International Journal of Engineering Research And Advanced Technology(IJERAT)
ISSN: 2454-6135 [Volume. 02 Issue.09, September– 2016]
www.ijerat.com

Characterization of Aluminium Alloy/ SiC Metal Matrix Composites

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ABSTRACT

The present research involved the conduction of hardness and compression tests of aluminium AA-2618 alloy matrix composite reinforced with white Silicon Carbide particulates. The composites were fabricated using Stir Casting technique of liquid metallurgy and machined to the required ASTM standards. The hardness tests were conducted using a Brinell hardness tester, whereas the compression tests were conducted using a Universal Testing Machine. Appropriate readings were taken during the conduction of the tests in order to be compared with each other as well as the base alloy. The results and conclusions were analyzed and compared to help determine the nature of the trends that arise due to the incremental addition of reinforcement particulates into the matrix material on the hardness and compressive behavior of the composites, in order to determine their potentiality for application in various industrial fields.

***Keywords**: Aluminium AA-2618 alloy, SiC, Metal matrix composites, Compression test, Hardness test.*

1. INTRODUCTION

A composite material can be defined as a material system in which a mixture of two or more materials or phases of the same material, insoluble in one another is present. Their properties are generally intermediate between the properties of the matrix material and the reinforcements. The two types of constituent materials of all known composites are known as matrix material and reinforcements. Generally, the addition of reinforcements such as SiC, B_4C, alumina particles etc. with aluminium and their alloy matrices results in the development of composites that generally possess reduced ductility and compressive strength but improved yield strength, hardness and tensile strength [1]. A good bond

produced between the reinforcement particles and the matrix enhances the overall strength of the composites [2]. This is mainly due to the addition of harder SiC reinforcements to the alloy matrix [3 & 4]. Quenching media and ageing duration can also have a significant effect on certain properties of the fabricated composites, such as the hardness property [5]. Applications using aluminium based metal/alloy matrix composites are included in industries such as Military, Defense, Construction, Aerospace, Automobile, Manufacturing, Electronic and Research and Development industries [6].

2. EXPERIMENTAL PROCEDURES

2.1. Material preparation

The composites were fabricated using Stir casting technique of liquid metallurgy. The castings are prepared with the help of metal dies. Totally, three types of composites were prepared with varying weight percentages of SiC particulates embedded within the aluminium matrix material. Variation of SiC particulate content in terms of weight percentages was from 2% to 6% in steps or increments of 2%. The test specimens are fabricated according to ASTM standards. The chemical composition of the aluminium AA-2618 alloy is as shown in the table below.

Table 2.1. Chemical composition of AA-2618 alloy

Component	% Composition
Aluminum	93.7
Copper	2.30
Iron	1.10
Magnesium	1.60
Silicon	0.18
Nickel	1.00
Titanium	0.07

2.2. Hardness Test

Brinell hardness test was conducted on the specimens using a Brinell hardness tester. Three hardness readings are taken for each specimen at separate distinct locations. The size of the indent is determined optically by measuring two diagonals of the round indent. Hardness readings were calculated depending on the indentations made. The average hardness value of the three readings for each of the specimens was taken as the final value. Also, the results were compared.

2.3. Compression Test

The test specimens were prepared according to the standard “ASTM E9”. The testing took place also using the Universal Testing Machine. During the conduction of the tests, the specimens were

compressed between two flat plates, one being movable and the other being stationary, and their deformations at various loads were recorded. Values were tabulated and compared with each other.

3. RESULTS AND DISCUSSIONS

3.1. Hardness Test Results

The addition of Silicon Carbide particulates as reinforcements to aluminium AA-2618 matrix material shows an increase in hardness is achieved by the produced composite. This is entirely due the hardness property of the reinforcements, dispersed in the soft aluminium alloy matrix. The test results show that the increase in the weight fractions of the reinforcement material has little influence on improving the overall hardness of the composite. The aluminium AA-2618 composite containing 6% weight ratio of SiC reinforcements shows the highest value of Brinell hardness.

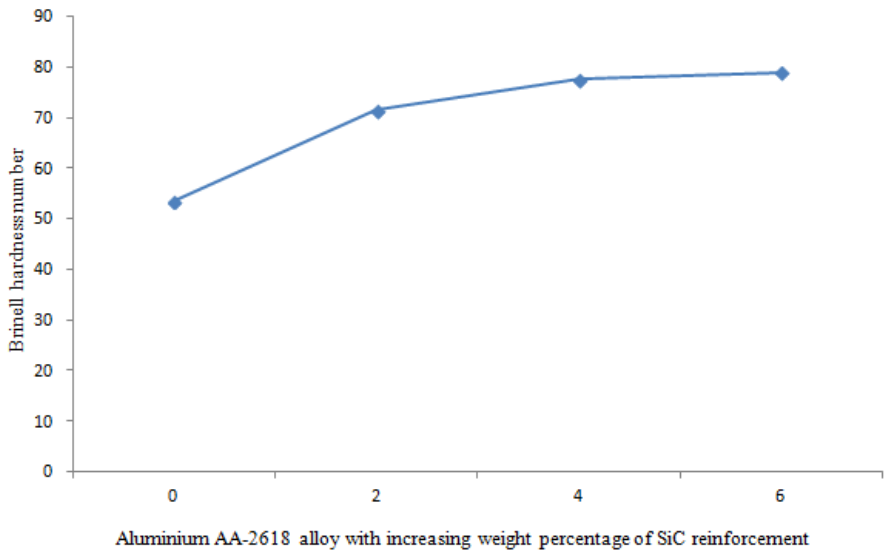

Figure 1: Effect of SiC reinforcements on Brinell Hardness

3.2. Compression Test Results

The compressive strengths on the composites under analysis shows an increasing trend with the increase in the weight percentage of the added SiC particulate reinforcements in the aluminium alloy matrix. The composite of aluminium AA-2618 alloy reinforced with 6% weight ratio of SiC reinforcements shows the highest value of compression strength. Overall, it can also be concluded that, with the addition of white SiC particulates as reinforcements into the aluminium AA-2618 alloy matrix material, the compressive strength of the resulting produced composite is increased.

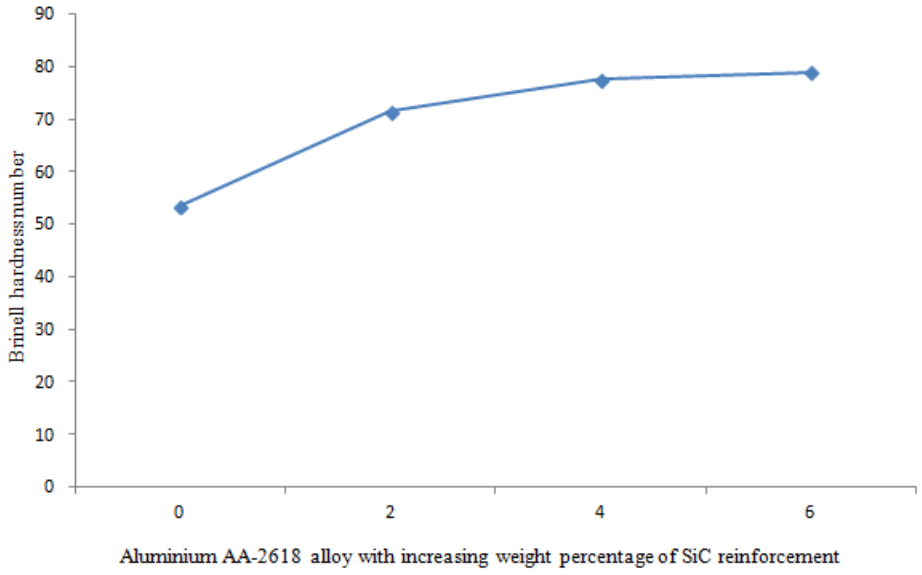

Figure 2: Effect of SiC reinforcements on compression strength

4. CONCLUSIONS

The following conclusions were drawn from the current research:-

- Compression and hardness tests were successfully conducted using the universal testing machine.
- From the compression test results, it is concluded that the addition of Silicon Carbide reinforcement particulates to the aluminium AA-2618 alloy significantly increases the compressive strength of the fabricated composite.
- The Brinell hardness test results shows that the addition of Silicon Carbide reinforcement particulates to the aluminium AA-2618 alloy increases the overall hardness of the fabricated composite.

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