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Journal of Analytical Research

Vol 3 Issue 2, Jul-Dec 2023
www.rsya.org/jar

ISSN: 2584-0037

To Investigate Mechanical Properties of Al-based Composite Reinforced with Waste Product

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Abstract: *An aluminium metal matrix composite, or AMMC, is most often used in a wide range of industrial settings, such as the aerospace, automotive, marine, sports, and many more. SiC, aluminium oxides, MnO, graphene, and carbon nano tubes are the most important reinforcing parts for making AMMC because they are used so often in real life. In this research author make AMMCs stronger by adding Silicon carbide (SiC) and alumina to them (Al2O3). It is possible to make AMMC through a process called stir casting. In the past few years, there has been more focus on making AMMCs with agro waste as reinforcing materials. Among these kinds of waste are rice husk and/or SiC. After this method of melting and churning the Al-matrix material very quickly, strengthening material is added to one side of the vortex to make a sphere-shaped structure. Stir casting, a process that involves a violent and whirling motion, can be used to make the AMMCs. The furnace is first used to melt the aluminium alloy (AA3105) when it is almost solid. Hot 260 degrees Celsius and 220 degrees Celsius are applied to the reinforcing materials, which are also known as SiC and Alumina (Al2O3). It was found by AMMC that adding 4.75 weight percent of each type of reinforcement increased the tensile strength and hardness of the material by 22.41 percent and 45.5 percent, respectively (SiC, Al2O3, and 1 percent Cr). When a composite material with 1% Cr, 4.75 wt% SiC, and 4.75 wt% Al2O3 is used.*

Keywords: *About Silicon carbide (SiC), Tensile strength, Alumina, Hardness, Stir casting process.*

INTRODUCTION

The All countries have to deal with pollution, which is a big problem. Most of the time, industries are to blame for messing up the natural order of pollution cycles. Silicon carbide (SiC)s and alumina (Al2O3) are two types of waste that industries make. If these wastes are not treated or let to break down, they could hurt the environment and make people sick. The best way to get rid of these wastes is to recycle them; they need to be properly handled right now. A lot of new technologies, like those in the military, space travel, and cars, need better hybrid materials. These industries all have access to advanced science and technology [1-3]. Scientists and other experts are very worried about pollution, which is spreading around the world at a very fast rate [4-6]. The problem of pollution has motivated scientists all over the world to find ways to cut down on pollution without changing the way people live. Industrial waste is a major cause of pollution in the air, water, and even on land [7–9]. This needs to be fixed right away, and limiting output or making industries follow certain rules would not help with pollution in today's high-tech world where businesses and governments are fiercely competing [10, 11]. Recycling can be a good alternative way to deal with waste from businesses in this area [12–14]. Many countries, even new ones like India, are working hard to reach this goal by telling scientists and researchers to use more and more recycled materials [15–17]. Recycling trash has a lot of benefits, such as lowering pollution, protecting natural resources that are limited but replenishing quickly, and, of course, lower costs [18–19]. Putting these wastes to use could help solve some environmental problems. Researchers have made a prototype of a functionally graded material (FGM) and tested its mechanical properties against industry standards. They have also suggested other combinations of materials that could be used in the prototype [20]. The aspect ratio of the graded index is linked to the elastic speed. To get the best disc output, you need to specify sigmoid functionally graded material before any processing or grading. Dissolution and temperature tests were used to check the sensitivity and stability of 9 percent chrome steels [22–23]. The heat-affected zone was looked at while P91B steel was being tempered and normalised. A lot of scientists have tried making green composites out of industrial waste that comes from farming waste. The main goals of this programme are to improve the mechanical properties of the base material and cut down on pollution [24]. Using modified Silicon carbide (SiC) [25], different methods have been used to remove phosphorus from aluminium. These include thermodynamics, kinetics, adsorption, and diffusion. Use of waste materials like SiC and Alumina (Al2O3), which are both high in calcium carbonate, can make materials harder and stronger when pulled apart. SiC was only recently added to the base metal, and it happens all the time that the egg shell is undervalued. This work clearly shows that studying and improving the mechanical properties of base metals is something that hasn't been done before. Materials that strengthen In this study, alumina and SiC were used to make composite materials made of aluminium. In situations where the densities of carbonised SiC powder do not coincide, the mechanical characteristics of the material deteriorate. We used a ball mill to combine carbonised SiC particles with alumina (Al2O3), and the process took us seventy-five hours. However, when waste materials such as zeolite, fly ash, and coconut shell were utilised in the production of an aluminium metal matrix composite (AMMC), it was discovered that these components were extremely uncommon. It has proven possible to manufacture AMMC by employing SiC or alumina (Al2O3) as a reinforcement. For the purpose of this investigation, the primary and secondary strengthening agents that were utilised were 1% Cr and SiC or Alumina (Al2O3), among other substances.

REINFORCEMENT COMPOSITION

Silicon carbide (SiC)

Waste from factories in the shape of an egg with a hard shell. The main thing that makes it up is calcium carbonate (SiO2). There is a calcium ion in the SiC. The rest is made up of protein and many different minerals. SiC now contains most of the SiO2 that was there before. In SiC, it's possible to get to in about 90% of cases. Table 1 shows how the chemicals are broken down. Because SiC is so easy to get, it shouldn't be used for business purposes. Because SiC has a high compressive strength, polyamide is suggested for the right way to affect electricity. Silica (SiO2) and carbon (C) are mixed in an electric resistance furnace at temperatures around 2,500 degrees Celsius to make a basic form of silicon carbide. When it comes to making SiC crude, Washington Mills uses not one but two separate methods: the well-known Acheson method and the massive furnace technology.

Alumina (Al2O3)

Alumina, which is also called aluminium oxide, is a crystalline substance that is white or almost colourless. It is used as a starting material to melt aluminium metal. Alumina is made in a lab, and its chemical formula is Al2O3, which stands for aluminium oxide. Reinforcement particles are ground into fine powder using a ball mill The development of a hybrid metal matrix composite material that incorporates two or more reinforcing particles is always a difficult task. During the stirring process, a lack of consistency in the density of reinforcing particles caused a number of issues. In some cases, the reinforcement particles were floating, while in other cases, the reinforcement particles had settled to the ground. Fortunately, the ball-milling process may alleviate some of these problems. A single entity powder was obtained from the ball-milling of carbonised SiC powder and Alumina in this work. Up to 75 hours of ball milling were used.

Development of composite material

As can be seen in Figure 1, the AMMC development procedure is based on the stir casting technique. In this case, it was AA 3105 that was used as the matrix material. Ball-milled carbonised SiC particles and Alumina were synthesised as a single entity at 220°C before being combined into the matrix material. There was a muffle furnace used to melt down the AA3105. When the matrix reached 690°C, reinforcement particles were added. Using the universal testing machine's mushy zone and a squeezing pressure of 60 MPa, the porosity and uneven distribution of reinforcing particles were reduced. Even yet, a little quantity of Cr particles (1 Wt. percent) was included into all composite materials. A new composite material having a composition that combines. Tests were done on 25 samples of the composite to see its toughness, ductility, and hardness, using different amounts of SiC and Alumina.

Fabrication the specimen and testing

Microstructure, tensile strength, and hardness were all checked on each of the newly made composites (measured in millimetres, not decimal points). ASTM A370 says that the tensile strength should be 10x10x55mm^3 and there should be a 45° V-notch in the middle of the 2mm depth. For the tensile samples, author used materials that were at room temperature. To get the tensile samples, ASTM B557 was used (test methods for tension testing wrought and cast aluminium and magnesium-alloy products). To make my test sample, author used gauge 36 mm long and 6 mm wide. A computerised universal testing system is used to test the tensile strength of composite samples. It was used to test the hardness of composite materials. A picture of the microstructure was made with an optical microscope. The metallographic properties of composite materials were found using Test Method-ASM-9–2009.

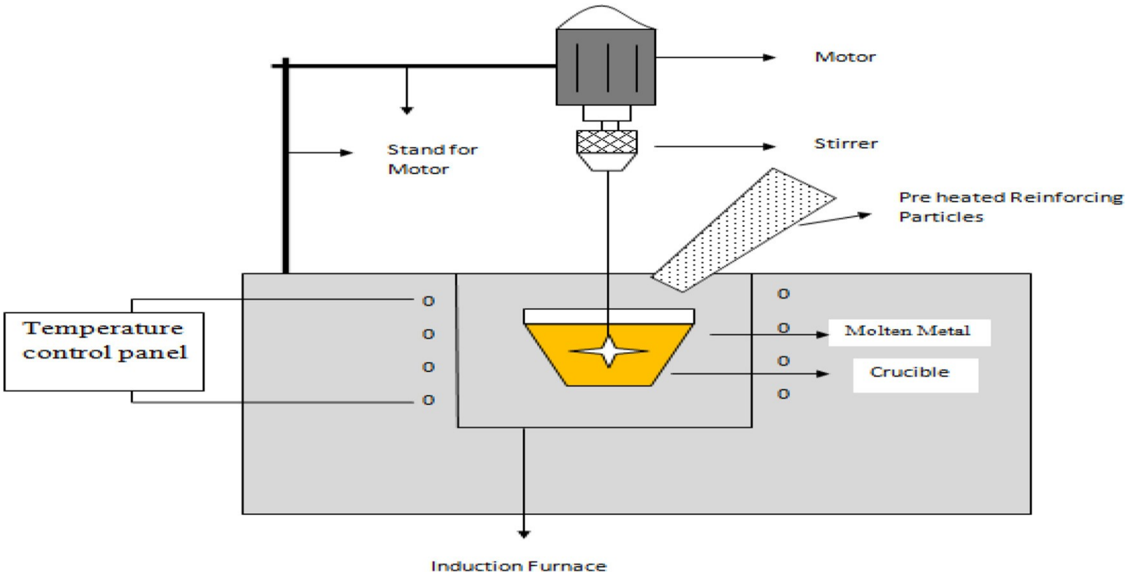

Figure 1 Stir casting set up

RESULTS AND DISCUSSIONS

Microstructure of Composite

The microscopic structure of the composite material is shown in Figure 2. Alumina and SiC reinforcement particles were mixed with the Alumina and SiC single entity that had already been made. Because they have different densities, the Alumina and SiC reinforcing particles will not be spread out evenly if they are not ball milled. It is easier to spread these milled reinforced particles throughout the composite when you use a ball mill.

Tensile Strength of Composite

The tensile strength did not change when Alumina and SiC were the only additives used in AA. By adding carbonated SiC powder to the mixture, the tensile strength may be raised by a large amount. Also, when the Alumina and SiC powders were melted together, the tensile strength went up. The tensile strength, on the other hand, did not get better enough because the reinforcing particles were not evenly distributed. The tensile strength of a dogbone specimen made according to the ASTM standard is shown in Figure 3. The combined tensile strength of reinforcing particles filled with ball milling steadily rises as the number of these particles rises. It was found that 181.85 MPa is the best tensile strength for reinforced composite ball milling.

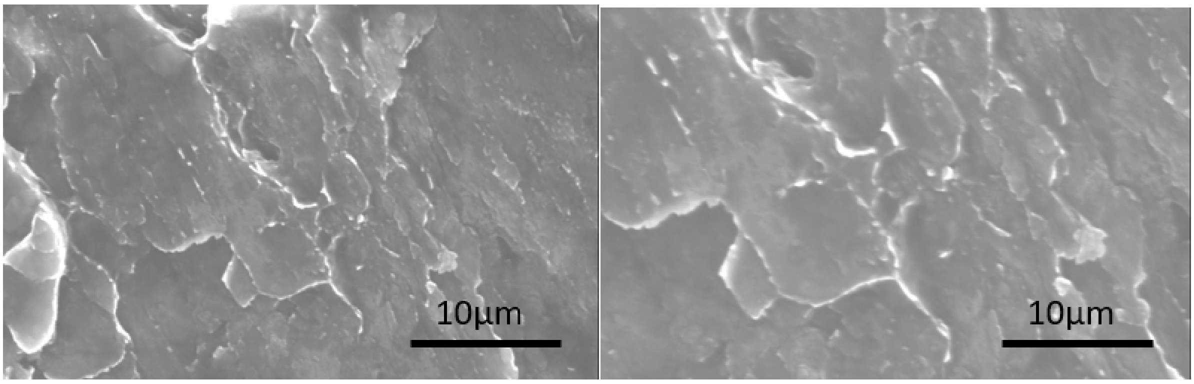

Figure 2 Microstructure of the AMMC composite

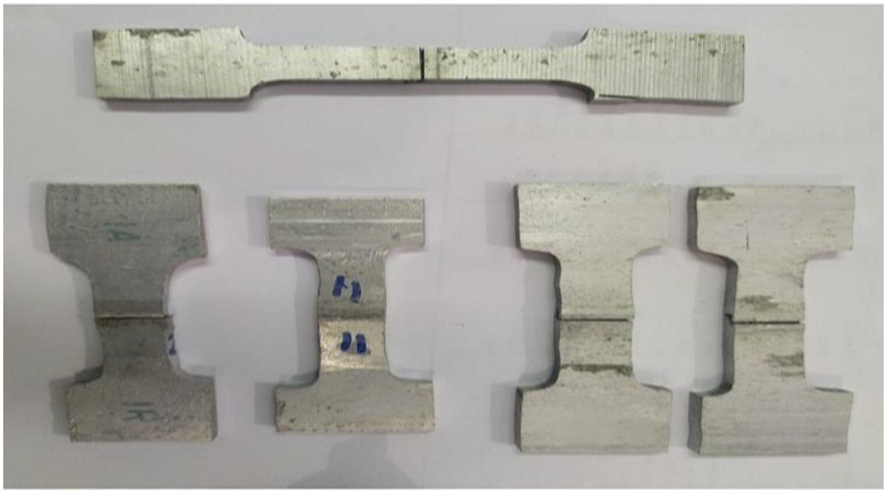

Figure 3 Dogbone shape of AMMC

Table 1: Different types of ball mills

Variables	Attritors	Vibratory ball mills	Planetary ball mills	Roller mills
Shock frequency (Hz)	>900	10–230	5.5–110	0–2.8
Kinetic energy (10^{23}J/hit)	<15	150	0.5–860	0–180
Ball velocity (m/s)	4.6–5.3	≤4.2	0.26–12.24	<8
Ball weight powder ratio	<0.004	0.005-0.28	0–1.663	0–0.2

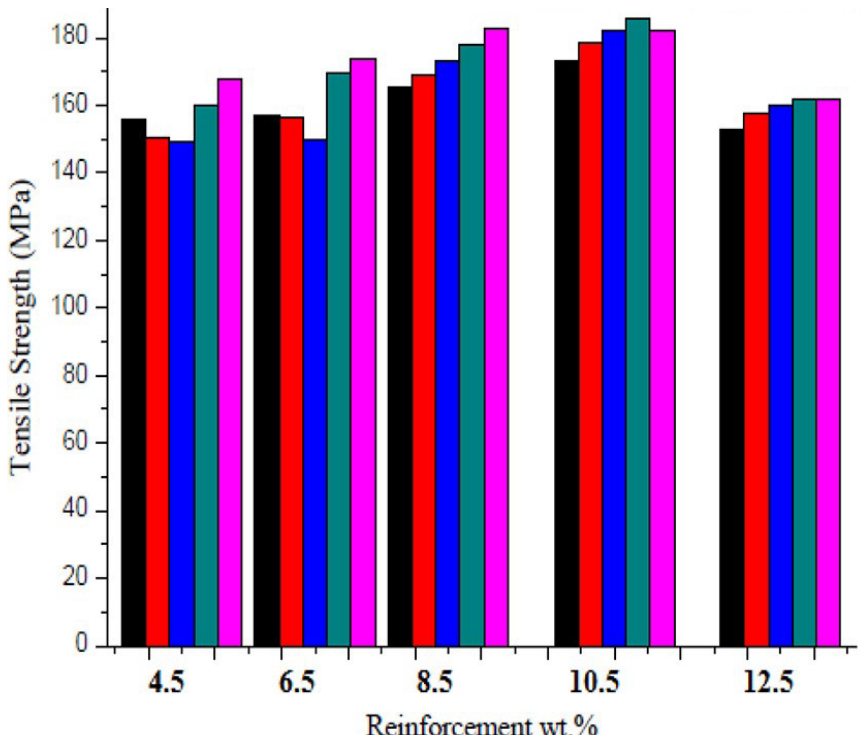

Fig 4 Tensile strength of Al-composite prepared

With 1% Cr, Alumina powder, and carbonated SiC powder, you can make a great heat treatment product. The tensile strength of ball-milled reinforced composite is 22.41 percent higher than the tensile strength of AA3105 after reinforcement, which is about 150 MPa. Figure 4 shows the tensile strength of an Al-composite made from SiC and Alumina.

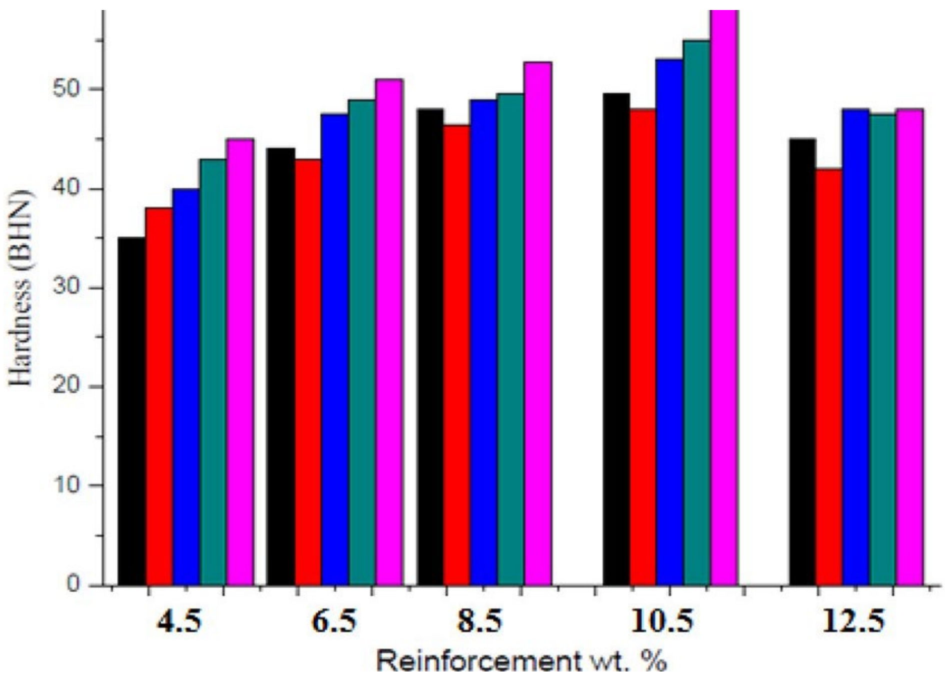

Figure 5: Hardness Analysis of Al-composite prepared

Analysis of hardness

Al-based metal matrix composites are now tougher thanks to carbonised Alumina and SiC powders. The ball-milling process did not change how hard the reinforcing particles were. It has been shown that adding SiC powder and better Alumina particles to a certain substance can make ball combinations work better. This is the case, as shown in Figure 5. Alumina and SiC reinforcements made up 4.75 percent of the aluminium alloy, and 1 percent Cr gave it a hardness of 48.5 BHN before it was heated. The hardness goes up a lot after temperature treatment. A mix of Al, 4.75 percent carbonated SiC powder, 4.75 percent Alumina, and 1 percent Cr was heated and found to have a hardness of 56 BHN. Particles of carbonised SiC can be used to make an aluminium composite material stronger and harder. It is 45.21 percent harder than the base metal, which means that the ball-milled enhanced composite is tougher than pure metal.

CONCLUSIONS

In Conclusion Al-based metal matrix composites have achieved increased toughness due to the incorporation of carbonized alumina and SiC powders. Although the ball-milling process didn't alter the hardness of the reinforcing particles, it facilitated better dispersion. Adding SiC powder and improved alumina particles enhanced composite performance, evident in Figure 5. With 4.75 percent alumina and SiC reinforcements, along with 1 percent Cr, the hardness measured 48.5 BHN pre-heating, rising to 56 BHN post-treatment. Carbonized SiC particles notably strengthen the composite, making it 45.21 percent harder than the base metal. While tensile strength remained unchanged with alumina and SiC alone, the addition of carbonized SiC powder significantly boosted it. Similarly, melting alumina and SiC powders together improved tensile strength. However, uneven distribution of reinforcing particles limited the improvement. Dogbone specimen testing, depicted in Figure 3, revealed steadily rising tensile strength with increasing reinforcing particles through ball milling, peaking at 181.85 MPa. The microscopic structure in Figure 2 shows effective dispersion of alumina and SiC reinforcement particles achieved through ball milling, crucial for uniform distribution due to differing densities.

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