International Journal of Advanced Mechanics and Control Systems

Volume1, Issue 4 2025

Production and Mechanical Properties of A356.2 /RHA Composites

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Research Article

Date of Submission: 16-09-2025 Date of Acceptance: 10-10-2025 Date of Publication: 11-11-2025

Abstract
The vortex technique was used in this investigation to create A356.2 Al/Rice husk ash (RHA) metal matrix composites (MMCs). The composites were made using various weight percentages of reinforcement. Microstructural characterisation is done using a scanning electron microscope with an energy dispersive X-ray analyzer. Properties such as ultimate tensile strength, density, and hardness were examined. The microhardness findings showed that the matrix material near the rice husk ash particle had a greater hardness. Particles of rice husk ash are added to composites to increase certain of their mechanical qualities while decreasing their density.

Keywords: Rice Husk Ash, MMC's A356.2.

Introduction

Metal-matrix composites (MMCs) are a new family of materials that may be used in wear, advanced structural, automotive, aerospace, electrical, and thermal management applications. Because of their unique mechanical, physical, and thermal characteristics—such as low density, high specific strength, high specific modulus, high thermal conductivity, and high abrasion and wear resistance—metal matrix composites provide a performance advantage. Generally speaking, several monolithic matrix materials are used to produce the MMCs' decreased weight as well as their increased strength and stiffness. Composites with inexpensive and low-density reinforcements have drawn more attention in recent years. Rice husk ash [1-3] is one of the most affordable and low density reinforcements accessible in large quantities as a solid waste byproduct, compared to other reinforcements as SiC, Al2O3, etc. An agricultural byproduct of milling rice is rice husk. For every 100 kg of rice, around 20 kg of rice husk are produced. 20% of the material in rice husks is inorganic, while the remainder is organic. Rice husk is burned to produce rice husk ash (RHA). RHA was used by several studies as a cement alternative in concrete. In the current study, an effort is made to use the widely accessible RHA as reinforcement in MMCs in order to enhance the material's mechanical qualities and reduce its density.

Experimental Work

After burning rice husk, the ash was completely cleaned of dust with water and allowed to dry for a day at room temperature. After washing, the rice husk was burned to 200 °C for one hour to eliminate the moisture and organic materials. The carbonaceous material was subsequently removed by heating it to 600 °C for 12 hours [4]. The resulting silica-rich ash was used as

a filler substance used in composite production. Table I displays the chemical makeup of the rice husk ash after the aforementioned procedures. The Ultima IV X-Ray diffractometer was used to capture the ash samples' X-ray diffraction patterns. Figure 1 illustrates that only peaks belonging to SiO2 and carbon in graphite form are seen to RHA.

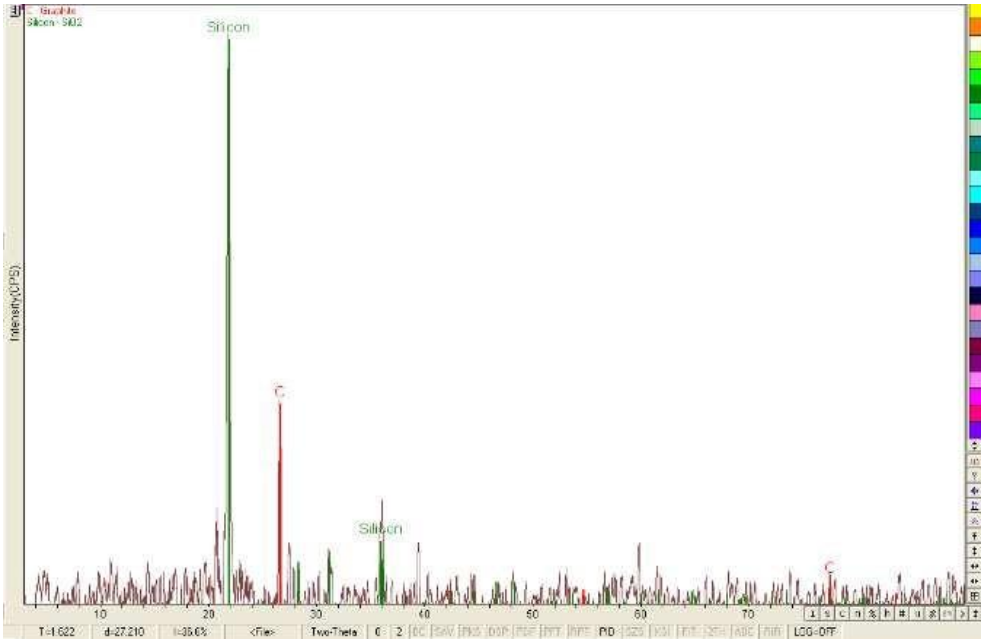


Fig 1: XRD Pattern of RHA Sample

Material System:

In this study, A356.2 alloy with the theoretic density of 2760 kg/m3 is used as the matrix material and RHA is used as the reinforcement. The chemical composition of A356.2 alloy is presented in the Table 2. Test specimens are fabricated which are classified based on the wt. %(4, 6 and 8) rice hush ash particles using vortex method [5-8].

Table 1: Chemical Composition of RHA

Constituent	SiO_2	Graphite	CaO	MgO	K_2O	Fe_2O_3
%	90.23	4.77	1.58	0.53	0.39	0.21

Table 2: Chemical Composition of A356.2 Alloy

Si	Fe	Cu	Mn	Mg	Zn	Ni	Ti
6.5-7.5	**0.15**	**0.03**	**0.10**	**0.4**	**0.07**	**0.05**	**0.1**

Specimen Preparation:
The matrix material for the preparation of composites is A356.2 and rice husk ash particles as the reinforcement. Initially, A356.2 Al with the theoretic density of 2760 kg/m^3 alloy was fed into the graphite crucible and heated to 750 ºC till the entire alloy in the crucible was melted. The reinforcement particles (RHA) were preheated to 800^0C for 1 hour before incorporating into the melt. After the molten metal was fully melted degassing tablet was added to reduce the porosity. Simultaneously, 1 wt % magnesium was added to the melt to enhance the wettability between rice husk particles and the alloy melt. It was noticed that without the addition of magnesium, the particles of rice husk ash were rejected. The stirrer made up of stainless steel was lowered into the melt slowly to stir the molten metal at the speed of 500 -700 rpm. The speed of the stirrer can be controlled my means of regulator provided on the furnace. The preheated RHA particles were added into the molten metal at a constant rate during the stirring time. The stirring was continued for another 5 minutes even after the completion of particle feeding. The mixture was poured into the mold which was also preheated to 500 ºC for 30 min to obtain uniform solidification. Using this method, 4, 6, and 8% by weight RHA particle-reinforced composites were produced. The cast MMC samples were examined in a Non destructive testing for blow holes.



Fig 2: Electric Furnace with Mechanical Stirrer

Results and Discussions:
JSM-6610LV Scanning electron microscope (SEM) equipped with energy dispersive X-ray analyzer is used to study the microstructure of the A356.2/RHA composites. The samples for SEM has been cut from tensile specimens and are ground by means of abrasive papers (P220, P400, P800, P1200) followed by rotating disc cloth polishing. Keller's reagent (95 ml water, 2.5 ml HNO_3, 1.5 ml HCL, 1.0 ml HF), very popular general purpose reagent for Al and Al alloys is used as an etching agent. The samples were immersed for 10-20 seconds in

the above solution and then washed with warm water, followed by dipping in concentrated HNO_3. Good retention of rice husk ash particles was clearly seen in the microstructures of A356.2/RHA composites.

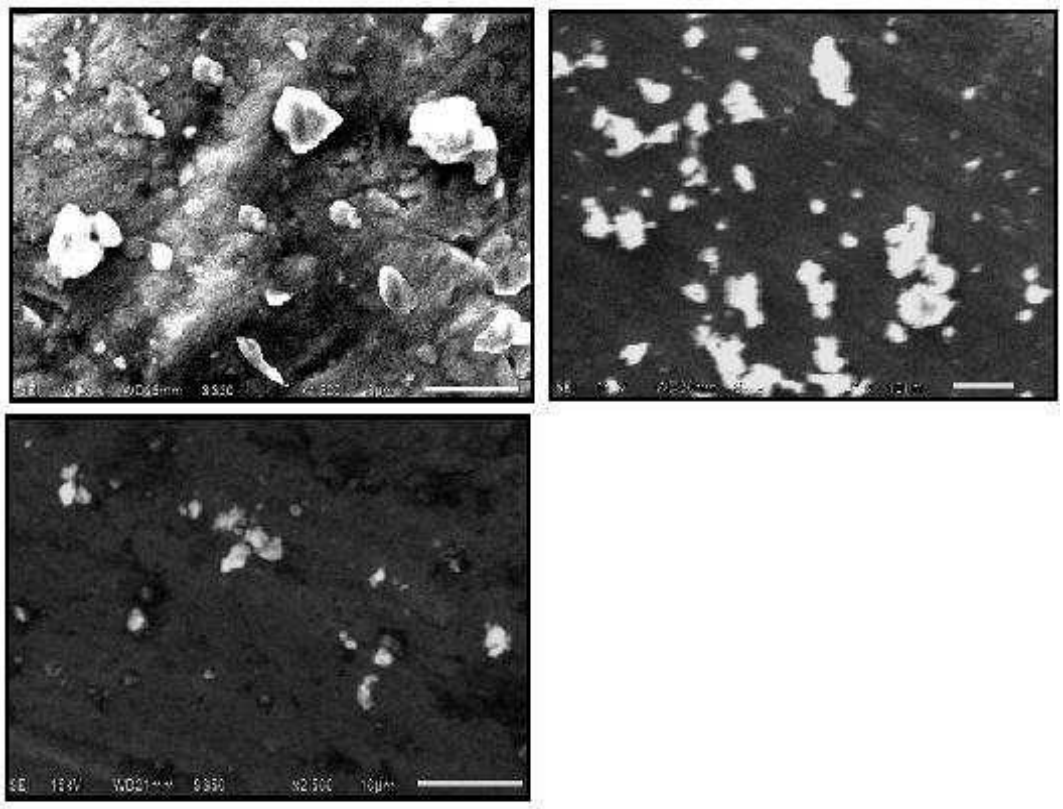


Fig2: a.SEM picture of A356.2/8%RHA Composites b. SEM picture of A356.2/6%RHA Composites c. SEM picture of A356.2/4%RHA Composites

Density Measurements:

The most reliable method of density measurement [9-11] simply involves weighing the sample in air and in another fluid of known density. Application of Archimedes' principle leads to the following expression for the density *(ρ)* of the sample in terms of measured weights (*W)*

$\rho = (W_a \rho_L - W_L \rho_a)/(W_a - W_L)$ (1)

Where the subscripts a and L refer to air and the second fluid (normally a liquid - water). In order to improve the precision, this liquid should have a high density. It must also be chemically stable, have a low vapour pressure and a low well-defined surface tension. It was observed that the density decreases with the increase in weight % of the reinforcement (Fig3).

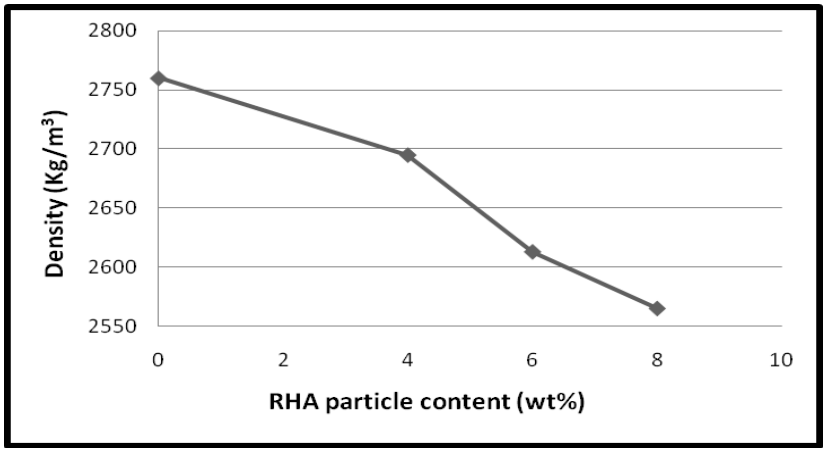


Fig3: Variation of Density with Weight % RHA

Hardness Measurements:

Hardness of the unreinforced and A356.2/RHA composites were measured using a standard Brinell hardness tester as per ASTM E10 standards. A test load of 500Kg is applied on the specimens for 30sec. The diameter of the steel ball indenter is 10mm. The size of the indent (d) is determined optically by measuring two diagonals of the round indent. The Brinell hardness number (BHN) is calculated for the unreinforced and A356.2/RHA composites using the equation 2. An average of five readings was taken of each sample for hardness measurements. Fig 4 shows the variation of hardness with weight % reinforcement. It was observed that the hardness increases with increasing weight fraction of the reinforcement. The increase in the hardness value results from the hard RHA particles in the matrix.

(2)

Where F is the applied lo[illegible] teel ball and d is the size of the indent.

$$BHN = \frac{2F}{\pi D\left(D - \sqrt{D^2 - d^2}\right)}$$

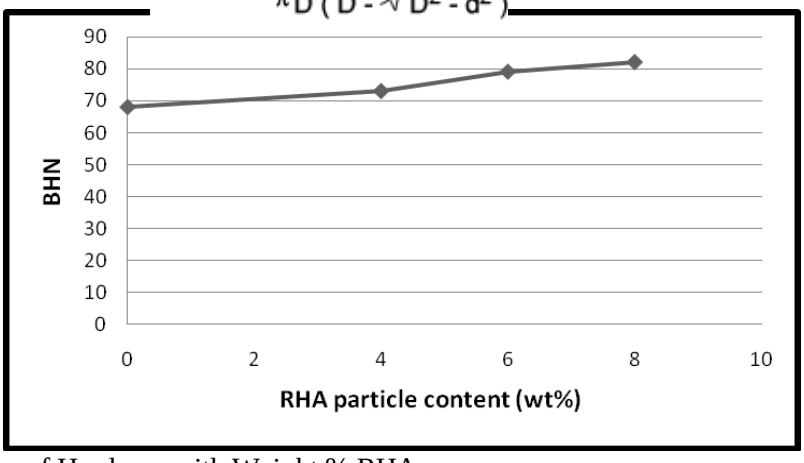


Fig4: Variation of Hardness with Weight % RHA

Mechanical Behavior:

The specimens for tensile test were prepared according to ASTM E8 standards. The tensile tests were performed on a universal material testing machine. The ultimate tensile strength obtained during tensile test is shown in Fig 6. It is found that the addition of rice husk ash has significant effect on the tensile properties. The addition of rice husk ash particles will increase the ultimate tensile strength (UTS) of the material. The addition of the rice husk ash particles increases strength mainly by the load transfer from matrix to the reinforcement due to the differences in the elastic constants. Fig 5 shows the die for tensile specimen.



Fig5: Die for Tensile Test Specimens

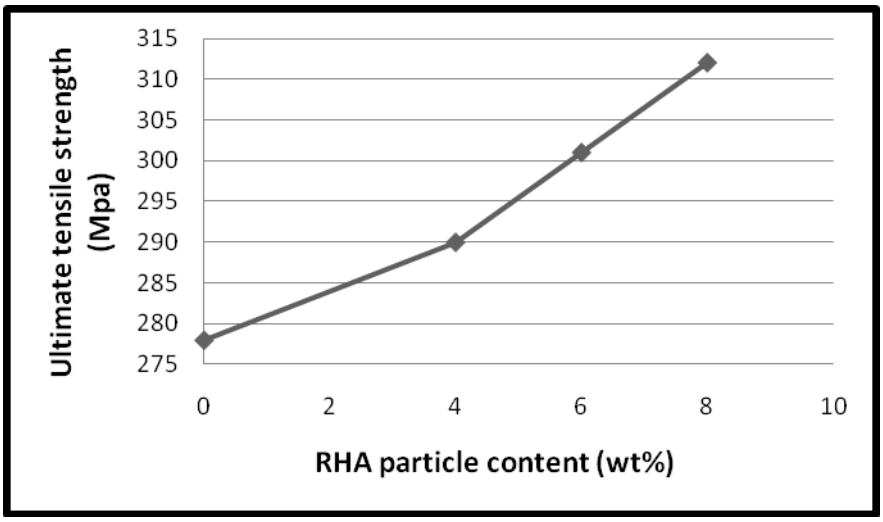


Fig6: Variation of UTS with Weight % RHA

Conclusions:

a. Using the stir casting method, rice husk ash particles were successfully added to the A356.2 alloy.
b. The homogeneous distribution of rice husk ash particles in the aluminum alloy is shown by microstructure analysis. Additionally, the microstructure showed that the rice husk ash particles were well retained in the matrix.
b. As the amount of rice husk ash increased, the density of A356.2/RHA composites decreased.

d. As the amount of rice husk ash in A356.2/RHA composites rises, so does their hardness.
e. As the amount of rice husk ash grew, so did the ultimate tensile strength.
f. Low-cost aluminum composites with increased strength and hardness may be produced by incorporating rice husk ash particles into the aluminum matrix. These composites may be used in connecting rods, cylinder liners, and pistons, among other automobile parts. These composites may also be used in situations when strong, rigid, and lightweight materials are needed.

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