements are added to the molten base metal. Then to have self stirring process temperature of the furnace is raised to 800°C and also the stirring is done with the help of stirring mechanism at normal speed.



Fig. 1: Induction Furnace with Crucible Containing Al7075

B. Specimen Preparation:

The test specimens were prepared by machining from the cylindrical bar castings. The samples for tensile test, each specimen having 12 mm dia X 100 mm gauge length in size. The specimen for impact testing the samples for Charpy test 10mm X55mm length with 2mm V- notch at the centre. For

wear test the specimens with 8mm dia X 22mm length were prepared.



Fig. 2: Tensile Test Specimen Before Testing



Fig. 3: Tensile Test Specimen after Testing

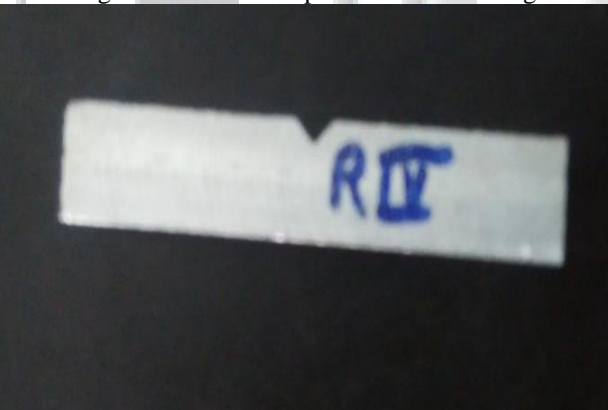


Fig. 4: Impact Test Specimen before Testing



Fig. 5: Impact Test Specimen after Testing

Constituents (Elements)	% (weight)	Constituents (Compound)	% (Weight)
Al	7.67	Al ₂ O ₃	14.49
Si	3.22	SiO ₂	6.89
Ca	3.67	Ca O	5.13
Ti	12.37	Ti O ₂	20.63
Fe	30.70	Fe ₂ O ₂	39.49
Cu	2.94	CuO	3.68
Zn	2.14	ZnO	2.68
O	32.09	Total	100
Total	100		

Table 1: Chemical composition of Al7075 in (Wt%)



Fig. 6: Wear Test Specimen after Ma

Components	Wt %
SiO ₂	44.8
Al ₂ O ₃	22.2
Fe ₂ O ₃	24
MgO	0.9
CaO	1.8
TiO ₂	0.8
K ₂ O	2.4
Na ₂ O	0.9
SO ₃	1.4

Table 2: Chemical composition of red mud in wt. %

III. RESULTS AND DISCUSSION

A. Tensile Testing:

In graph () it has been observed that the tensile strength also increases with increase in weight % of red mud. In our study we considered weight % from 0 to 6%. Excess addition may reduce the strength of material because of poor wettability. As per in our study is concerned we got improved tensile property up to 6%. Red mud is plenty and cheaply (almost Zero cost) available material, hence it can be used to improve the tensile property of the material.

Sample	Composition	Tensile Strength N/mm ²	% Elongation
Red Mud 1	Al7075 + 0.1% nano Sic + 2% Red Mud	153.658	3.14
Red Mud 2	Al7075 + 0.1% nano Sic + 4% Red Mud	127.32	3.16
Red Mud 3	Al7075 + 0.1% nano Sic + 6% Red Md	160.64	2.86

Red Mud 4	Al7075 + 0.2% nano Sic + 2% Red Mud	118.15	1.18
Red Mud 5	Al7075 + 0.2% nano Sic + 4% Red Mud	122.50	0.62
Red Md 6	Al7075 + 0.2% nano Sic + 6% Red Mud	153.30	3.42
Pure Al7075	Al7075	154.24	3.1

Table 3: Results of Tensile Test

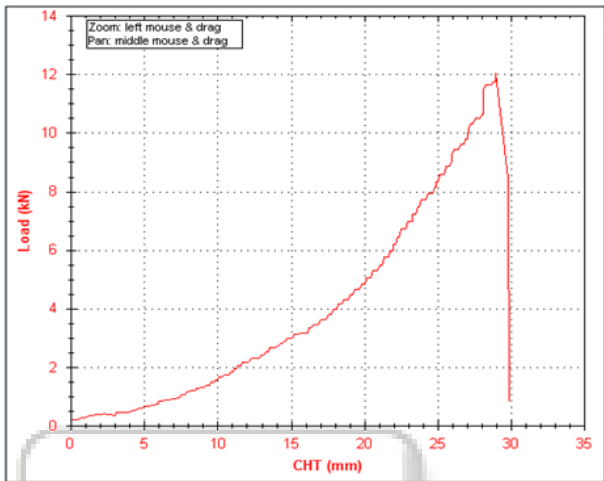


Fig. 7: Graph1. Tensile test result for sample 1

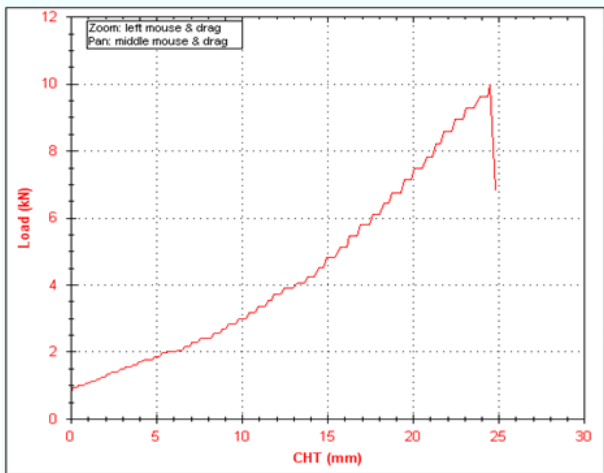


Fig. 8: Graph2. Tensile test result for sample 2

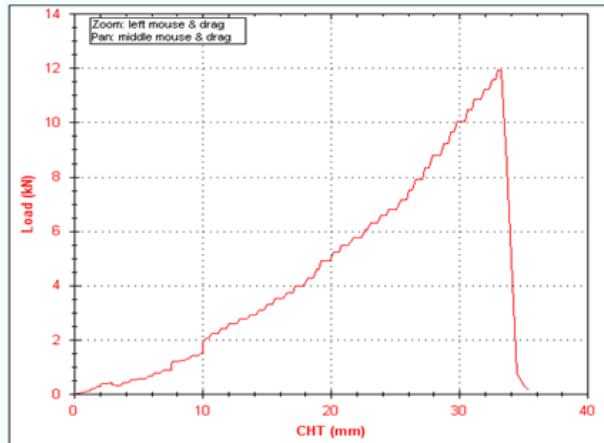


Fig. 9: Graph3. Tensile test result for sample 3

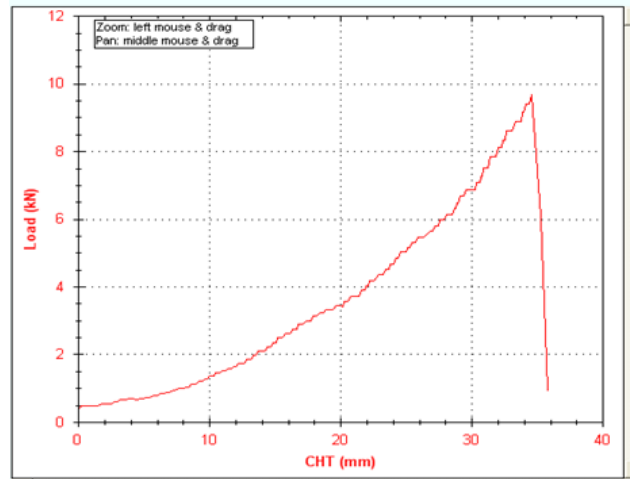


Fig. 10: Graph4. Tensile test result for sample 4

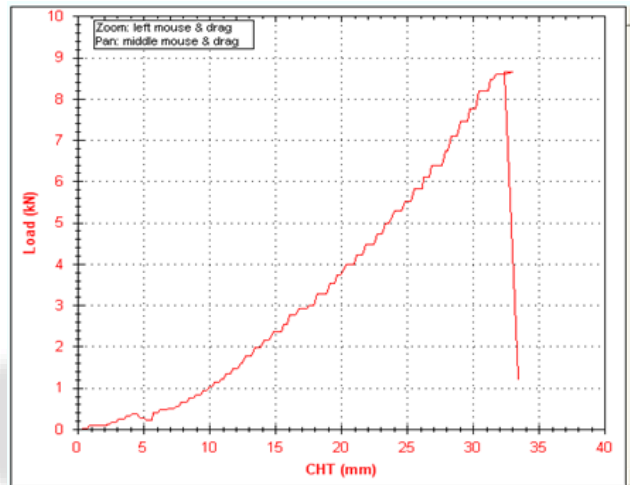


Fig. 11: Graph5. Tensile test result for sample 5

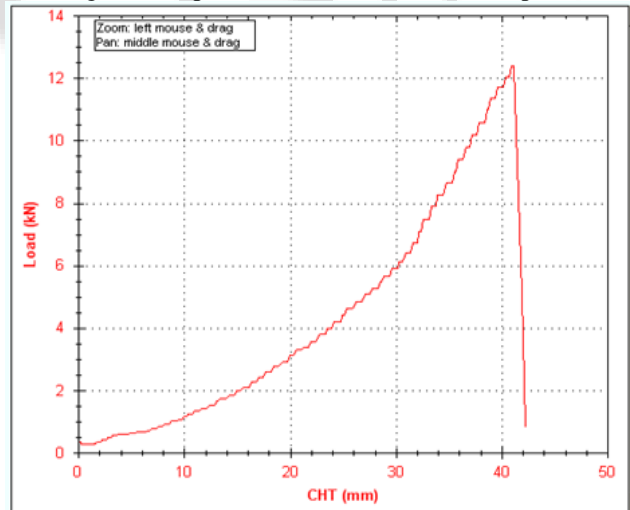


Fig. 12: Graph6. Tensile test result for sample 6

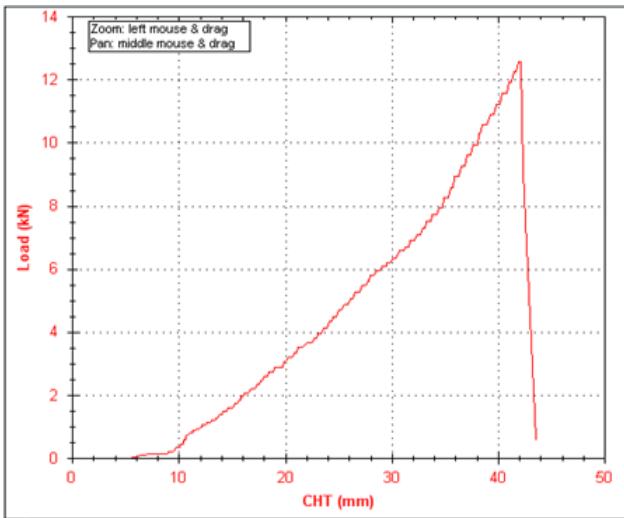


Fig. 13: Graph7. Tensile test result for pure Al7075

B. Impact Testing:

Impact strength is nothing but energy absorbed before failure when a sudden load is applied on an object. We have done the charpy test to know the impact strength of the prepared aluminium composite specimen. The graph shows the addition of Red mud improves the impact strength of the composite material. the density of the SiC is more than the Aluminium Alloy, hence the denser particles of SiC will settle down suddenly when we stop stirring. That is the reason in our study we varied very less to avoid this problem.

Sample	Composition	Energy Absorbed N-m
Red Mud 1	Al7075 + 0.1% nano Sic + 2% Red Mud	6
Red Mud 2	Al7075 + 0.1% nano Sic + 4% Fly Ash	7
Red Mud 3	Al7075 + 0.1% nano Sic + 6% Red Mud	6
Red Mud 4	Al7075 + 0.2% nano Sic + 2% Red Mud	5
Red Mud 5	Al7075 + 0.2% nano sic + 4% Red Mud	6
Red Mud 6	Al7075 + 0.2% nano sic + 6% Red Mud	6
Pure Al7075	Al7075	6

Table 4: Result of Impact Test

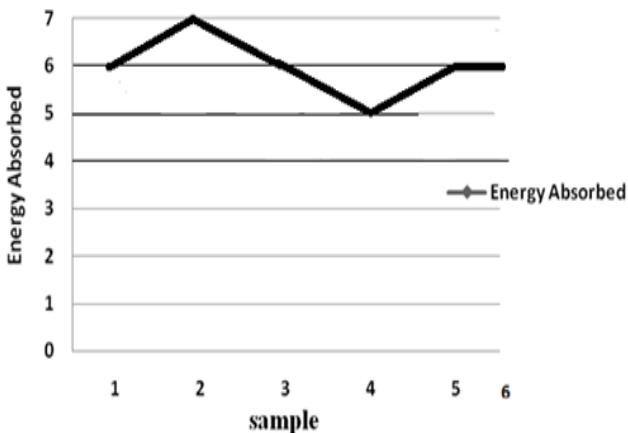


Fig. 14: Graph 8. Impact test result

C. Wear Test:

A cylindrical pin of size 8mm diameter and 24mm length Hybrid composite specimens were prepared and loaded in a pin-on-disc wear testing rig as shown in Fig. (15). Before testing, the surface of the specimens was polished by using 1000 grit paper. Wear tests were carried out at room temperature for 4 minutes. Wear, the progressive loss of material from the sliding surfaces of the elements of a tribo system can be determined in terms of weight loss. Material properties of the sliding elements, applied load and disc speed determine the wear rate. The result of wear test is shown in below Table (4). By these result we can see that the wear resistance is increased by increase in addition of Red mud in a Al7075-SiC Hybrid composite.



Fig. 15: Pin-on-Disc Wear test set up

1) Wear Test Results:

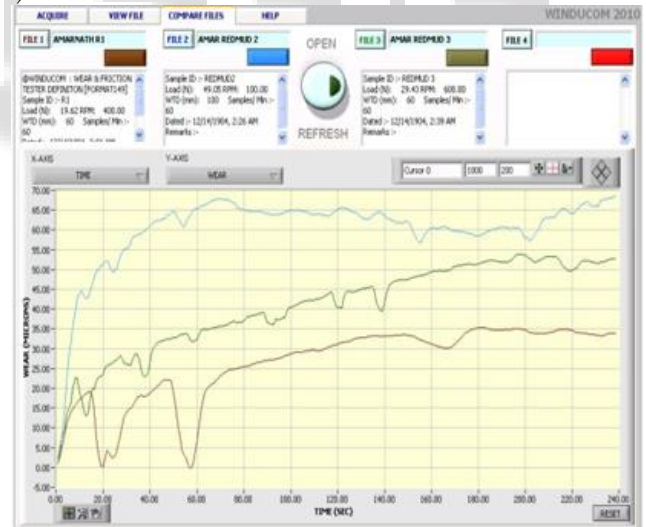


Fig. 16: Graph8. Shows Wear Comparison Graph of Sample 1-3



Fig. 17: Graph9. Shows Wear Comparison Graph of Sample 4-6

D. X-Ray Diffraction:

x-ray powder diffraction(XRD) is a rapid analytical technique primarily used for phase identification of crystalline material and can provide information on unit cell dimensions. Analyzed material is finely ground, homogenized and average bulk composition is determined. Graph 13 and 14 shows the XRD pattern of nano Silicon Carbide powder and Red Mud powder.

1) Results of XRD:

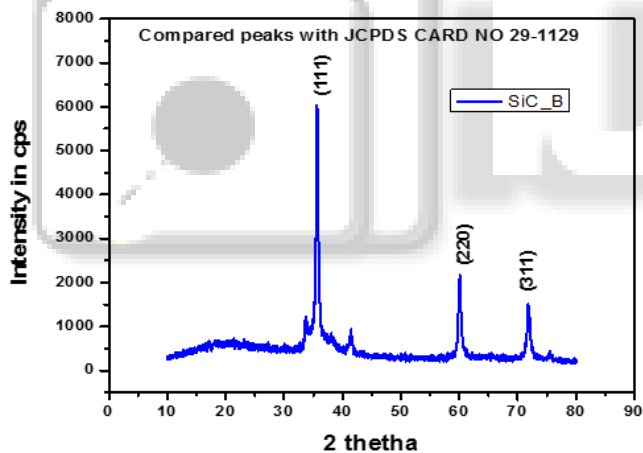


Fig. 18: Graph10. Shows XRD Pattern of Nano Sic Powder

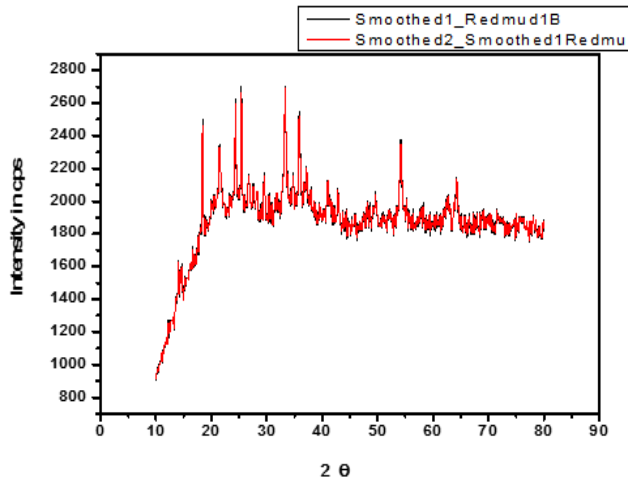


Fig. 19: Graph 11. Shows XRD Pattern of Red Mud Powder

IV. CONCLUSION

From the experiments conducted to study the effects of adding various weight fractions of nano Sic and Red mud, following conclusions can be drawn. Composite material 7075 Al alloy reinforced with (Nano SiC & Redmud) was successfully casted by stir casting method. It is observed that the fact that the combination of SiC with red mud particles possess higher hardness than the aluminium alloy.

- 1) The tensile strength in Al7075-Nano SiC-Red Mud sample, is found to increase maintaining the increasing percentage of Nano sized SiC.
- 2) Increases in the tensile strength is higher in Al7075 + 0.1% Nano SiC + 6% Red Mud composite.
- 3) The Impact Strength is higher in Al7075 + 0.1% Nano SiC + 4% Red Mud.
- 4) In Al7075-NanoSiC-Redmud wear resistance increases with increase in Nano SiC weight percentage content. Higher wear resistance was found in Al7075 + 0.2%Nano SiC +6%Redmud samples.

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