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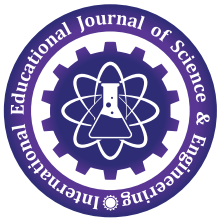


# SYNTHESIS AND CHARACTERIZATION OF ALUMINIUM 7075-SILICON CARBIDE METAL MATRIX COMPOSITE

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**ABSTRACT**

Silicon carbide has gathered widespread attention as a potential reinforcement for aluminum matrix composites (AMCs) to enhance the properties and reduce the cost of production. Aluminum alloy 7075 reinforced with various amounts (5, 8 and 10 %) of silicon carbide particles were prepared by stir casting method. Silicon carbide particles were incorporated into the semisolid aluminum melt. The microstructures of the MMCs were analyzed using scanning micro electron microscopy. The MMCs were characterized with the homogeneous dispersion of silicon carbide particles having clear interface and good bounding to the aluminum matrix. The incorporation of silicon carbide particles improved the micro-hardness and ultimate tensile strength (UTS) of the MMCs.

**KEYWORDS:** Silicon Carbide, Aluminum alloy 7075, SEM

## 1. INTRODUCTION

A Composite material (also called a composition material or shortened to composite, which is the common name) is a material made from two or more constituent materials with significantly different physical or chemical properties that, when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter, or less expensive when compared to traditional materials. More recently, researchers have also begun to actively include sensing, actuation, computation and communication into composites which are known as Robotic Materials. Casting is a manufacturing process in which a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various cold setting materials that cure after mixing two or more components together; examples are epoxy, concrete, plaster and clay. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make.Silicon carbide (SiC), also known as carborundum is a compound of silicon and carbon with chemical formula SiC It occurs in nature as the extremely rare mineral moissanite. Synthetic silicon carbide powder has been mass-produced since 1893 for use as an abrasive. Grains of silicon carbide can be bonded together by sintering to form very hard ceramics that are widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors in early radios were first demonstrated around 1907. SiC is used in semiconductor electronics devices that operate at high temperatures or high voltages, or both. Large single crystals of silicon carbide can be grown by the Lely method; they can be cut into gems known as synthetic moissanite. Silicon carbide with high surface area can be produced from SiO2 contained in plant material. Electrical discharge machining (EDM), also known as spark machining, spark eroding, burning, die sinking, wire burning or wire erosion, is a manufacturing process whereby a desired shape is obtained by using electrical discharges (sparks). Material is removed from the work piece by a series of rapidly recurring current discharges between two electrodes, separated by a dielectric liquid and subject to an electric voltage. One of the electrodes is called the tool-electrode, or simply the “tool” or “electrode,” while the other is called the work piece-electrode, or “work piece.” The process depends upon the tool and work piece not making actual contact.

## 2. EXPERIMENTAL PROCEDURE

### 2.1 Tensile Test

Tensile testing, is also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types

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of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain-hardening characteristics. Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials.

**2.2 Vickers Hardness**

The Vickers hardness test was developed in 1921 by Robert L. Smith and George E. Sand land at Vickers Ltd as an alternative to the Brinell method to measure the hardness of materials. The Vickers test is often easier to use than other hardness tests since the required calculations are independent of the size of the indenter, and the indenter can be used for all materials irrespective of hardness. The basic principle, as with all common measures of hardness, is to observe the questioned material's ability to resist plastic deformation from a standard source. The Vickers test can be used for all metals and has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV) or Diamond Pyramid Hardness (DPH). The hardness number can be converted into units of Pascal's, but should not be confused with pressure, which also has units of Pascal's. The hardness number is determined by the load over the surface area of the indentation and not the area normal to the force, and is therefore not pressure.

**2.3 Brinell Hardness Test**

The Brinell scale characterizes the indentation hardness of materials through the scale of penetration of an indenter, loaded on a material test-piece. It is one of several definitions of hardness in materials science. Proposed by Swedish engineer Johan August Brinell in 1900, it was the first widely used and standardized hardness test in engineering and metallurgy. The large size of indentation and possible damage to test-piece limits its usefulness. However it also had the useful feature that the hardness value divided by two gave the approximate UTS in ksi for steels. This feature contributed to its early adoption over competing hardness tests. The typical test uses a 10 millimeter's (0.39 in) diameter steel ball as an indenter with a 3,000 kgf (29.42 KN; 6,614 lbf) force. For softer materials, a smaller force is used; for harder materials, a tungsten carbide ball is substituted for the steel ball. The indentation is measured and hardness calculated as:

$BHN = 2P/\pi D(D-\sqrt{D2-d2})$

Where:

BHN = Brinell hardness number (kgf/mm2)

P = applied load in kilogram-force (kgf)

D = diameter of indenter (mm)

d = diameter of indentation (mm)

**2.4 Stir Casting Setup**

In this paper, the relatively low cost stir casting technique is evaluated for use in the production of silicon carbide/ Aluminium alloy MMCs. The technical difficulties associated with attaining a uniform distribution of reinforcement, good wettability between substances, and a low porosity material are presented and discussed. In this study 7075 matrix alloy is chosen and SiC particles having average particle size of 29 μm was incorporated into the alloy at the liquid state before vertical pressure casting. Four different additions of SiCp were made and the weight fractions used are 5%, 8%, and 10%. Composites were processed by vertical pressure/squeeze casting machine developed. The mold is specially designed to produce specimens for tensile and three point bend tests. Both as-cast and heat treated aluminum composites were examined and the T6 heat treatment was applied. Three point bend tests were performed to reveal the fracture strength of the aluminum composites. The 10 wt% SiCp aluminum matrix composites showed the maximum flexural strength both for the as-cast (450 MPa) and heat treated conditions (588 MPa). The maximum flexural strength increased by about 40 MPa (10%) for the as-cast and 180 MPa (44%) for heat treated composites. Hardness tests were performed to determine the maximum value. For the as-cast specimens the hardness values increased from 133 to 188 Vickers (10 kg) with an increase in SiCp content from 0 to 30 wt% and for the heat treated specimens the hardness values increased from 171 to 221 Vickers (10 kg). The peak hardness values were obtained for the 24 h precipitation heat treatment.In a stir casting process aluminium 7075 and silicon carbide is add at 5% , 8% and 10% and it is pour into a die to get a required shape. In this process is known as stir casting process

**3. RESULT AND DISCUSSION**

**3.1 Tensile Test**

Tensile testing, is also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area.

| S.No | Load in kN | Deflection in mm |
|---|---|---|
| 1 | 2 | 0.2 |
| 2 | 4 | 0.4 |
| 3 | 6 | 0.8 |
| 4 | 8 | 1.2 |
| 5 | 10 | 2.2 |
| 6 | 12 | 2.6 |
| 7 | 14 | 3.1 |
| 8 | 16 | 4.5 |
| 9 | 18 | 6.6 |
| 10 | 20 | 7.9 |
| 11 | 22 | 8.7 |
| 12 | 24 | 9.1 |
| 13 | 25.1 | 9.4 |

**Sample 10%**

**3.2 Rockwell Hardness**

The Rockwell test determines the hardness by measuring the depth of penetration of an indenter under a large load compared to the penetration made by a preload. There are different scales, denoted by a single letter, that use different loads or indenters.

| S.NO | Sample | Load in Kgf | Rockwell Hardness Number |
|---|---|---|---|
| 1 | 5% | 100 | 51 |
| 2 | 8% | 100 | 40 |
| 3 | 10% | 100 | 36 |

### 3.3 Brinell Hardness

The large size of indentation and possible damage to test-piece limits its usefulness. However it also had the useful feature that the hardness value divided by two gave the approximate UTS in ksi for steels. This feature contributed to its early adoption over competing hardness tests.

Ball diameter 10mm

| S.No | Sample | Load in Kgf | Diameter |
|---|---|---|---|
| 1 | 5% | 250 | 25 |
| 2 | 10% | 250 | 30 |

BHN at 5% sample = 3.033
BHN at 8% sample = 3.111
BHN at 10% sample = 3.104

### 3.4 Izod Test

Izod impact testing is an ASTM standard method of determining the impact resistance of materials. A pivoting arm is raised to a specific height (constant potential energy) and then released. The arm swings down hitting the sample, breaking the specimen.

| S.No | Sample | Load in Kgf |
|---|---|---|
| 1 | 5% | 14 |
| 2 | 10% | 12 |

## 4. CONCLUSION

1. In aluminium 7075 – SiC metal matrix composite have high tensile strength compare to normal aluminium material.
2. Tensile test analysis the ultimate strength and elongation graph is presented this operation is done on servo UTM.
3. In tensile test, the composites containing 10 wt% silicon carbide showed the maximum strength in both the as cast and at heat treated state.
4. Hardness test comparison between 5%, 8%, and 10% variation is normal at same load at 100 Kgf at Rockwell hardness and 250 Kgf Brinell hardness.
5. In stir casting process mixing silicon carbide is added at correct manner at given procedure.

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