Synthesis and Evaluation of Tensile and Compression Strength of Aluminium A356 Reinforced With Rice Husk Ash and Tio_2 Particles

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Abstract- Aluminium based composites offer high strength, stiffness and resistance to wear. The combination of properties produced on the surface makes hybrid composites attractive to a wide range of applications in Automotive and Aerospace industries. In this present study, Aluminium A356 Matrix Material is reinforced with different weight percentage (1wt%,2%wt,3%wt,4%wt) of Rice Husk Ash (RHA) and Titanium dioxide (Tio2) by stir casting technique. The hybrid composite was then tested for tensile strength and compression strength in Universal Testing Machine (UTM) in two cases of with heat treatment and without heat treatment. The test result showcases the improvement of the tensile and compressive strength of the hybrid composite material.

Index Terms- Aluminum A356, RHA, TiO2, Stir Casting, Heat Treatment

I. INTRODUCTION

Today the whole world is in search of a material which is low cost, low density but at the same time should offer high strength. Hence Aluminium based metal matrix composite are the area for the research which have emerged as a class of materials capable of advanced structural, aerospace, automotive wear applications[1].

Now the most of the research work is carried out to develop composites using various recycled wastes. Rice Husk Ash (RHA) is an agriculture waste by product available in plenty in villages. For every 1000 Kgs of paddy milled about 220 kg (22%) of husk is produced. When this rice husk is burnt, 25 Kgs of ash is generated which is rich in Silica [2-5].

A356 belong to a group of hypo eutectic Al-Si alloy and has a wide field of application in automotive and avionics industries [3]. Alloy A356.0 has great elongation higher strength and considerably higher ductility than 356.0. Impurities less and hence have wide application in airframe casting, machine parts, truck chasses [4].

Titanium dioxide, also known as titanium is the naturally occurring oxide of titanium. It has a wide range of applications, from paint to sunscreen to food coloring.

The aim of the process was to reinforce Tio_2 and RHA in Aluminium A356 to enhance the mechanical properties such as tensile and compressive strength for with and without heat treatment.

II. MATERIALS AND EXPERIMENTAL PREPARATION

2.1 Matrix Material

For the experimental investigation Aluminium A356.0 was used as a matrix material whose chemical composition (in wt %) is listed in table 2.1. This alloy has good cast ability, mach inability, weld ability, heat treatable and corrosion resistance properties. The main chemical composition is Silica with up to 7.5% wt% which provides greater hardness.

Table: 2.1 Chemical Composition of the Aluminium A356 Alloy

Chemical Compositions	Si	Fe	Cu	Mn	Mg	Zn	Ti	Others	Aluminium A356
Percentages (%)	6.5-7.5	0.20	0.20	0.10	0.25-0.45	0.10	0.20	0.15	Remainder

2.2 Reinforcement Material

2.2.1 Rice Husk Ash (RHA)

Rice Husk is the outermost layer of protection encasing a rice grain. It is a yellowish colour and has a convex shape. It is slightly larger than a grain of rice with typical dimensions 4mm by 6mm. It is light weight, available in plenty having bulk density of 340kg/m^3 to 400kg/m^3.

The Ash was obtained by burning Rice Husk in a steel vessel. This was thoroughly washed with water to remove dust particles and dried at room temperature for one day. The washed Rice Husk Ash was then heated to 100^0C for 2hrs in order to remove the moisture and organic matter. Lastly the RHA was again heated in furnace (Owen) to 500^0 C for 12hrs. The chemical composition of RHA is listed in table 2.2. The step by step preparation of RHA is shown in fig

Table: 2.2 Chemical Composition of Rice Husk Ash

Chemical Compositions	Sio_2	Gr	Cao	Mgo	K_2o	Fe_3O_3
Percentages (%)	90.23	4.77	1.58	0.53	0.39	0.21

Fig.2a
Burning of Rice Husk

Fig. 2b
Soaking of Prepared ash in a water for 1 day

Fig. 2c
Drying the Ash in room temperature

Fig. 2d
Heating rice husk ash in a Micro Owen for 2hr(100º) and 12hrs(500º)

Fig. 2e
Sieving this ash to get RHA particles

Fig. 2f
Prepared Rice Husk size of 55µ to 75µ

Fig. 2: Step wise Preparation of RHA

2.2.2 Titanium Dioxide

The purpose of selecting Titanium dioxide is due its low density, easily blend with Aluminium Alloys to improve mechanical property and low cost.

III. EXPERIMENTAL PROCEDURE

3.1 Specimen Preparation

The synthesis of the composite material in the present study is carried out by stir casting technique. Figure 3.a shows the stir casting equipment in process. The Aluminium A356 Alloy in the form of ingots were placed in the Graphite Crucible and heated to 850^0 C till the entire Alloy in crucible is melted. The reinforcement particles RHA and TiO_2 are pre heated to 400^0C for 2hrs before incorporating into the Graphite Crucible containing Aluminium A356 melt. Degassers tablet like Hexa Chloro Methane and 1% of Magnesium was added before reinforcing the TiO_2 and RHA particles. Degasser reduces the blow holes and porosity during the cast preparartion. While Magnesium is added to get wet ability property for the formation of the composite.

A mechanical stainless stirrer was lowered for mixing of matrix and reinforcement material thorough at a speed of 600 rpm [6]. The reinforcement of 1% wt of Tio_2 and 1% wt RHA was added into the melt and stirred for constant speed for 15mins for proper mixing. Finally the combined mixture is poured into the mould which is preheated to 400^0 C for 20mins for proper solidification of the molten mixture. The above steps are repeated for the other weight volume fraction of 2%, 3%, and 4% RHA and Tio_2 particles and necessary post finishing operations are carried out for respective tests to be conducted in later stages.

3.2 Heat Treatment of prepared Composite

Heat treatment is a combination of heating and cooling operation carried out on a metal or Alloy in solid state so as to produce a particular micro structure and hence the desired properties. Figure 3.b shows the casting for different varying reinforcement of RHA and TiO_2.

The test specimen is heated in a micro-over at a temperature 350^0 C to improve mechanical property of proposed composite specimen. After this heating process specimen is subjected to a sudden cooling by using 4T oil and kept in room temperature for three days for phase stability. The same specimen is heated at a temperature of seven days for uniform gain distribution. This prepared specimen is then tested for tensile and compressive strength.

Figure 3.a

Figure 3.b

IV. RESULT AND DISCUSSIONS

4.1 Evaluation of Mechanical Properties

(a) Tensile property analysis for the specimen which are not heat treated

Specimens were processed according to the ASTM The relation between ultimate tensile strength of the fabricated specimen with different weight fraction of RHA and TiO_2 is shown in figure 4(a). From the figure it can be said that for 4% volume fraction of reinforcement, the ultimate tensile strength is highest because the maximum load is distributed among the reinforcement, Hence for higher volume fraction of reinforcement greater resistance to external load is observed.

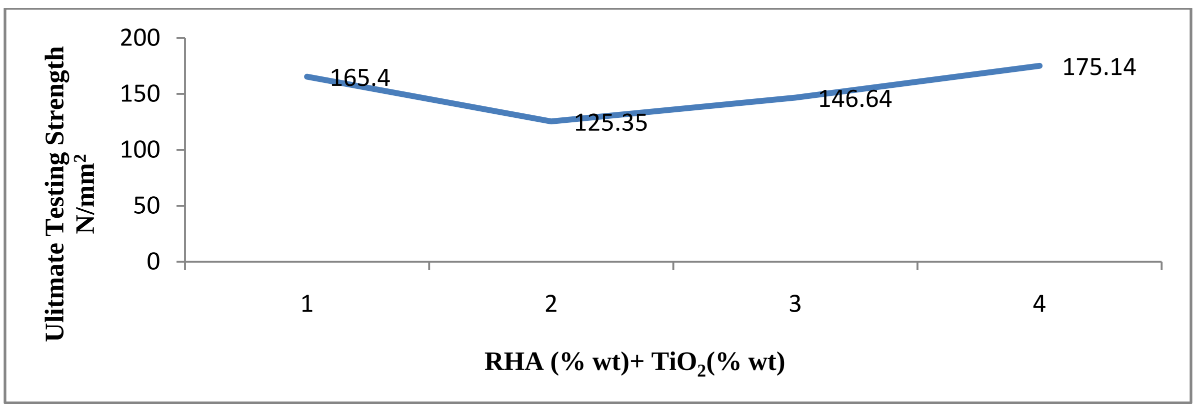

Figure: 4(a). Variation of Tensile Strength with the weight fraction of RHA and TiO_2

(b) Tensile property analysis for the specimen which heat treated

The standard test specimen which was heat treated was considered for Ultimate Tensile Strength in UTS. The relationship between fabricated heat treated specimen with different weight fractions of RHA and Tio_2 is shown in Figure 4(b). The ultimate Tensile strength increases with increases in volume weight fraction of reinforcement.

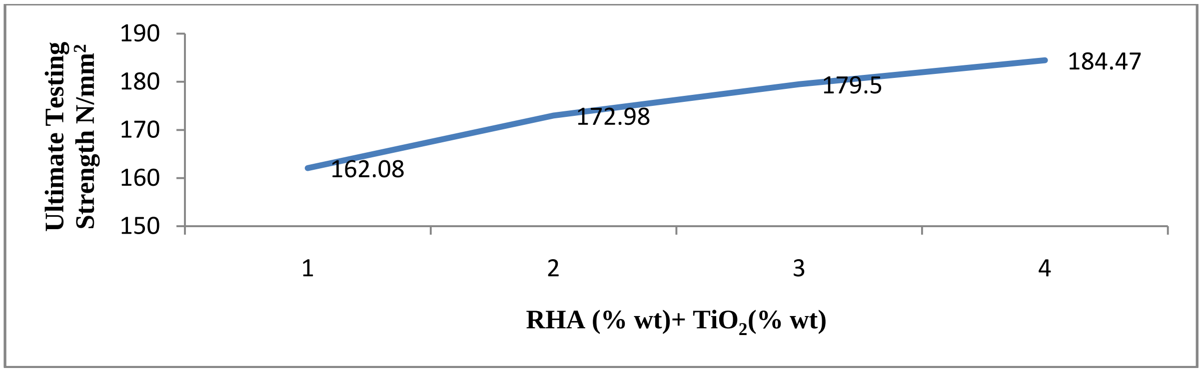

Figure: 4(b). Variation of Tensile Strength with the weight fraction of RHA and TiO_2

4.2 Evaluation of Compressive Strength

(a) Compressive property analysis for the specimen which are not heat treated

The variation of compressive strength with the addition of rice husk ash and TiO_2 is shown in the fig. 4(c). The compressive strength increases with the increase in the addition of reinforcement and is at highest for 4%wt RHA and 4%wt TiO_2 specimen combination.

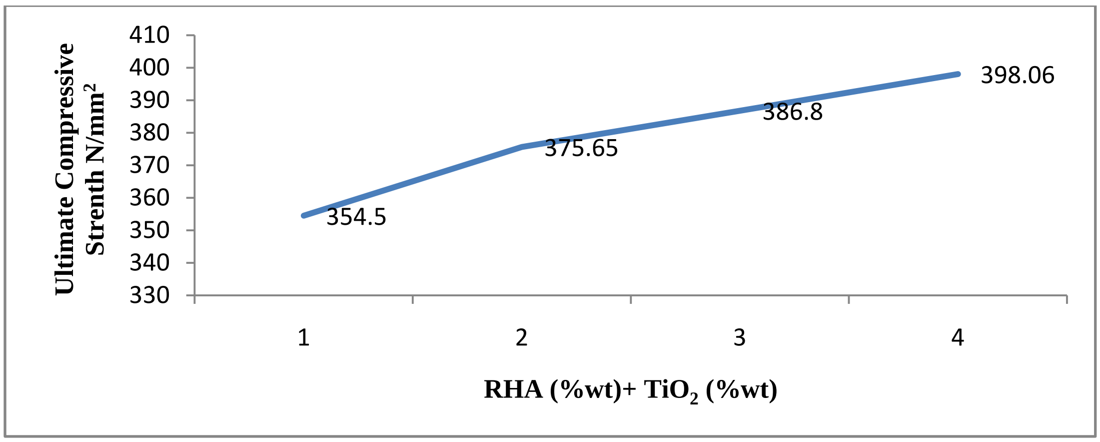

Figure: 4(c). Variation of Compression Strength with weight fraction of RHA and TiO

(b) Compressive property analysis for the specimen which are heat treated

The variation of compressive strength with the addition of rice husk ash and TiO_2 is shown in the fig. 4(d). The linearity of the graph suggests that the heat treated specimen subjected to the compression test results in the improvement of the compressive strength. It might be due to the uniform grain distribution on the surface of the specimen prepared.

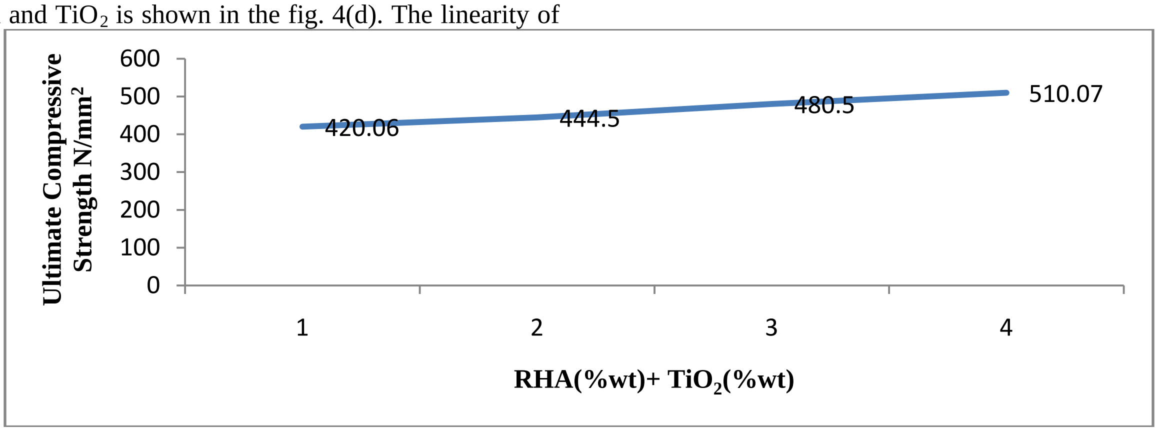

Figure: 4(d). Variation of Compression Strength with weight fraction of RHA and TiO_2

V. CONCLUSION

The conclusions drawn from the present study are discussed below

- A low cost agricultural waste in the form of Rice Husk Ash (RHA) and Titanium Di-oxide was successfully reinforced with Aluminium A256 alloy by stir casting technique to form a hybrid composite.
- As RHA is available in plenty, it can be utilized as an reinforcement with Aluminium alloy.
- The weight fraction of reinforcement increases the tensile property for the specimen with and without heat treatment due to surface resistance and elongation property of the reinforcement.
- The compression strength is increased linearly as shown in the fig. 4(c) and 4(d). This may be due to the hardening of the base alloy by RHA and TiO_2.
- Heat treatment incorporation to the composite plays a significant role in the improvement of the mechanical properties of the specimen prepared.

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