Behavior Analysis of Aluminium Alloy with Reinforced Silicon Carbide Particles

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Abstract - Aluminium alloy materials finds many applications in the field of engineering. They are made up of combining two or more materials, so that the resulting materials have some improved properties than the initial one. The Aluminium alloy composite materials consist of higher tensile strength, thermal stability, more corrosion and wear resistance, better fatigue life. In this paper stir casting of aluminium alloy (LM 25) along with silicon carbide in two ratios (4% and 6%) have been experimented and various mechanical properties tested. Maximum tensile strength found in 6% SiC composition. Also the microstructure of specimens captured using SEM.

Keywords – Aluminium alloy, Silicon Carbide (SiC), Stir Casting, SEM

I. INTRODUCTION

According to Arsenault, 1984 the mechanical properties of aluminium alloys reinforced with ceramic particulates are known to be influenced by the particle size and the volume fraction. He has concluded from the series of experiments that 0.2% proof stress and ultimate tensile strength tend to increase, and toughness and ductility decrease with increasing volume fraction of particulate or decreasing particle size. Hashim et al., 1999 have detailed stir casting process to make Al based composites.

II. STIR CASTING

Among the variety of manufacturing processes available for discontinuous metal- matrix composites, stir casting is generally accepted, and currently practiced commercially its advantages is in its simplicity, flexibility and applicability to large- scale production and, because in principle it allows a conventional metal processing route to be used, and its low cost This liquid metallurgy technique is the most economical of all the available routes for metal matrix composite production, allows very large sized components to be fabricated, and is able to sustain high productivity rates According to Skibo et al , the cost of preparing composites materials using a casting method is about one-third to one-half that of a competitive methods, and for high volume production, it is projected that costs will fall to one-tenth.

Figure 1. Aluminium chips Silicon Carbide powder (400 grit size, 37 microns)

Preparation of Aluminium Silicon Carbide Alloy

In this preparation Aluminium metal is melted initially at 780°C and then added with the SiC powder in 4%, then 6% mass fraction inside the stir casting furnace. After that pouring it into a previously made mould cavity to shape the desired component. Allowing the molten metal to cool and solidify in the mould. Removing the solidified component from the mould, cleaning it. Finishing is done on the casted object by using lathe machine for required shape and size.

Figure 2. Tensile test specimens

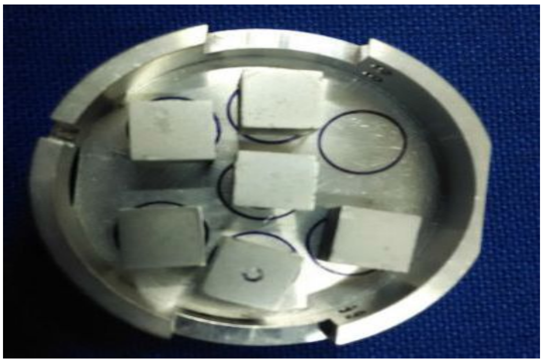


Figure 3. AlSiC samples pieces for SEM test

III. TENSILE TEST

Mechanical testing plays an important role in evaluating fundamental properties of engineering materials as well as in developing new materials and in controlling the quality of materials for use in design and construction. If a material is to be used as part of an engineering structure that will be subjected to a load, it is important to know that the material is strong enough and rigid enough to withstand the loads that it will experience in service. As a result engineers have developed a number of experimental techniques for mechanical testing of engineering materials subjected to tension, compression, bending or torsion loading.

The most common type of test used to measure the mechanical properties of a material is the Tension Test. Tension test is widely used to provide basic design information on the strength of materials and is an acceptance test for the specification of materials.

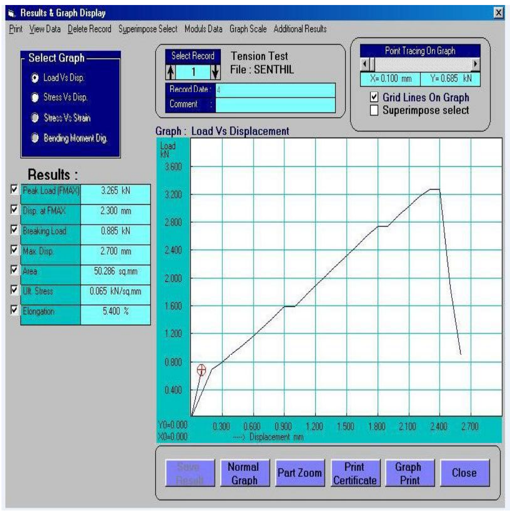
The major parameters that describe the stress-strain curve obtained during the tension test are the

- tensile strength (UTS),
- yield strength or yield point (σy),
- elastic modulus (E),
- percent elongation (ΔL%) and
- the reduction in area (RA%).

Toughness, Resilience, Poisson's ratio (ν) can also be found by the use of this testing technique. In this test, a specimen is prepared suitable for gripping into the jaws of the testing machine type that will be used. The specimen used is approximately uniform over a gauge length (the length within which elongation measurements are done)
The stretch undergone by the specimen is measured by an elongation scale with a least count of 1 mm fixed to the loading unit for every increment in the load. The simple stress and strain developed in gauge length portion is calculated using the formulae.

Stress (**σ**) = Load/ Original cross sectional area

Strain (**e**) = Increment in length / original gauge length.



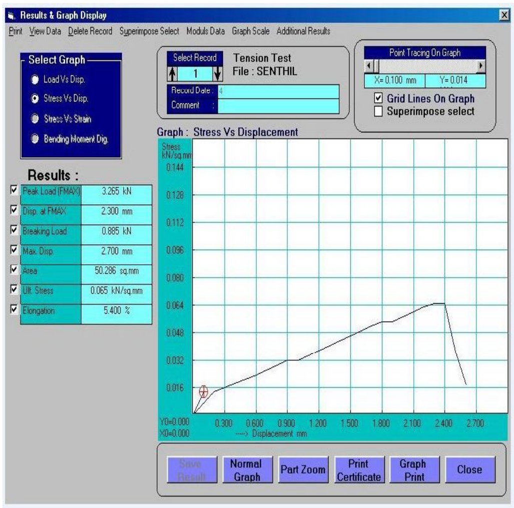
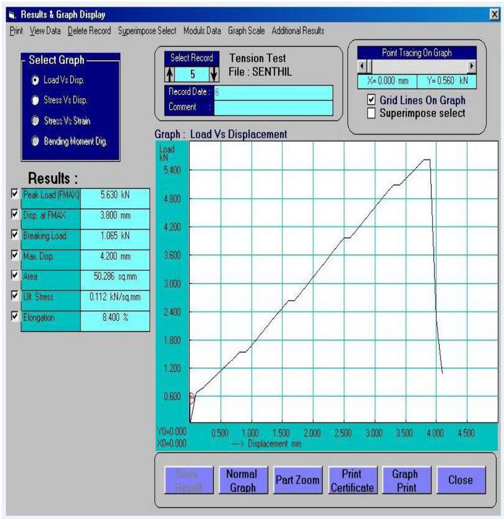


Figure 4. (a) Load Vs Displacement curve (4% SiC - Tensile strength: 65N/mm²)

(b) Stress Vs Displacement curve (% Elongation: 5.42)



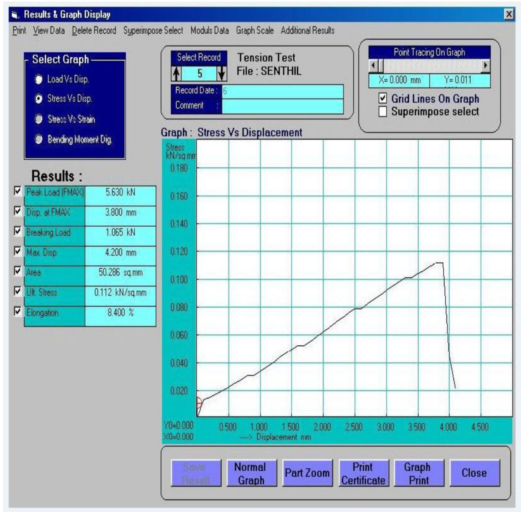


Figure 5. (a) Load Vs Displacement curve (6% SiC - Tensile strength: 112N/mm²) (b) Stress Vs Displacement curve (% Elongation: 8.4)

IV. ROCKWELL HARDNESS TEST

The Rockwell hardness test method consists of indenting the test material with a diamond cone or hardened steel ball indenter. The indenter is forced into the test material under a preliminary minor load *F0* usually 10 kgf. When equilibrium has been reached, an indicating device, which follows the movements of the indenter and so responds to changes in depth of penetration of the indenter is set to a datum position. While the preliminary minor load is still applied an additional major load is applied with resulting increase in penetration. When equilibrium has again been reach, the additional major load is removed but the preliminary minor load is still maintained. Removal of the additional major load allows a partial recovery, so reducing the depth of penetration. The permanent increase in depth of penetration, resulting from the application and removal of the additional major load is used to calculate the Rockwell hardness number.

$$\mathrm{HR} = E - e$$

F0 = preliminary minor load in kgf
F1 = additional major load in kgf
F = total load in kgf
e = permanent increase in depth of penetration due to major load F1 measured in units of 0.002 mm
E = a constant depending on form of indenter: 100 units for diamond indenter, 130 units for steel ball indenter
HR = Rockwell hardness number
D = diameter of steel ball

V. EXPERIMENTAL RESULTS

Table -1 Average Value Calculated From Experimental Readings

Property	SiC- 4%	SiC- 6%
Tensile strength (N/mm2)	63	128.5
Elongation (%)	5.4	11.8
Rockwell Hardness Number	38.25	39.25

VI. SEM RESULTS

In figure 6 and figure 7 SiC particle distributions in aluminium material captured by using Scanning Electron Microscope (SEM) is shown. The Scanning Electron Microscope (SEM) is used for observation of specimen surfaces. When the specimen is irradiated with a fine electron beam (called an electron probe), secondary electrons are emitted from the specimen surface. Topography of the surface can be observed by two-dimensional scanning of the electron probe over the surface and acquisition of an image from the detected secondary electrons.

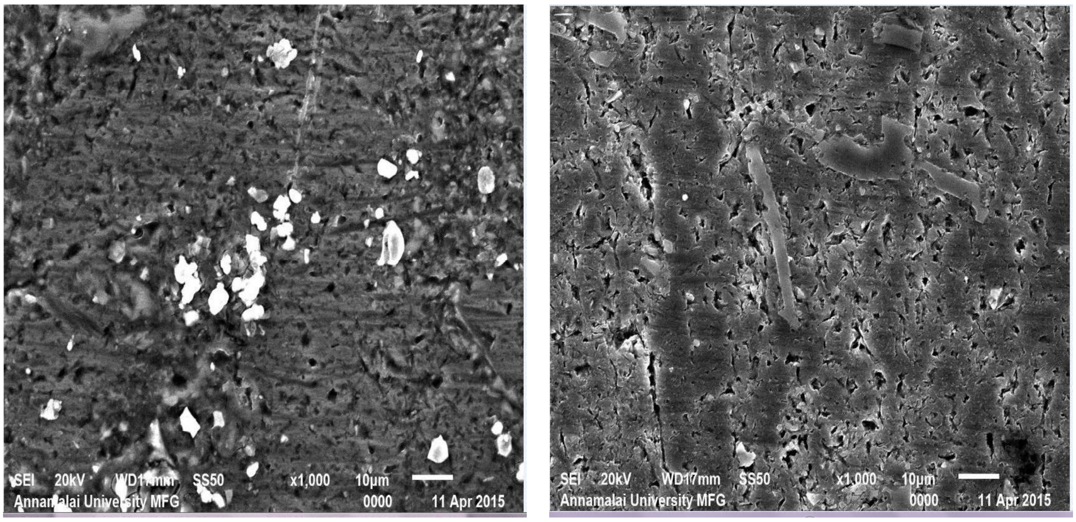


Figure 6. (a) 4% SiC Particles distribution images at different locations and magnifications

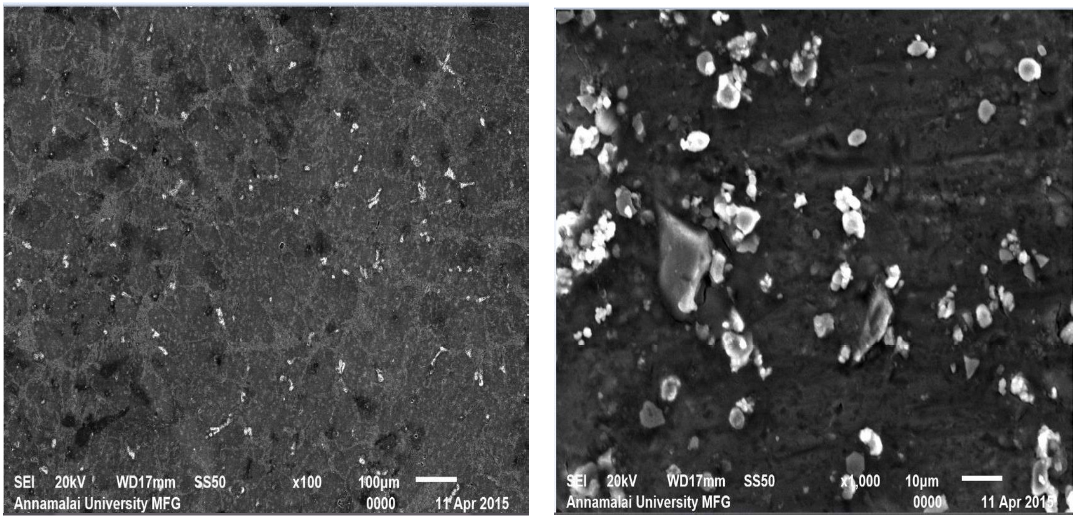


Figure 7. (b) 6% SiC Particles distribution images at different locations and magnifications

VII.CONCLUSION

From the above 3 experiments (Tensile test, Rock well hardness test and SEM), It has been concluded that 6% of Al-SiC composite alloy have more tensile strength, thermal stability and hardness while comparing with pure aluminium and 4% Al-SiC composite alloy.

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