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To Determine the Mechanical Properties of Aluminum 6061 Reinforced with Silicon Carbide

Gaganjot Singh Sidhu[1], Mohit singla[2], Shubham[3] and Gyanendra Bagri[4]

E-mail: [1]gagan.sidhu0321@gmail.com, [2]itsmohitsingla@gmail.com, [3]kangrahimachali1109@gmail.com, [4]gpbagri@gmail.com

Abstract—*The purpose of this work is to study the properties of the aluminum and silicon carbide and their application are studied in various industries such as aerospace and automobile industry because of its high strength to weight ratio and also need not mention high temperature resistance. Although there are numerous challenges to any new development and mmc is no exception to this, the one of the biggest challenge is to attain the uniform composition throughout material as it affects not only properties but also quality of the composite material.*

To achieve the required properties the matrix of aluminium and silicon carbide was formed with the help of stir casting and then further experiments were carried out on the al-sic composite. Experiments have been conducted by varying the weight fraction of Sic (19%, 21% and 23%), keeping all other parameters constant. The results would be evaluated by conducting tests in the laboratory. The tensile strength and hardness both are increased with rising of reinforced weight fraction. Different mechanical tests were conducted and presented by varying the particle size and weight fractions of silicon carbide.

Keywords*: aluminium, silicon carbide, stir casting, mmc's*

1. INTRODUCTION

A composite material is a material which consist of two or more physically and chemically distinct phases. The composite so obtained has superior characteristics than compared with individual components. When the matrix is a metal, the composite is termed a metal matrix composite (MMC), and the reinforcement usually takes the form of particles, whiskers, short fibers, or continuous fibers.

Composites materials are having high stiffness and strength, with low density, high temperature stability, high electrical and thermal conductivity, corrosion resistance, improved wear resistance etc. The Aluminun matrix holds the reinforcement to derive the desired shape and the reinforcement improves the mechanical properties of the composite produced. So, when properly designed, the matrix exhibits better properties compared to each individual material.

Classified of composites can be done in different ways based on the geometry of reinforcement as it is responsible for the mechanical properties and high performance of the composites. The two broad classes of composites are (1) Particulate composites and (2) fibrous composites.

The unique thermal properties of aluminium composites such as metallic conductivity with coefficient of expansion made it to be used as a metal matrix for reinforcement of SiC particles and it can be used in aerospace and avionics industries. Whereas, SiC used as a reinforcement has been noted for its excellent mechanical properties, like hardness and wear resistance. SiC is also not attacked by most acids and can only be etched by alkaline hydroxide bases (i.e. KOH) at molten temperatures (>600°C).

2. METHODOLOGY: STIR CASTING

Stir-casting methodology is one of the most simplest and commercial method of production of MMCs. This method includes mechanical mixing of the components into a molten metal bath and then transferring the mixture to a shaped mould before solidification is achieved. The most important factor is to have good wetting between the particulate reinforcement i.e SiCand the molten metal Al. The main advantage of this process is of low production costs of MMCs.

Problem definition

The problem for the proposed work is to determine the mechanical properties of Aluminum 6061 reinforced with silicon carbide using stir casting and to analyze it different compositions to derive out the best result.

Steps for experimental methodology

Aluminium metal was melted by heating it in a muffle furnace at 800^{o} C for three to four hours. Then silicon carbide particles were preheated at 1000^{o} C for one to three hours to make their surfaces oxidized. The furnace was first raised above the liquidus temperature of Aluminium near about 750^{o} C to melt

the alloy completely and was cooled down just below the liquidus to keep slurry in Semi solid state.

Step 1: First step includes preparation of sand mould using molding sand to form the drag or the cores of the mould.

Step 2: Preparation of Specimen of various compositions. The alloying element proportionately by weight in the ratio of 19%, 21%, 23% were prepared. The percentage of alloying element to be used in composite were determined by literature and history for development.

Step 3: Machining of specimen for test For Charpy/ Izod Impact test. The material were sized as a square section for tests with a notch as specified by the relevant IS standard .

Step 4: Checking Hardness of the composites over `Hardness testing machine' Brinell Hardness Test and 'Rockwell hardness test'.

Preparation

For the preparing of aluminum silicon carbide composite `by using the stir casting, the percentage of silicon carbide used is of 19%, 21% and 23%. The aluminum metal is used in the form of ingots. The material ingots is cleaned and melted to the desired temperature of 750^{o} C. Silicon carbide used is of about 320 grit and it was preheated to temperature around 500^{o} C and then added to the molten metal to prepare the composite and stirred continuously by a mechanical stirrer . The stirring time is between 5 to 8 minutes. During stirring borax powder was added in small quantity in order to increase the wetability of silicon carbide particles to achieve the uniform compsition. The melt, along with the reinforced particulates is poured into the dried, and coated sand mould. After poring, the melt was allowed to solidify in the mould.

3. RESULT AND CALCULATION

TEST NO. 1

Rockwell hardness test

S.No.	Composition	Time (sec.)	Load applied (kg)	Hardness (HRB)
1	6061Al+19%SiC	8	100	17
2	6061Al+21%SiC	8	100	19
3	6061Al+23%SiC	8	100	21

TEST NO. 2

Brinell hardness test

S.no.	Composition	Mean dia. (d)	Brinell hardness no. (BHN)
1	6061Al+19%SiC	6.4	74.12
2	6061Al+21%SiC	6.59	77.05
3	6061Al+23%SiC	6.53	78.71

TEST NO.3

Izod test

S. no.	Composition	Initial energy (j)	Residual energy (j)	Energy absorbed (j)
1	6061Al+19%SiC	336	70	266
2	6061Al+21%SiC	336	73	263
3	6061Al+23%SiC	336	76	260

TEST NO.4

Charpy test

S. No	Composition	Initial Energy (j)	Residual Energy (j)	Energy absorbed (j)
1	6061Al+19%SiC	600	80	520
2	6061Al+21%SiC	600	85	515
3	6061Al+23%SiC	600	86	514

TEST NO. 5

Utm calculation S.no.	Composition	Tensile stress (N/mm^2)	Strain	Elongation (%)
1	6061Al+19%SiC	101.77	1.09	9
2	6061Al+21%SiC	97.72	1.095	9.5
3	6061Al+23%SiC	83.22	1.105	10.5

4. CONCLUSION

- It can be concluded from the hardness test that 6061Al+23% SiC is better than the other compositions.
- It can also be seen that the impact strength of 6061Al+19%SiC is better than the other compositions because the energy absorbed by the 19% composition was most in both charpy and izod impact test.
- From the UTM test following observations were made:-

a. The results of study suggest that with increase in composition of SiC, an increase in tensile strength, yield stress and elongation have been observed.

b. The maximum elongation = 10.5 % , which was observed at 23% composition of Sic in Al.

c. The maxium tensile stress was observed at 19% SiC in Al that is 101.77 N/mm^2

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