SYNTHESIS AND EVALUATION OF HARDNESS AND IMPACT STRENGTH OF ALUMINIUM A356 REINFORCED WITH RICE HUSK ASH AND TIO_2 PARTICLES

S. Prajval, *Research scholar, VTU-RRC, Belagavi, Assistant Professor, Department of Mechanical Engineering, G. Made Gowda Institute of Technology, Mandya District, Karnataka, India*

Dr. P. Rajendra Prasad, *Principal, Yadavrao Tasgaonkar Institute of Engineering and Technology, Tal. Karjat, District. Raigad, Maharashtra*

Abstract: *Hybrid Materials and their properties are always under research which may be required for the purpose of replacements of regular monolithic metal which does not fulfill the necessary applications. In this present study, Aluminium A356 Matrix Material is reinforced with different weight percentage (1%, 2%, 3%, 4%) of Rice Husk Ash (RHA) and Titanium dioxide (TiO_2) by stir casting technique. This hybrid composite was then tested for Hardness by using Brinells Hardness Testing Machine and Impact strength in Impact Testing Machine in two cases of with heat treatment and without heat treatment. The test result showcases the improvement of the hardness and impact strength of the hybrid composite material.*

Keywords: *Aluminum A356, RHA, Tio_2, Heat Treatment, Stir Casting*

1. 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 100kgs of paddy milled about 220kg (22%) of husk is produced. When this rice husk is burnt, 25kgs of ash is generated which is rich in Silica [2].

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 has great elongation higher strength and considerably higher ductility than 356.0. Impurities are less and hence have wide application in airframe casting, machine parts, and 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 RHA and TiO_2 in Aluminium A356 by Varied weight percentage (1%, 2%, 3%, 4%) to enhance the mechanical properties such as hardness and impact strength for with and without heat treatment of specimens casted using stir casting technique.

2. 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% weight percentage 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 burring 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 table2.2. Thus the prepared RHS is ready as reinforcement.

Table: 2.2 Chemical Composition of Rice Husk Ash

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

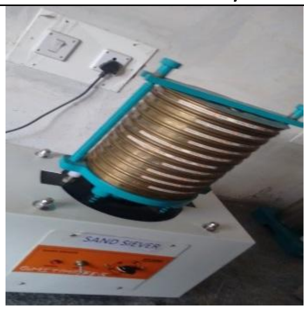
 Fig. 2a Burning of Rice Husk	 Fig. 2b Soaking of Prepared ash in a water for 1 day	 Fig. 2c Drying the Ash in room temperature
 Fig. 2d Heating rice husk ash in a Micro Owen for 2hr(100º) and 12hrs(500º)	 Fig. 2e Sieving this ash to get RHA particles	 Fig. 2f Prepared Rice Husk size of 55µ to 75µ

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 (for 1000gm its price is Rs 1200/-).

3. EXPERIMENTAL PROCEDURE

3.1 Specimen Preparation

The synthesis of the hybrid composite material in the present study is carried out by stir casting technique. The Aluminium A356 Alloy in the form of ingots are placed in the graphite crucible and heated to 750^0 C till the entire alloy in crucible is melted. The reinforcement particles RHA and TiO_2 are pre heated to 300^0C for 2 hrs before incorporating into the graphite crucible containing Al A356 melt. Degassers tablet like Hexa Chloro Methane and 1% of Magnesium was added before the reinforcing the TiO_2 and RHA particles. Degasser reduces the blow holes and porosity during casting. Magnesium is added to get wet ability property. A stainless mechanical stirrer was lowered for mixing of matrix and reinforcement material thoroughly at a speed of 500 rpm. The reinforcement of 1% wt of RHA and TiO_2 was added into the melt and stirred at constant speed for 20 mins for proper mixing. Finally the combined mixture is poured into the desired mould which is preheated to 400^0 C for 30 mins for proper solidification. The above steps are repeated for the other weight volume fraction of 1%, 2%, 3% and 4% of RHA and TiO_2 particles. The melt is solidified for 1 hr before removing it from the mould and machined to required standards for the investigation of certain mechanical observation

3.2 Heat Treatment of Prepared Composite

Heat treatment is a combination of heating and cooling operation carried out on a metal or an Alloy in solid state so as to produce a particular micro structure and hence the desired properties can be achieved.

The test specimen is heated in a micro-over at a temperature 250^0 C to improve mechanical property of proposed composite specimen. After this heating process, the specimen is subjected to a sudden cooling by using 4Toil and kept in room temperature for hour days for phase stability. The same specimen is heated at a 200ºC for seven hours for uniform gain distribution. Figure 3.a and 3.b shows the prepared specimens which is tested for hardness and impact strength.

Figure 3(a) Hardness Test specimens

Figure 3(b) Impact Test specimens

ISSN: 2278-6252
Impact Factor: 6.655

4. RESULT AND DISCUSSION

4.1 Evaluation of Hardness by Brinell's Test

(a) Hardness Calculation for Specimen Without heat Treated

The specimen fabricated was tested for tested for hardness by Brinell's hardness testing machine where each specimen was applied a 1500kg force by 5mm ball indenter for 15 seconds. The result shows in the figure 4 (a) Where the highest hardness is obtained for the 2% volume fraction of reinforcement. The surface area is protected by reinforcement hence resist the load and plastic deformation.

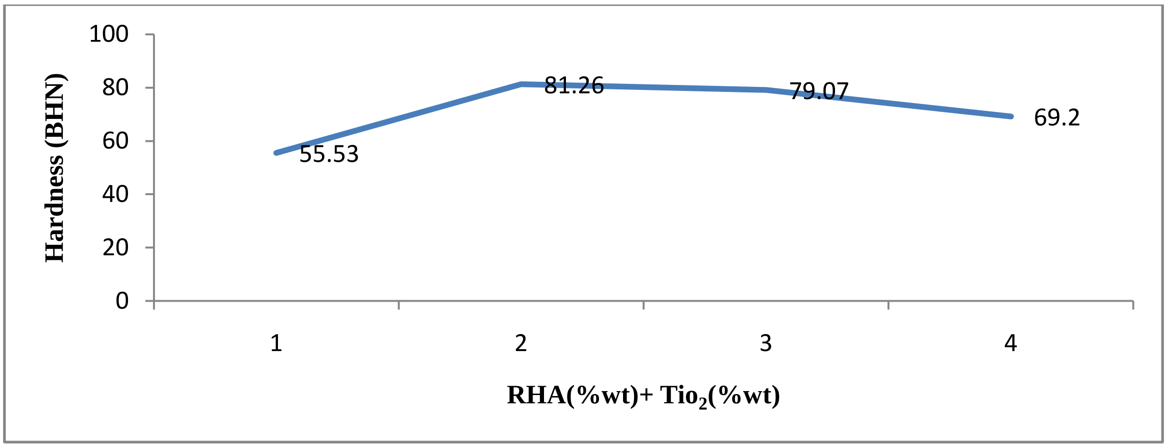


Figure: 4 (a)

(b) Hardness Calculation for Specimen with Heat Treatment

The specimen fabricated was tested for hardness using Brinell's hardness testing machine. The relationship between weight percentage of RHA and Tio_2 reinforcement and hardness of fabricated specimen is shown in figure 4(b). The hardness increases with increases in reinforcement. The reinforcement makes the surface area hard and resists plastic deformation on application of load.

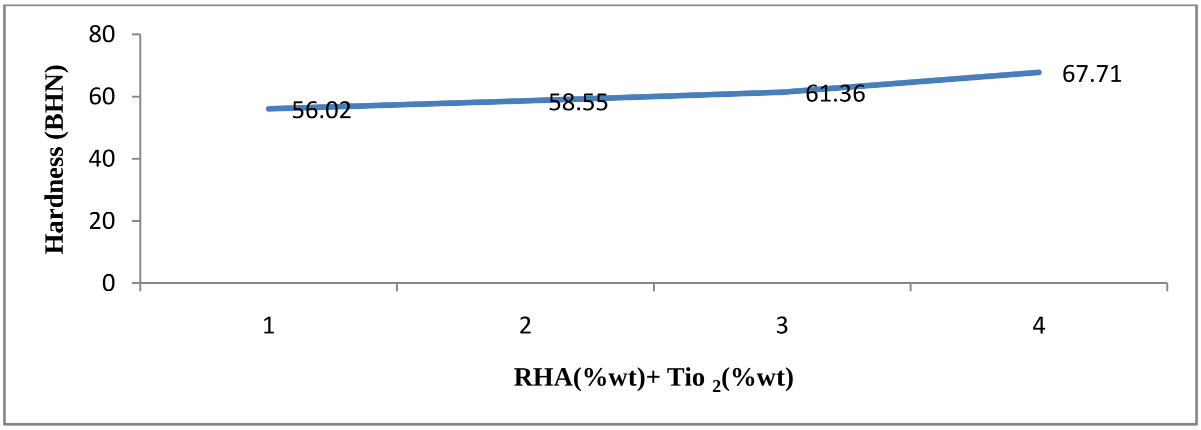


Figure: 4 (b)

4.2 Evaluation of Impact Strength

(a) Izod Impact Strength for Specimen Without Heat Treatment

The specimen fabricated was tested for impact strength by using Izod Impact Test. The relationship between weight percentage of RHA and Tio_2 reinforcement and impact strength of fabricated specimen is shown in figure 4(c). The result shows there is slight linear increase in impact strength with increases in reinforcement addition.

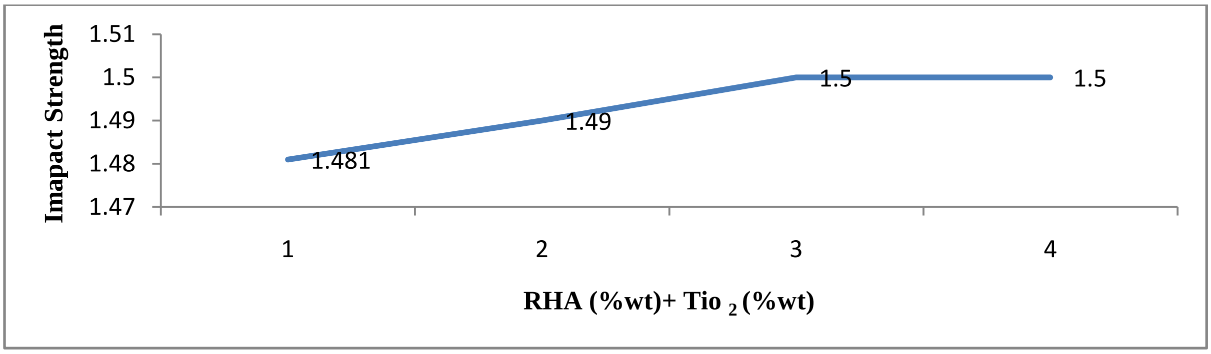


Figure: 4 (c)

(b) Izod Impact Strength for Specimen

The specimen fabricated was tested for impact strength by using Izod Impact Test. The relationship between weight percentage of RHA and Tio_2 reinforcement and impact strength of fabricated specimen is shown in figure 4.(d). The result shows there is slight linear increase in impact strength with increases in reinforcement addition.

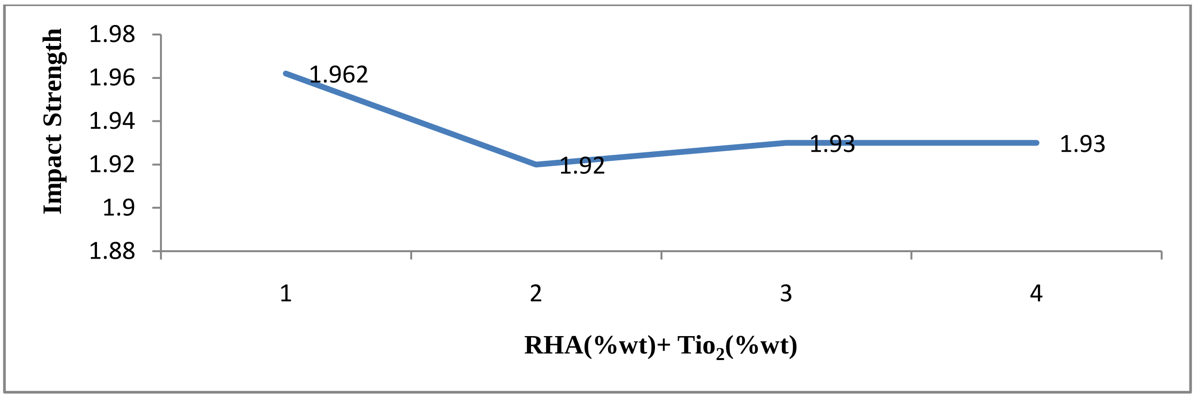


Figure: 4 (d)

(c) Charpy Impact Strength for Specimen without Heat Treatment

The specimen fabricated was tested for impact strength by using Izod Impact Test. The relationship between weight percentage of RHA and Tio_2 reinforcement and impact strength of fabricated specimen is shown in figure 4.(e). The result shows there is slight linear increase in impact strength with increases in reinforcement addition.

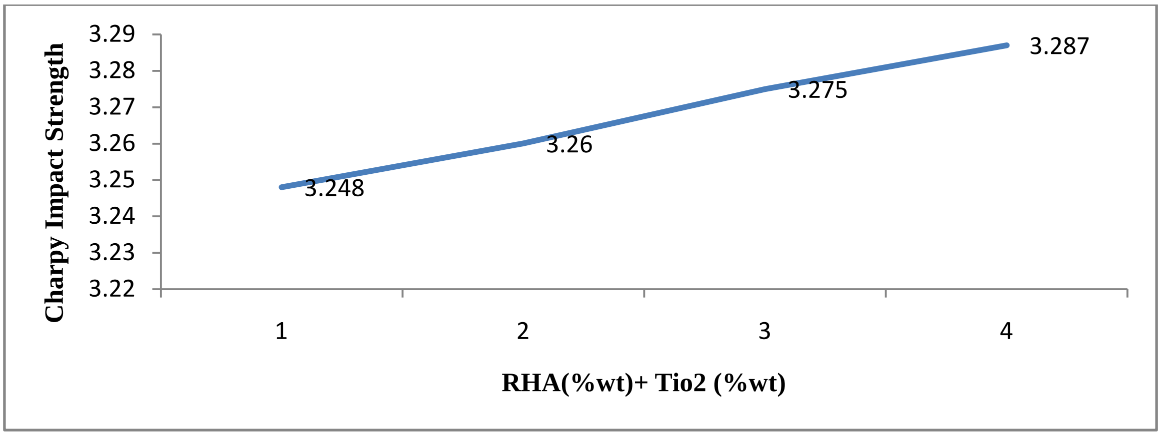


Figure: 4 (e)

(d) Charpy Impact Strength for Specimen For With Heat Treatment

The specimen fabricated was tested for impact strength by using Izod Impact Test. The relationship between weight percentage of RHA and Tio_2 reinforcement and impact strength of fabricated specimen is shown in figure 4(f). The result shows there is slight linear increase in impact strength with increases in reinforcement addition

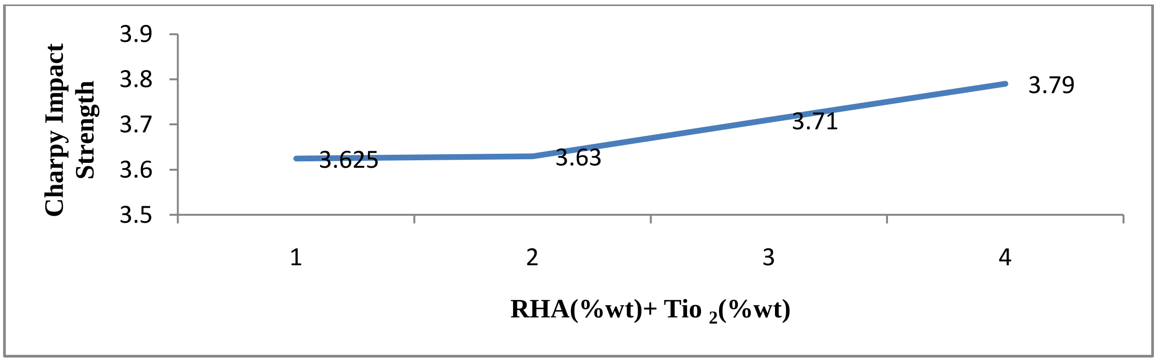


Figure: 4 (f)

5. 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 A356 alloy by stir casting technique to form a hybrid composite.
- As RHA is available in plenty, it can be utilized as reinforcement with Aluminium alloy.
- At 2% weight fraction of reinforcement, the hardness increases for the specimen without heat treatment. For the specimen with heat treatment, there is a linear

increase in hardness due to surface resistance and elongation property of the reinforcement.

- The Izod impact strength is increased linearly as shown in the fig. 4(c) for the specimen without heat treatment. The Izod impact strength increases at the 1 wt % and then deceases of the heat treated specimens as shown in fig. 4(d). This may be due to the hardening of the base alloy by RHA and TiO_2.
- The Charpy impact strength is increased linearly as shown in the fig. 4(e) and fig. 4(f) for the specimen with and without heat treatment.
- Heat treatment incorporation to the composite plays a significant role in the improvement of the mechanical properties of the specimen prepared.

REFERENCES

1. Siva Prasad .D and Rama Krishna. A (2011) “Production and Mechanical Properties of A356.2/RHA Composites”, *International Journal of Advanced Science and Technology*, Vol.33.
2. Saravan and Senthil Kumar .M (2013) “Effect of Mechanical Properties on Rice Husk Ash Reinforcement Aluminium Alloy (Al Silo Mg) Matrix Composites”, *International Conference on Design and Manufacturing,* IconDm 2013, (ELSEVLER).
3. Miskovic, Ilija Bobic, Snezana Rac.A and Vend. A (2006) “The Structure and Mechanical Properties of an Aluminium A356 Alloy Base Composite with Al_2O_3 Particle ’’, Tribologg in Industry, Vol.28, No.3&4.
4. A Guide to Aluminum Casting Alloys, Mid Atlantic Casting Services.
5. T. SornaKumar, D. Ravindran and G. Seshanandan (2015), “Studies on effect of Nano TiO2 Ceramic Filler of polymer Matrix composites”, *International Journal of ChemTech Research* Vol.7, Pp No.617-621.
6. Ajay kumar, Kalyani Mohanta, Devendra kumar and Om Prakash (2012), “ Properties and industrial applications of Rice Husk: A Review”, *International Journal of Emerging Technology and Advanced Engineering*, volume 2.
7. M. Ravichandran and S. DineshKumar(2014) “Synthesis of Al-TiO_2 composite through liquid powder metallurgy route”, *SSRG International Journal of Mechanical Engineering,* volume 1, page 12-17.