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Research Paper

Influence of CDA and WC Reinforcements on Hardness Property of AMMC

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Abstract
Metal matrix composites (MMCs) provide superior properties than other materials. Because of these advantages, MMCs are widely employed in a variety of engineering applications. Metal has better properties in general, and when reinforced with certain particles, exceptional properties can be obtained. This study focuses on environmentally beneficial agricultural waste, cow dung ash, and tungsten carbide reinforced stir cast aluminium hybrid metal matrix composites. Hardness has been investigated and evaluated as a mechanical property. The hardness of hybrid composites has increased due to the addition of stiffer and stronger reinforcement in the matrix material. The matrix alloy's ability to reinforce with WC and cow dung ash can significantly increase the hardness of an aluminium hybrid composite.

Keywords*: AMMC, cow dung ash, Hardness, tungsten carbide (WC), Stir Casting*

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I. INTRODUCTION

Aluminium and alloys are commonly utilized in a variety of industrial applications due to their low weight. aluminium alloys may often increase strength by a range of methods, such as I adding insoluble reinforcing to make composites in metallic matrix [1], (ii) hardening precipitation, [2] (iii) cryogenic treatments,[3] (iv) surface coatings, etc. Metal matrix composites have been highly attentive among the techniques used to improve the mechanical and tribological properties of aluminium. A composite material is generally made up of two or more insoluble phases, the characteristics of which may be superior than those of the constituents. [4-5] In most situations, aluminium is used as a matrix material due to its low density, simplicity of manufacturing, and good technical characteristics. Solid state processing, which includes powder metallurgy, diffusion binding, and flow deposition, and fluid state processing are the two techniques used most frequently to make aluminium composites (stir casting, pressurised die casting, and in-situ processing). The most practical and cost-effective of these methods, according to research, is stir casting.

In composites made of aluminium metal, the characteristics of the matrix material (aluminium) are improved by the inclusion of a single strong reinforcement. Both continuous and discontinuous reinforcement (such as carbon fibre, SIC fibre, etc.) are possible (short fibers, whiskers and particles). One of them is aluminium matrix composites with improved particle adsorption. Aluminum casting can make use of ceramic particles such as carbides (SiC, B_4C, TiC, etc.) and oxides (Al_2O_3, MgO, $ZrSiO_4$, ZrO_2, etc.). The application of these strengthening's enhances the mechanical and tribological characteristics of the material.

Composites with hybrid aluminum metal matrix were produced to improve composite characteristics above and beyond single reinforcement. The hybrid metal matrix results in the combination of two or more synthetic ceramics in an aluminum matrix. Synthetic ceramics and industrial waste such as fly ash, graphite, red mud and other industrial waste were used to employ industrial waste with good results without compromising the composite properties. The addition of two synthetic ceramics to the matrix results in composite materials losing ductility and gaining fragilité. Surface roughness is impacted by increasing breakdown, and weight of composite materials rises as a result of the difference in particle and matrix densities. Given its usually tough character, synthetic pottery is usually utilized as abrasives for high-cost applications. One such solution is to employ agricultural waste to overcome the aforesaid drawbacks.

In order to produce a hybrid aluminium metal matrix, agricultural waste is combined with synthetic ceramics. Agricultural waste has a number of advantages, including low costs, simple access, low density, and less pollution. Bagasse ash, ground nut shell ash (GSA), bamboo leaf ash (BLA), rice husk ash (RHA), and rice husk ash are a few examples of agricultural waste (BLA). The ash from the shells of palm kernels, corn cobs, maize stalks, shelled bean waste, and other materials have all been studied. Aluminium 7075 is widely used in aerospace applications because to its high tensile strength. In addition to its high hardness, improved impact and wear resistance, low specific density, low heat conductivity, and high stiffness, tungsten carbide has a number of benefits over aluminium for strengthening.CD Aash has components such as SiO_2, Al_2O_3, Fe_2O_3, MgO, and others that may increase aluminium's properties.

The advantages of CDA integration include minimal costs, easy access, low density and low pollution. This led to efforts to enhance the CDA as the second strengthening of the matrix. Aluminum 7075 is widely known for its high tensile strength and is often utilized in the automotive and aerospace industry. In the automobile industry, alloy 7075 is used to make pistons, brake calliper's, wheels and rockers. The percentages of reinforcements vary in the current investigation, and the effects are evaluated using mechanical behaviour, such as hardness.

Table 1

E	Zn	Cu	Mn	Mg	Fe	Cr	Ti	Si	Al
W%	5.4	1.42	0.12	2.42	0.42	0.21	0.11	0.13	89.77

II. MATERIALS AND METHODS

2.1 MATERIAL SELECTION

The matrix material in this investigation was aluminum 7075 alloy. Table 1 shows the composition of Al 7075 based on Spectro analysis. As reinforcement of the investigation, natural pottery, (CDA) and WC were utilized. Raw cow dung had been gathered and dried in the sun three days in order to remove the dung cake and to make it. The cake was divided into small parts to produce ash and burned into an open-air metal drum. For two hours at 600°C in a muffle furnace, the ash was collected and burned to eliminate the carbonaceous elements included in CD ash. In the current study, CDA with a size of less than 40 microns and WC with a size of less than 10-25 m were utilized. Table 2 shows how samples are prepared with various weight percentages of reinforcements.

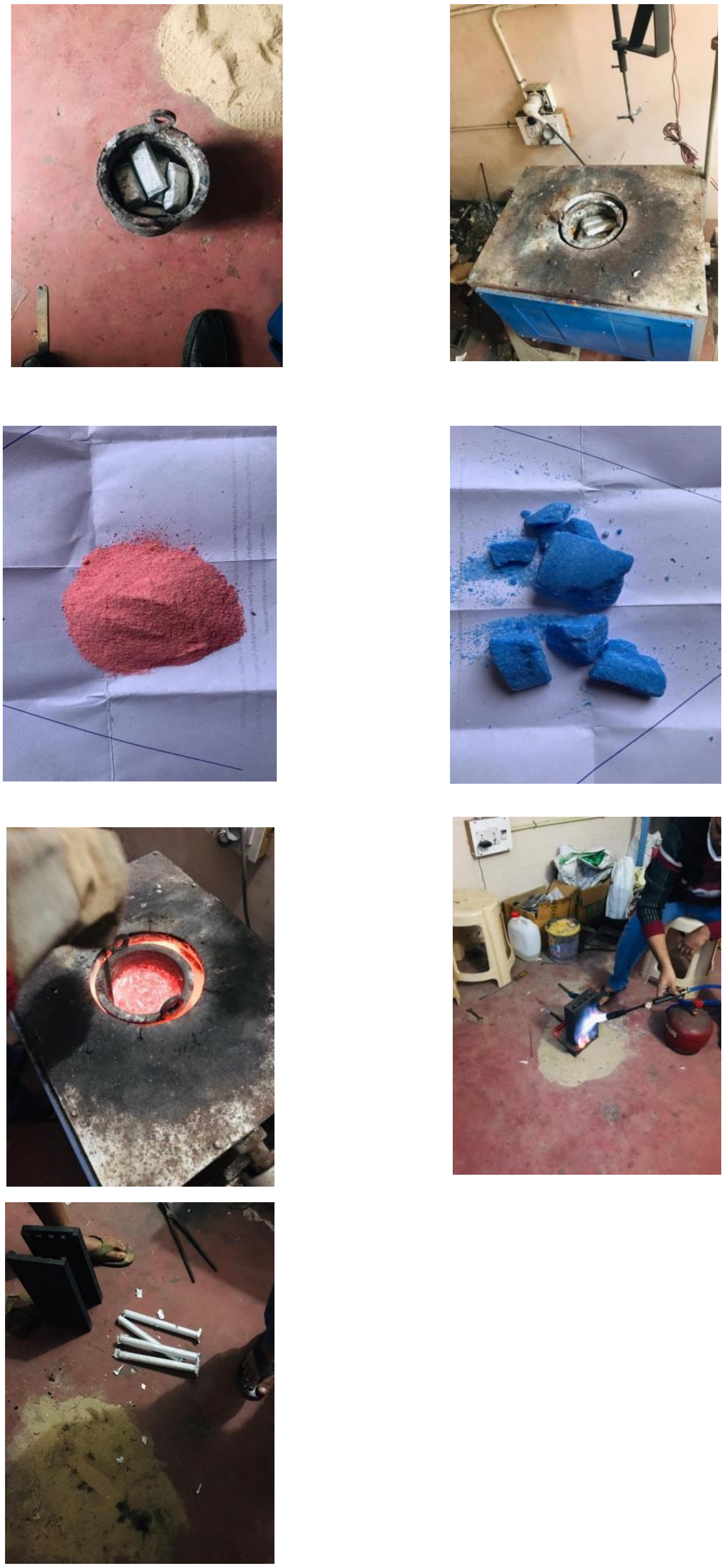
Table 2

Sample	Al7075 (wt%)	WC (wt%)	CDA (wt%)
S1	95	1.5	3.5
S2	95	2.5	2.5
S3	95	3.5	1.5

2.2 EXPERIMENTAL SETUP AND FABRICATION PROCESS

The experimental equipment has a conical graphite sink that can withstand temperatures up to [2400°C], for fusion aluminum alloy. This crumb is placed in a mouth made up of high ceramic alumina and is sprayed around by a heating element. Kanthol-A1 is the heating component of the spindle. This is known as a heating resistance oven. In 45 minutes, it may reach temperatures of 900°C. If the air oxygen contains liquid Aluminum is very reactive Trinh SNand Sastry S (2016). It generates oxidation when it arrives to the outside air. K-type sheet.

A thermocouple with a working range of -200°C to 1250°C is used to record the current temperature of the liquid. EN 24 was chosen as the stirrer shaft material due to its resistance to corrosion in the environment. With a flange connection, one end of the shaft is linked to a 0.5 HP PMDC motor. At the opposite end, the blades are joined. At 45°C, four blades are soldered to the shaft. In order to stir reinforcement such as SiC, blades are constructed of SS316. It also has a CI permanent mould for pouring molten metal. Because Al7075 is molten, warmed CDA and WC were manually added and blended. The molten composite metal was heated to 1000 °C for varying percentages of reinforcements after the manual mixing was finished. The mechanical stirrer was set at 400–500 rpm to produce a homogeneous mixture. The composite melt was poured into a rectangular stainless-steel mouth to improve solidification rate and eliminate unwanted casting difficulties. Figure 1 shows the complete stir casting process.



Figures shows the complete stir casting process

Al billets are transferred into Crucible. Crucible is placed in the electric arc furnace. Reinforcements (CDA & WC) e) Melting and Stirring of AMMC f) Heating of Permanent Mould to avoid the sudden solidification of molten composite g) Composites in the form of cylinders after solidification.

2.3. TESTING METHODOLOGY

Hardness tests, such as Brinell, Rockwell, and Vickers, are used to determine the hardness of a material. ASTM E92 is the standard for Vickers hardness, E18 is for Rockwell hardness, and E10 is for Brinell hardness testing. In this present investigation Rockwell hardness test has been carried out. Load applied was 100kg for 30s- and 1.587-mm diameter steel ball indenter. Three indentations were made at room temperature, and the mean value was calculated.

III. RESULT AND DISCUSSION

3.1 HARDNESS EVALUATION

The hardness value in composites is improved by increasing the weight % of WC reinforcement particles, since the presence of hard reinforcement particles in the matrix inhibits dislocation movement. Sample 1, which included 3.5 percent CDA particles, was harder than sample, which contained just Al7075. The hardness has risen considerably as compared to sample Al7075. The inclusion of refractory materials in the matrix may be to responsible for the matrix's decreasing hardness as the number of CDA particles has increased (SiO_2, Al_2O_3, and Fe_2O_3).

The displacement of tiny CDA particles is made easier by an increase in CDA particle concentration in the matrix, which results in sliding during indentation and a reduction in hardness. The modest change in hardness of sample S1 may be caused by the different densities of reinforced particles and the aluminium matrix. Sample S2 has an equal distribution of WC and CDA particles. In comparison to sample S1, the addition of WC decreased the flow movement of tiny CDA particles while increasing the hardness. Because sample S3 has a greater fraction of WC, resistance to plastic deformation grows during indentation, hardening the surface area by increasing the hardness of the composite material.

Rockwell hardness table 2 was shown to be resistant to indentation on the reinforcements. The average durability values for the samples S1, S2 and S3 are 24HRC, 25HRC and 35HRC.

Table 3: Rockwell hardness of composites

Composites	Rockwell Hardness (HRC)
S1	24
S2	25
S3	35

IV. CONCLUSION

- The study of Al 7075- WC-CDA reinforcement was based on the following observations.
- The hybrid composite was fabricated using the stir casting technique.
- The incorporation of CDA enhanced the hybrid composites' hardness. In comparisons samples 1 and 2, sample S3 had a maximum 31 percent increase in hardness for composites.
- The incorporation of CDA enhanced the hybrid composites' hardness. In comparisons samples 1 and 2, sample S3 had a maximum 31 percent increase in hardness for composites.
- According to the study, CDA particles can be employed as reinforcement to enhance the mechanical (i.e., hardness) characteristics of hybrid composites.

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