Development and Evaluation of Tensile and Compression Strength of Al based MMC

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***Abstract*—The Metal Matrix Composites have almost replaced the conventional metals due to their high strength, stiffness and durability. Aluminium based MMCs are most widely explored due to their low cost and availability. The present work focuses on the development and evaluation of tensile and compression properties of Al 7075 and fused SiO_2 Metal matrix composite. Stir casting route has been adopted for the production of the composite. The specimens were subjected to T6 heat treatment. The reinforcement was varied in steps of 3%, 6%, 9% and 12%.**

***Keywords*—Al 7075, Fused SiO_2, Stir Casting, Heat Treatment (T6), Strength**

I. INTRODUCTION

Metal matrix composites (MMCs) usually consist of a low-density metal, such as aluminum or magnesium, reinforced with particulate or fibers of a ceramic material, such as silicon carbide or graphite. Compared with unreinforced metals, MMCs offer higher specific strength and stiffness, higher operating temperature, and greater wear resistance, as well as the opportunity to tailor these properties for a particular application. New and high performance particle reinforced metal matrix composites (PRMMC) are expected to satisfy many requirements for a wide range of performance-driven, and price sensitive, applications in aerospace, automobiles, bicycles, golf clubs, and in other structural applications. In general, these materials exhibit higher strength and stiffness, in addition to isotropic behavior at a lower density, when compared to the un-reinforced matrix material. The recognition of the potential weight savings that can be achieved by using the advanced composites, which in turn means reduced cost and greater efficiency, was responsible for this growth in the technology of reinforcements, matrices and fabrication of composites. If the first two decades saw the improvements in the fabrication method, systematic study of properties and fracture mechanics was at the focal point in the 60's. Since then there has been an ever-increasing demand for new, strong, stiff and yet light-weight materials in fields such as aerospace, transportation and automobile and construction sectors. These materials have low specific gravity that makes their properties particularly superior in strength and modulus to many traditional engineering materials.

II. SCOPE AND OBJECTIVE

The aim of the present investigation is to develop and characterize tensile and compression properties of Al 7075 reinforced with fused SiO_2. The objectives of the present work are as follows:

- Preparations of composite by Stir Casting route.
- Heat treatment (T6) of obtained composite specimens.
- Preparation of specimens as per ASTM Standards.
- Evaluation of tensile properties.
- Evaluation of compression properties.

III. EXPERIMENTAL SETUP

A. selection of materials:

Matrix Material

Fig 1: Ingot Structure of Al 356

Table 1: Chemical composition of Al 7075 Matrix Material

Element	Wt. %	Element	Wt. %	Element	Wt. %
Al	87.1 - 91.4	Mg	2.1 - 2.9	Si	Max 0.4
Cr	0.18 - 0.28	Mn	Max 0.3	Ti	Max 0.2
Cu	1.2 - 2	Other, each	Max 0.05	Zn	5.1 - 6.1
Fe	Max 0.5	Other, total	Max 0.15		

Reinforcement Material:

Fig 2: Reinforcement Fused SiO_2

B. Fabrication by Stir Casting

- Aluminum (Al 7075) 2kg was melted in the furnace to a temperature of 750^0c
- Addition of scum powder.
- Formation of slag.
- Slag removal.
- After 10 mins degassing tablet 190 was added to remove the entrapped gases (degasification) and Stirrer was introduced.
- Reinforcement material fused SiO_2 powder was added according to the required proportions to molten metal in steps of 3% while stirring.
- Stirrer was rotated at a speed of 0 to 300 rpm to create a vortex in the liquid metal.

C. Percentage composition of matrix and reinforcement material:

Table 2: Different wt% ratios of matrix metal & Reinforcement

Samples	Al 7075 (kg)	Fused SiO_2 (%)
1	2	0
2	2	3
3	2	6
4	2	9
5	2	12

The casting samples with different wt% reinforcements were
Prepared respectively as shown below.

Casting 1: Al 7075 + 0% Fused SiO_2 (%)
Casting 2: Al 7075 + 3% Fused SiO_2 (%)
Casting 3: Al 7075 + 6% Fused SiO_2 (%)
Casting 4: Al 7075 + 9% Fused SiO_2 (%)
Casting 5: Al 7075 + 12% Fused SiO_2 (%)

IV. EXPERIMENTAL DETAILS

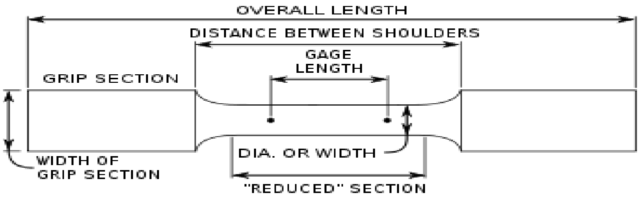

Fig 3: Tensile Specimen

A. Tensile test:

Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. The tests were conducted according to ASTM E8M - 04 at room temperatures

Fig4: Specimens of Tensile test

B. Compression test

Compression test was carried out using a standard 10-ton capacity universal testing machine. Compression tests were conducted on specimens of 20 mm diameter and 3
0 mm length machined from the cast compositesThe tests were conducted according to ASTM E9 at room temperature.

Fig 5: Specimens of Tensile test

V. RESULTS AND DISCUSSIONS:

A. Tensile Test Results

It is observed that the tensile strength and yield strength are increased at 3% weight of Fused SiO_2 The increase in tensile strength is due to the presence of the hard and higher SiO_2 particles embedded in the Al (7075) matrix, which act as a barrier to resist plastic flow when the composite is subjected to strain from an applied load. Also, the decreased interparticle spacing, due to the increasing weight percent of Fused SiO_2 reinforcement, creates increased resistance to dislocation motion, which contributes to the enhanced strength of the composites.

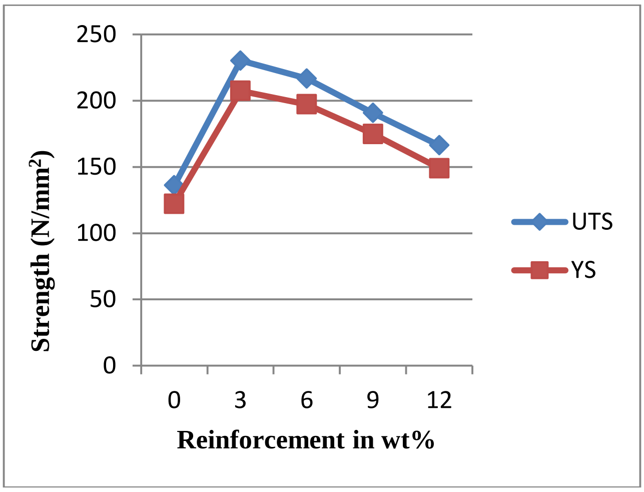

Fig 6: Variation of tensile strength and yield strength

The resultant graph shows that the tensile properties are high in case of the composite Fused SiO_2 as the reinforcement as compared to the aluminium alloy.

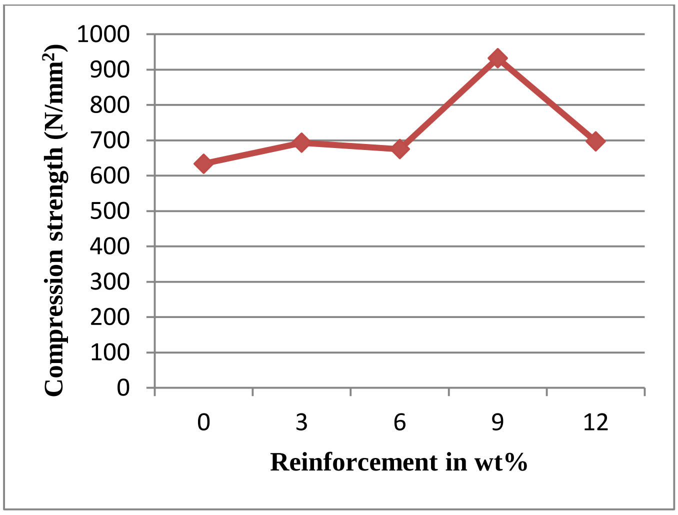

Fig 7: Variation of compression strength

The graph shows that the compression strength has increased with addition of reinforcement.

VI. CONCLUSION:

From the experimental results it has been found that the tensile strength maximum at 3% reinforcement and there is marginal decrease in the tensile strength with increase percentage reinforcement. The compression strength has increased gradually and is maximum at 9% reinforcement.

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