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Investigation of Mechanical Properties of Metal Matrix of Aluminum 7075 reinforced silicon carbide

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Abstract - *Aluminium 7075 alloy as a matrix material and the silicon carbide as a reinforcement material have been used because it has potential applications in aerospace and aircraft industries because of its low weight to high strength ratio. It also used because it has high wear resistance and creep resistance property. The investigation about the mechanical properties such as tensile and compressive strength of Al7075 and silicon carbide is needed so that metal matrix composite fabricated for the aerospace and aircraft industries should be defect free. In this work Al 7075 is reinforced with 0, 5, 10 wt % of silicon carbide particles by stir casting method. The resulted casted specimens are tested to know the tensile and compressive properties of the composite.*

Key words: Al 7075, Stir casting, Tensile Strength, Compressive strength.

1. INTRODUCTION

The use of metal matrix composite as structural engineering material has more attention in current years. Because of their high strength to low weight ratio, and toughness at high temperature which makes them suitable for various applications. Whereas engineering materials like steel are used as MMC because of its superior stiffness and high mechanical strength compare to matrix alloys, but the major disadvantage is its poorer ductility and lesser fracture toughness. MMC have high tensile and compressive stresses by transfer and distributing the applied load from ductile matrix to the reinforcement material. The transfer of load takes place from matrix to reinforcement if it has interfacial bonds. Therefore, appropriate selection of matrix material and reinforcement material with their properties and the method of fabrication selected which effect this bond will significantly influence the resulting MMC.

2. METHODOLOGY

The current research has been carried out on Aluminium 7075 alloy which is reinforced with silicon carbide particles. For Al 7075 metal various weight percentage of silicon carbide is added by stir casting technique. Three samples each prepared for tensile test and Compression test. Samples are prepared by varying the silicon carbide weight percentage as 0%, 5%, 10%. In this process initially silicon carbide powder is preheated at a temperature of 400^0c for an hour in the muffle furnace. After this preheated silicon carbide powder is poured in to the molten aluminium at a temperature of 750^0c. Degasifier and cover flux is added. Hexachloroethane (c_2cl_6) is used as a degasifier to remove the entrapped air and cover flux (45 % Nacl, 45% Kcl, and 10% NaF) is added to prevent oxidation losses of aluminium during melting this improves theyield of molten metal from the charge. The silicon carbide powder is mixed in the molten aluminium with the help of stirrer so that uniform supply of silicon carbide particles in molten aluminium can be achieved. Following stirring hold molten metal for 5minutes and then it is poured in to the suitable moulds. The moulds in which the molten metal is poured should be preheated in order to keep away from thermoelectric voltage arise due to huge differences in temperature, and not to decrease the repair life of the moulds or scratch the coating applied. After pouring allow the molten metal to solidify and then take out from the mould.

Fig: 1: Muffle furnace

Fig: 2: Pouring of Molten metal

Fig: 3: Casted Specimens

Material Selection:

Matrix Material:

Al7075 is chosen as matrix material due to its wide applications in many engineering sectors. Aluminium 7075 is an aluminium alloy with zinc as main alloying element. The Composition of Al7075 is shown in the Table.

Table: 1: Composition of Al-7075

Material	Zn	Mg	Cu	Cr	Si	Fe
Wt %	5.67	2.53	1.59	0.21	0.8	0.10

Table 3: Composition used for Metal Matrix Composite:

Sample	**Wt. of Al-7075**	**Wt. of Sic**
Al-7075 with 0% Sic	300 g	0 g
Al-7075 with 5% Sic	325 g	16.25 g
Al-7075 with 10% Sic	325 g	32.5 g

4. Results and Discussions

Tensile Test:

The tensile test specimen is ready with size according toASTM standard E8. The specimen for tensile test is shown in figure 5. The tensile test is carried out in computerized tenso-meter.

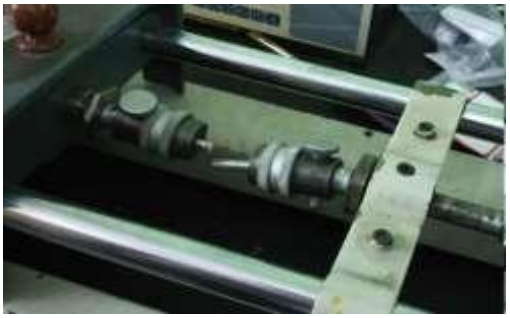

Fig: 5: Specimen on Tenso-meter

Reinforcement Materials

Silicon carbide used as reinforcement material. The properties of silicon carbide are shown in the table below

Table 2: Properties of Sic

Mechanical Properties	Values
Melting Point ^{0}C	1400
Flexural Strength MPa	550
Hardness	2800
Density g/cm^3	3.1
Fracture Toughness MPa/m^2	4.6
Poisson's Ratio	0.14

Fig: 6: Tested Specimens

Table: 4: Ultimate Tensile Strength (MPa)

Materials	Ultimate Tensile Strength (MPa)
Al-7075 with 0% Sic	151.95
Al-7075 with 5% Sic	163.09
Al-7075 with 10% Sic	172.38

Variation in Tensile Strength:

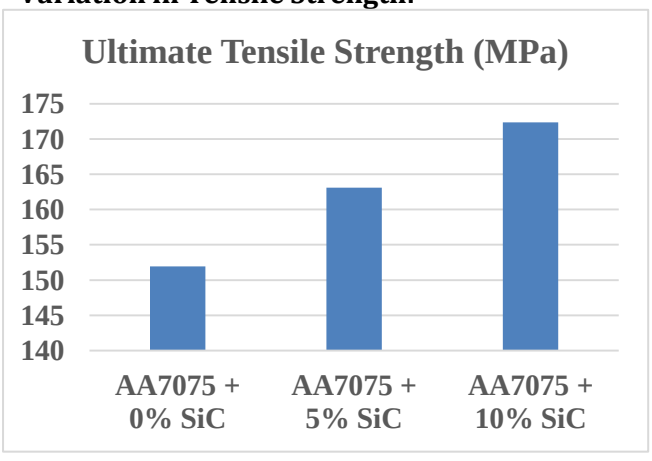

Fig: 7: Comparison of Ultimate Tensile strength

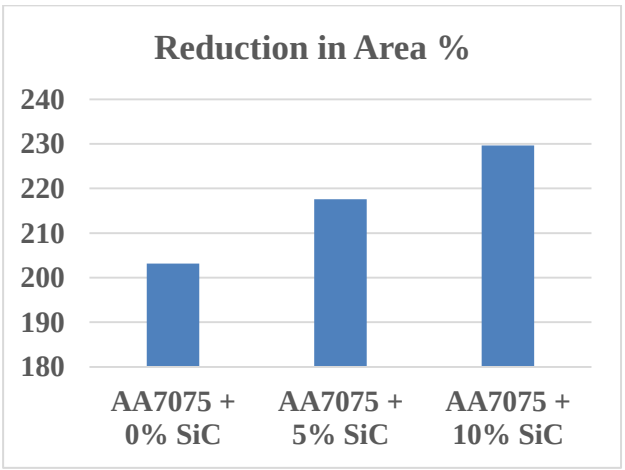

Fig: 9: % of Reduction in Area

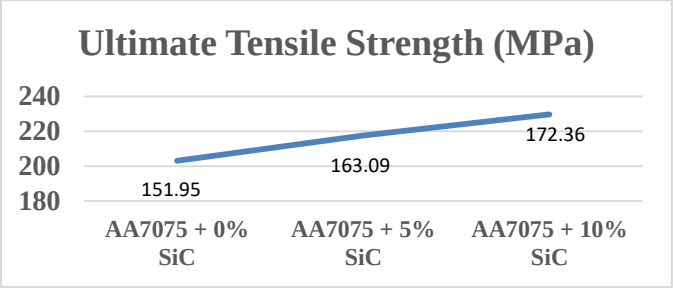

Fig: 8: Variation of Ultimate Tensile Strength

Tensile test are perform on a Tenso-meter for 0, 5 and 10 % of SiC by weight mixed with AA7075 and the readings are tabulated. Practically it was observed that the tensile strength increases with the increases in wt% of SiC as shown in the above graph. From the above graphs it clears that for 10 wt% of SiC in Al-7075 has maximum ultimate tensile strength.

Table: 5: % of Reduction in Area

Materials	Reduction Area %
Al-7075 with 0% Sic	0.052
Al-7075 with 5% Sic	0.054
Al-7075 with 10% Sic	0.056

From the above table it's clear that as the percentage of reinforcement i.e. Silicon Carbide increase the percentage of reduction area decreases.

4.1 Compression Test:

Compression test is used to determine a material's behavior under applied crushing loads, and are typically conducted by applying compressive pressures to a test specimen using platens or specialized fixtures on a universal testing machine.

Experiment has been conducted by changeable weight fraction of SiC (0%, 5% and 10%). Compressive strength is recorded and tabulated. Compression test have been conducted on each sample by means of crushing load applied using universal testing machine. The equivalent value of compressive strengths was calculated by performing the experiments.

Table: 6: Compressive strengths (MPa)

Materials	Compressive Strength
Al-7075 with 0% Sic	203.15
Al-7075 with 5% Sic	217.59
Al-7075 with 10% Sic	229.68

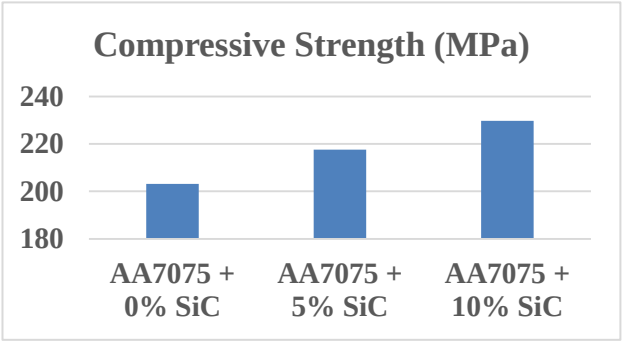

Fig 10: : Comparison of Compressive Strength

Above table show the Compressive strengths of composite material which contain varying wt. % of SiC reinforcements. The chart shows that adding of SiC particles in Al7075 matrix composites enhance the compressive strength in the composite, when compared with unreinforced Al7075.

5. CONCLUSIONS:

In this experimental study, Aluminium Alloy 7075 is reinforced with varying silicon carbide content (0, 5 and 10 wt %) prepared by using stir casting manufacturing method. Tensile strength and compressive strength of the samples are calculated.

Based on the investigational results the following conclusions are made:

The adding of silicon carbide particles in the Aluminium 7075 matrix increases the tensile strength and compressive strength when compared with unreinforced Aluminium 7075 alloy.

10% of silicon carbide content by weight in Aluminium 7075 matrix composite shows the maximum tensile strength and compressive strength.

From the outcome above, silicon carbide reinforced Aluminium 7075 matrix composite showed better tensile strength and compressive strength than the unreinforced Aluminium 7075.

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