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FABRICATION AND PROPERTY EVALUATION OF HYBRI COMPOSITE OF Al 6061 with 2% RHA & 2% SSP

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ABSTRACT

Alloy and composite materials are both made up of a mixture of at least two components. The ceramics are expensive and environmental pollutions. To avoid this, many researchers are focusing the Argo industrial waste as hybrid composites. These are less expensive and environment free and also ductility of the matrix will reduce.

The waste particles improve the hardness of the base matrix so we are varying the weight fraction 2% rice husk ash (RHA) and 2% snail shell powder (SSP) in aluminum alloy as a base material. With this combination, the hybrid material is prepared for machining. This hybrid composite is prepared by using Argo industrial waste particles in general to improve the properties of the base material people using ceramics. The stir casting process were used in this work for the preparation of hybrid composite material.

This hybrid composite material improves Mechanical properties of the material and also Mechanical properties are evaluated to conducted two experiments tensile test, hardness test. The agenda of this hybrid material is to improve mechanical properties compare to base material.

Keywords: AHAJM, Soda lime glass, sic (abrasive particles), MRR, surface roughness

1 INTRODUCTION

Accompanying the development of the mechanical industry, the demands for composite materials having high hardness, strength, wear resistance, and corrosion resistance are increasing is one of the new materials finding a lot of scope to meet the mechanical industry's demand. Research has been carried out in MMC composites over several years, by researchers on fabrication methods and material property estimations, and many excellent research results have been obtained. All MMCs have a metal or a metallic alloy as the matrix. The reinforcement can be metallic or ceramic. There are four kinds of metal matrix composites. (1) Particulate reinforced MMCs (2) Short fiber or whisker reinforced MMCs (3) Continuous fiber or sheet reinforced MMCs
(4) Laminated or layered MMCs

In particulate MMCs, various materials are combined with one another get intended properties. The obtained properties are different from those of the base materials. Such composite materials make this concept true, and reinforcement in a matrix of this material contributes to the enhancement of the properties. But, neither the matrix nor the reinforcement by itself, but only the MMC can fulfill the requirements. The application of particulate MMCs is unlimited in the field of aerospace, defense, transportation, recreation, sports, and numerous other commercial and consumer products. Particulate reinforced MMCs have special importance because of the following reasons.

- Particulate reinforced composites are inexpensive. Cost is an important and essential item for large volume usage.
- Processing by casting or powder metallurgy, followed by conventional secondary processing by rolling, forging, and extrusion can be used.
- Higher temperatures are possible than with the unreinforced metal.
- Enhanced modulus and strength
- Increased thermal stability
- Better wear resistance
Relative isotropic properties compared to those of the fiber reinforced composites

1.1 Machining of Composites

Particulate metal-matrix composites are of particular interest, since they exhibit higher ductility and lower anisotropy than fiber reinforced MMCs. While many engineering components made from particulate metal matrix composites are produced by the near net shape forming and casting processes, they frequently require machining to achieve the desired dimensions and surface finish. The machining of particulate metal-matrix composites presents a significant challenge, since a number of reinforcement materials are significantly harder than the commonly used high-speed steel (HSS) and carbide tools; the reinforcement phase causes rapid abrasive tool wear, and therefore, the widespread usage of particulate metal- matrix composites is significantly impeded by their poor machine ability and high machining costs. It becomes important that certain issues are addressed in order to increase the usage of MMCs in different engineering as well as recreational industries. The inherent abrasiveness of the ceramic reinforcement causes severe tool wear during the cutting of MMCs, thus resulting in high tool and machining costs. The premature failure of the cutting tool leads to frequent tool changes, and hence, increased production time and cost. During the machining of MMCs, the reinforcement particles are fractured by the cutting tool and pulled out of the matrix. This mechanism of particle pulls out results in severe sub-surface damage and micro crack propagation, which affects the fatigue and creep performance of the machined component, when put into service. The engineering usage of this material can be increased only if the problems encountered during the secondary and tertiary processing stages can be solved.

Stir casting is a type of casting process in which a mechanical stirrer is introduced to form vortex to mix reinforcement in the matrix material. It is a suitable process for production of metal matrix composites due to its cost effectiveness, applicability to mass production, simplicity, almost net shaping and easier control of composite structure. Stir casting setup as, consist of a furnace, reinforcement feeder and mechanical stirrer. The furnace is used to heating and melting of the materials. The bottom poring furnace is more suitable for the stir casting as after stirring of the mixed slurry instant poring is required to avoid the settling of the solid particles in the bottom the crucible. The mechanical stirrer is used to form the vortex which leads the mixing of the reinforcement material which is introduced in the melt. Stirrer consists of the stirring rod and the impeller blade. The impeller blade may be of, various geometry and various number of blades. Flat blades with three numbers are the preferred as it leads to axial flow pattern in the crucible with less power consumption. This stirrer is connected to the variable speed motors, the rotation speed of the stirrer is controlled by the regulator attached with the motor. Further, the feeder is attached with the furnace and used to feed the reinforcement powder in the melt. A permanent mold, sand mold or the vortex, the stirring process is continued for certain time period after complete feeding of reinforcements particles.

The molten mixture is then poured in preheated mold and kept for natural cooling and solidification. Further, post casting process such as heat treatment, machining, testing, inspection etc. has been done. There is various impeller blade geometry are available. Melting of the matrix material is very first step that has been done during this process.

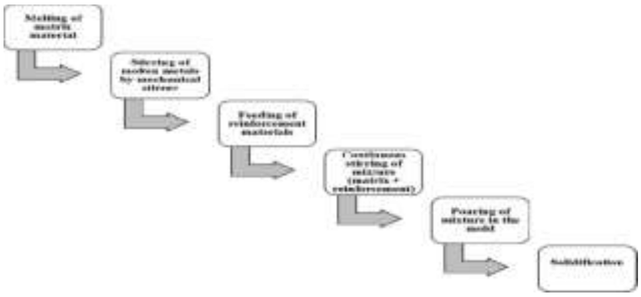

Fig – 1 Process of stir casting

AMCs and HAMCs are used in wide range applications such as automobile applications aerospace applications, electronics applications and sports applications due to its attractive properties. In automobiles applications, these are mainly used in engines, suspension system, driveline, housing and bakes. Whereas in aerospace applications jet engine blade, satellite solar reflector and missile fins are their main application.

AMCs and HAMC sin various industries i.e. automobile, aerospace, military, electronics and sports applications. The applications of the Aluminum matrix composites and the hybrid aluminum matrix composites are in various types of industries such as automobile industries, aerospace industries, electronic industries, sports and aerospace and military industries. It is mainly used in the engines of the automobiles and aerospace. It is also used in the brakes and driveline as in disk brake rotors and propeller shaft.

2. Literature Review

The purpose of this literature review is to provide background information on the issues to be considered in this thesis and to emphasize the relevance of the present study. This dissertation embraces various aspects of aluminum composites with a special reference to their mechanical, wear, and machining characteristics. This chapter includes reviews of available research reports:

- Aluminum MMCs
- Machining of Aluminum MMCs
- Modeling and Optimization Techniques

2.1 Aluminium Metal Matrix Composites

The use of aluminum alloy is inevitable in aerospace and automobile industries owing to its properties of high strength to weight ratio, exceptional corrosion resistance, easy machine ability and low cost (Singh et al2001). But problems associated with aluminum and its alloy material *is* poor high temperature performance and low wear resistant.Engineering materials have been developed by reinforcing hard reinforcement material on soft aluminum matrix is called aluminum metal matrix composites (Pedersen and Romulo 2006).

Nowadays aluminum metal matrix composite materials is one of the widely known composites because of their superior properties such as high strength, hardness, stiffness, wear and, corrosion resistance (Ozben et al2008). The high thermal conductivity, improved wear resistance, and low coefficients of thermal expansion of these materials have led to a number of applications (Bekar et al 2008) such as stator vanes, annulus filler, fan, valve assembly, sliding contacts, cylinder liners, and automobile pistons (Suresh Babu etc al 2010). The thrust for finding the new processing and estimation method is increased substantially by the researchers. Because, there is widespread application of particulate aluminum metal matrix composites in various industries (To sun 2010).

(Abdullah Mohammed Usman et al) studied to produce and analyze the properties of Aluminum Alloy -Rice Husk Ash composites. Rice husk ash (RHA) with high silica content of up to 97.095% was used for the study with the RHA varied from 0vol% – 30vol% at intervals of 5vol% in the aluminum alloy as reinforcement. The density and some mechanical properties of the composites including tensile strength, impact strength, hardness and fatigue strength were investigated. The results showed that the density of the composite decreases with the percentage increase of reinforcement from 2840.242 kgm-3 for the control sample to 2402.899 kgm-3 for 30vol% RHA. The Ultimate Tensile Strength (UTS) varies from 164.374 MNm-2 at 0% RHA to 176.837 MNm-2 with maximum value at 10% RHA, impact strength values vary from 84.020kJm-2 at 0% RHA to 155.244 kJm-2 with maximum value at 10% RHA, hardness value varies from 70.467 RHV at 0% RHA to 109.367 RHV with maximum value at 25% RHA and fatigue strength varies from 0.224x106 cycles to 2.582x106 cycles with maximum cycle at 20% RHA. The results of analysis of variance showed that there are significant differences among the means of each property of the composites at different levels of replacement of the ash addition (P<0.05).

(Dwivedi et al) This study was carried out to produce and analyze the properties of Aluminum Alloy-Rice Husk Ash composites. Rice husk ash (RHA) with high silica content of up to 97.095% was used for the study with the RHA varied from 0vol% – 30vol% at intervals of 5vol% in the aluminum alloy as reinforcement. The density and some mechanical properties of the composites including tensile strength, impact strength, hardness and fatigue strength were investigated. The results showed that the density of the composite decreases with the percentage increase of reinforcement from 2840.242 kgm-3 for the control sample to 2402.899 kgm-3 for 30vol% RHA. The Ultimate Tensile Strength (UTS) varies from 164.374 MNm-2 at 0% RHA to 176.837 MNm-2 with maximum value at 10% RHA, impact strength values vary from 84.020kJm-2 at 0% RHA to 155.244 kJm-2 with maximum value at 10% RHA, hardness value varies from 70.467 RHV at 0% RHA to 109.367 RHV with maximum value at 25% RHA and fatigue strength varies from 0.224x106 cycles to 2.582x106 cycles with maximum cycle at 20% RHA. The results of analysis of variance showed that there are significant

(Siva Prasad et al) Good retention of the reinforcement in the aluminum alloy can be seen. The hardness of A356.2/RHA composites increases with an increase in rice husk ash content. The wear rate decreases with the increase in weight percentage of the RHA particles. Friction coefficient of A356.2 alloy decreases with increasing RHA particles content. However, 8%RHA reinforced composites show an increase in the friction coefficient at higher loads of 39.22N and 49.03N, because poor interfacial bonding between the reinforcement and the matrix alloy causes particle transferring from the matrix to the steel disc inter face, which leads to an increase in the friction coefficient. The size of the wear debris decreases with the increase in weight fraction of the reinforcement.

(Mohadeseh Seddighi et al) Rice husk ash was used as a silica support for the synthesis of anatase-phase titanium nano particles and a RHA/TiO2 material and also the tensile behavior of the composite. The result of this is increase in interfacial area between the matrix material and the RHA particles leading to increase in strength appreciably. It was found that tensile strength, compression strength and hardness increase with the increase in the weight fractions of rice husk ash and decreases with increase in particle size of the rice husk ash. The ductility of the composite decreases with increase in the weight fraction of reinforcement and also decreases with increase in its particle size. The enhancement in the mechanical properties can be well attributed to the high dislocation density. However, for composites with more than 12 wt % of RHA particles exhibits poor wet ability.

(Nishant Verma et al) This paper investigates the mechanical behavior of AA 7075-B4C -Rice Husk Ash (RHA) hybrid composite. The samples AA 7075 and 5 wt% of B4C along with 3, 5wt% of RHA are prepared by using the Stir Casting technique. The Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) analysis are used to characterize the prepared AA7075 hybrid composite. The mechanical behaviors hardness tensile and compression are tested using their ASM standards. The fractured samples are studied using SEM. The data obtained from various test are quantitative. The hardness is higher for AA 7075-5 B4C-5RHA. The highest hardness is 121 HV at 5 wt% of B4C and 5 wt% of RHA. The highest tensile strength is 260 MPa at 5 wt% of B4C. The highest compression strength is 563 MPa at 5 wt% of B4C and 5 wt% of RHA in hybrid composite. The obtained data are analyzed on Design Expert version V.10 using two levels factorial design. The regression equations obtained from the software is validated using diagnosis plots and the optimized values of reinforcements are obtained using the desirability analysis.

Based on the review of literature the gaps in the current research are identified are the mechanical wear, and corrosion characteristics of particulate reinforced aluminum MMCs. However, a possibility of incorporating the solid industrial wastes as reinforcement in aluminum composites has rarely been reported. However, a number of avenues are being

implemented for utilization and disposal of solid industrial wastes there is only limited report available in the existing literature on the use of in aluminum MMCs.

3. Methodology

3.1 Rice Husk Ash (RHA): -

Rice husk is washed with water to remove the dust particles and clay if any and dried at room temperature for 1 day. To remove the moisture and organic matter, rice husk is placed inside muffle furnace for 1 hr at a temperature of 210°C. During this operation, the color of husk changed from yellowish to black (fig b) because of the charring of organic matter. RHA particles are then sieved (fig c) through 100 μm sieve, ball milled this powder to get fine grains (fig d) and then heated to a temperature of 650 °C for 24 h to remove any carbonaceous matter (fig: e). Among the projected techniques, this is an easy way for extraction of silica from RHA. At this stage ash changes from black to grayish white color. Subsequently, the collected ash is ball milled for 16 hr. The different stages of rice husk to RHA are shown in Fig. a–e.

Fig 3.1: Different Types of Rice Husks

3.2 Snail Shell Powder (SSP): -

Step 1: collection of SSP from the sea shore

Step 2: By using ball milling method, the snail is making
into small pieces for a long period.

Fig 3.2: Collection of Snail Shells from Sea

3.3 Aluminum 6061: -

The 6061 alloy is primarily composed of aluminum, magnesium and silicon. Its other metallic elements include iron, copper, chromium, zinc, manganese and titanium, in descending order of quantity. Alloy 6061 set the standard for a medium-to-high strength, lightweight, economical material. Earlier alloys had been susceptible to stress-corrosion cracking, but the addition of a small amount of Chromium made this alloy highly resistant ant corrosion. 6061 aluminum properties include its structural strength and toughness, its good surface finish, its good corrosion resistance to atmosphere and sea water, its machinability and its ability to be easily welded and joined.

Most other aluminum alloys are difficult to weld due to their chemical composition and lack of conductivity. While welded 6061 aluminum alloy materials may lose some strength, they can be re-heat-treated and artificially aged again to restore strength, making this one of the superior alloys.

Procurement of materials is Al alloy 7 Kg of ALLUMINIUM 6061 Preparation of RHA & SSP by Ball milling method. Al 6061 with 2% RHA & 2% SSP, hybrid material is prepared by using stir casting machine. Tensile test and hardness test. Preparations of test specimens are as per ASTM Standard to check mechanical properties.

4 Fabrication of Composites by Stir Casting: -

Stir casting is a liquid state method for the fabrication of composite materials, in which a dispersed phase is mixed with a molten matrix metal by means of mechanical stirring.

Stir Casting is the simplest and the most cost-effective method of liquid state fabrication.

Fig 4.1: Stir Casting Machine

Specifications: -

- 250kVA power
- 300kg capacity
- 1000rpm high frequency induction based ultrasonic stirring

- Frequency: 600 cycles per second
- Crucible used: 10kg

Fig 4.2: Fabrication of material in different stages

Fig 4.3: Casting Pieces

5.Physical and Mechanical Properties

An investigation of the mechanical properties of the composites is made to ascertain the effect of the addition of red mud reinforcement to the aluminum matrix material. This investigation is made for all the composites fabricated by the stir casting and powder metallurgy processes.

TABLE 5.1: Hardness Sample collection

S.No	LOCATION	SAMPLE 1	SAMPLE 2	SAMPLE 3	AVG
1	AL 6061+ 2%SSP 2%RHA	47.5	47.1	47.5	47. 37
2	AL 6061	40.2	40.2	40.5	40.3

Hardness: - Hardness is defined as the resistance offered by the material to surface indentation. It is the function of the stress required to produce some specific types of surface deformation. The hardness of the fabricated samples made by the stir casting and powder metallurgy processes is measured, using Rockwell cum brittle hardness machine with a load of 250kgf. The load is applied for 30 seconds. In order to eliminate a possible segregation effect, a minimum of five hardness readings are taken for each specimen at different locations of the test samples.

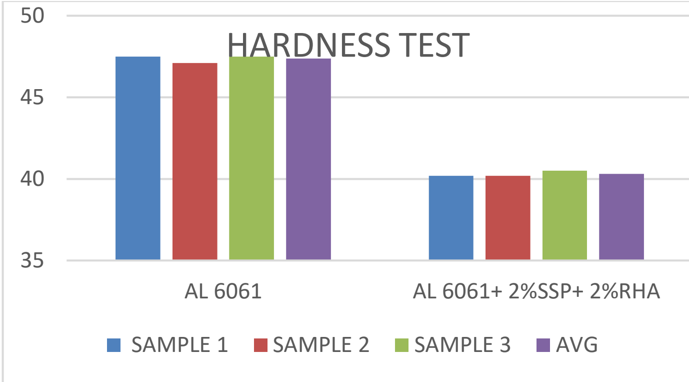

Fig 5.1: Hardness test graph

Fig 5.2: after testing the hardness to the work pieces

The Tensile Test Process: -Material strength testing, using the tensile or tension test method, involves applying an ever- increasing load to a test sample up to the point of failure. The process creates a stress/strain curve showing how the material reacts throughout the tensile test. The data generated during tensile testing is used to determine mechanical properties of materials and provides the following quantitative measurements.

- Tensile strength, also known as Ultimate Tensile Strength (UTS), is the maximum tensile stress carried by the specimen, defined as the maximum load divided by the original cross-sectional area of the test sample
- Yield strength is the stress at which time permanent (plastic) deformation or yielding is observed to begin
- Ductility measurements are typically elongation, defined as the strain at, or after, the point of fracture, and reduction of area after the fracture of the test sample.

Test Methods/Specifications:

- ASTM A370
- ASTM B557 (Chosen for this current work)

	AL 6061 +2% RHA and 2% of SSP	AL 6061 pure
ultimate load (KN)	13.08	11.080
ultimate tensile strength (N/mm2)	100.701	83.990
Elongation %	8.8	5.54
yield load (KN)	8.84	7.960
yield stress (N/mm2)	68.0	60.340

- ASTM D638
- ASTM E8
- ASTM E21
- EN 2002-1
- EN 10002-1
- ISO 527-1
- ISO 6892-1

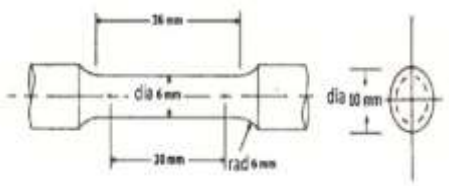

Fig 5.3: ASTM B557 M-02a sub-size specimens used for tensile tests

Fig 5.4: After tensile test
Table 5.2: Tensile Test Result

6. Results and Discussions

This project was carried out to produce and analyze the properties of Aluminum Alloy-Rice Husk Ash and snail shell powder composites. Rice husk ash (RHA) with high silica content of up to 97% was used for the study with the RHA varied with 2% and 2% of SSP. RHA &SSP are prepared with ball milling process to get micron size and mixed with AL 6061 in the casting process

The following results are obtained from the experimentation

- Rice husk ash can is successfully incorporated into aluminum alloy as reinforcement at a temperature of 800°C.
- . Incorporating rice husk ash into the aluminum alloy improves its mechanical properties
- The maximum ultimate tensile strength of Al 6061+ 2% RHA and 2% of SSP is 100.701 MPa and for aluminum is 83.990 MPa.
- The maximum yield stress of Al 6061+ 2% RHA and 2% of SSP is 68.058 MPa and for aluminum is 60.34 MPa.
- The elongation for Al 6061+ 2% RHA and 2% of SSP is 8.8 and for aluminum are 5.54.
- The maximum hardness of Al-2% RHA and 2% of SSP is more when compared with pure aluminum.

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