DEVELOPMENT OF MMC'S MECHANICAL CHARACTERIZATIONS AND SEM ANALYSIS OF AL7075 REINFORCED WITH 50NM SILICON CARBIDE PARTICLES

Anil Kumar S Kallimani

Assistant Professor & Head, Department in Mechanical Engineering,
Government Engineering College Huvinahadagali, Karnataka, India

N Chikkanna

Professor & Chairman, Department of Aerospace & Propulsion Technology,
Visvesvaraya Institute of Advanced Technologies (VTU), Karnataka India

Suresha P

Assistant Professor, Mechanical Engineering Department, South East Asian College of
Engineering and Technology, Bangalore, Karnataka, India

Hareesha G

Assistant Professor, Mechanical Engineering Department, Government Engineering College,
Huvinahadagali, Karnataka, India

ABSTRACT

Metal matrix composites of aluminum alloy reinforced with silicon carbide reinforcement are useful in aerospace, automobile and general engineering industries because of their favourable microstructure and mechanical behavior. In this work, Composites of aluminum alloy Al7075 and 50nm silicon carbide were fabricated by using stir casting. Further tests like, compression, tensile, hardness and SEM analysis were carried out. a significant improvement in material strength is observed in aluminum alloy Al7075 metal matrix composite as compared to the Al7075 alloy without silicon carbide addition. Cast base metal and its composites were found to fairly predominantly in brittle mode. The 50nm silicon carbide content varies 0%,2%,4%,6% &8%wt.fractions. Comparison of mechanical properties microstructure studies are presented in this paper.

Keywords: 50 μ SiC, Al7075, MMC's, and Tensile, Compression, Hardness tests and microstructure studies

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1. INTRODUCTION

Metal matrix composites are obtained by popular aluminum alloy series such as 2000,3000,6000,7000 etc which are used in aircraft structure design due to their high strength and weight ratio. due to the demand in high performance of the aircrafts weight reduction methods are used in aviation sector and new materials are under search.(1-5).Aluminum alloys reinforced with silicon carbide (MMC's) have shown greater signs in order to decrease the weight and consequently proved to be better structural components to provide strength to the structure. Vast research work has been undergoing in the area of MMC's. Because of their weight to strength ratio, MMC's are gradually replacing the popular Al.alloys which were used post world war in Aircraft and in other applications (8-16).

Present work describes the production of MMC's by using stir casting technique tensile, compression, hardness microstructure analysis of Al7075 Aluminum alloy with reinforcement of silicon carbide with various %wt.

Table 1 Composition of the Al7075

Element	Wt.%	Element	Wt%
Copper	1.6	Zinc	5.5
Magnesium	2.5	Chromium	0.15
Silicon	0.4	Titanium	0.2
Iron	0.5	aluminum	Balance
Manganese	0.3		

The aluminum zinc alloy matrix is being chosen in this work as it is mostly used to make bulkheads and struts of undercarriage, engine mountings which carry concentrated heavy mass in an aircraft. The nanometric SiC powder (size 50nm) is used as a reinforcement with mentioned compositions. This composition was determined on a SPECTROMAX machine. The testing specimens with different wt.fractions were prepared using popular low cost stir casting method.

- For manufacturing of composite samples and their testing, Following machines and equipment's are used. Matrix (Al 7075 alloy) and 50nm SiC Reinforcement (SiC)
- Weighing Machine
- Crucible (Graphite)
- Furnace
- Mould (Mild Steel)
- Stirrer
- Ultrasonic Probe (For ultrasonic stir casting
- Cutting Grinder
- Universal Testing Machine, Hardness and Lathe machines

2. DEVELOPMENT OF MMC'S BY USING STIR CASTING PROCESS

The metal matrix composites are produced by using a stir casting process, crucible furnace molten metal poured in to graphite mold casted products as shown in below figure.

Figure 1 Stir casting set up

Figure 2 poured into mold

Figure 3 Casted products

Figure 4 SEM samples

3. EXPERIMENTAL DETAILS

The base of metal matrix and the reinforcing phase for the present studies selected were Al7075 and particles SiC of size 50 μm . Table:1 Presented with the chemical composition of Al7075.

The commercial al-zn alloy blocks were heated at melting temperature with optimum care and standard procedure was followed to obtain the cast composites prepared by using the stir casting that shown in above fig:3.1. The particles were preheated before being introduced into the vortex and stirring of the molten composite were accomplished for 10 minutes at 400 rpm stirrer speed. Pouring temperatures adopted were 477 $^{\circ}\text{C}$. The moulds of 22mm dia. X 210mm length cast composites of Al7075-SiC were obtained. Testing specimens were machined according to the ASTM Standards. Machined specimens of MMC's were undergone for Tensile, Compression, and Hardness tests. The samples of these MMC's were also checked for microstructure observations.

4. RESULTS AND DISCUSSIONS

4.1. Production of MMC's

Developed the metal matrix composites successfully by using the stir casting techniques as shown in fig: 1 and casted products shown in fig 3. The reinforcement of SiC uniformly distributed in base metal of Al7075 and compositions are confirmed with using of SPECTROMAX testing machine.

4.2. Tensile Test

Tensile testing was being carried for Al7075 reinforced with nano SiC specimens as a function of percentage weight. The following results obtained for various combinations which are shown below table: 1 and variation of these values have been interpreted in the form of graphs in below fig: 5, 6 & 7

Table 2 Tensile test properties

Sl	Compositions	UTS (Mpa)	YS (Mpa)	% Elangation
1	0%SiC+Al7075	213.15	174.49	14.29
2	2%SiC+Al7075	227.36	181.32	14.10
3	4%SiC+Al7075	252.89	199.89	13.2
4	6%SiC+Al7075	299.62	234.62	12.6
5	8%SiC+Al7075	359.69	259.69	11.10

Figure 5 ASTM-E8

Figure 6 Ultimate tensile Strength

Figure 7 Percentage of Elongation

Figure 8 Yield Strength

From figure 6 & 7 from the graphs, it is very much clear that tensile strength and yield strength have been gradually increased with the gradual increase in wt. Percentage of nano SiC. It is also observed that percentage elongation of Al7075-SiC is decreasing with increase in the weight percentage of reinforcement. Which clearly indicates in the fig: 8

4.3. Compression Test

Table 3 Compression strength properties

Sl	Compositions	Compression strength (Mpa)
1	0%SiC+Al7075	631.28
2	2%SiC+Al7075	659.15
3	4%SiC+Al7075	715.82
4	6%SiC+Al7075	768.33
5	8%SiC+Al7075	783.03

Figure 9 ASTM

Figure 10 Compression strength

From the figure 10 Compression tests for the prepared specimen also revealed that compression strength of the specimen are higher than that of their base matrix. and have shown better increased compression strength values for the chosen wt.fractions of nano SiC. which will lead to improve the brittleness of MMC's.

4.4. Hardness Test

Table 4 BHN

Sl	Compositions	BHN
1	0%SiC+Al7075	66.60
2	2%SiC+Al7075	74.30
3	4%SiC+Al7075	82.17
4	6%SiC+Al7075	99.40
5	8%SiC+Al7075	110.60

Development of MMC's Mechanical Characterizations and SEM Analysis of Al7075 Reinforced with 50nm Silicon Carbide Particles

Figure 11 ASTM

Figure 12 BHN although heat treated

Al7075-T6 and Al7075-T651 alloys show good resistance to plastic deformation under predetermined loads, The nonmetric SiC reinforced specimens also were tested using indenter at an applied load of 100N and are presented in figure 12 From the figure, it shows that higher values of hardness were obtained with increase in the amount of reinforced SiC.

4.5. Microstructure Studies using SEM

Figure 13 SEM analysis of Al7075/SiC

Figures: 13 (a-e) is presented with the microphotographs (SEM analysis) of cast Al7075-nanoSiC samples respectively. Suitable sizes were taken from the prepared samples. These pieces are prepared carefully by polishing the surface using graded sequence of abrasive materials to get flat scratch free surface for the micro structural analysis. The distribution of reinforced SiC particles in Al7075 matrix with 0, 2, 4, 6, and 8 weight percentages was studied using scanning electron microscope. The above images shows silicon carbides of mesh 600 under magnification 1500x and the images reveal the uniform distribution of SiC particles in Matrix material.

5. CONCLUSIONS

The significant conclusions of the studies on Al7075-50 nm SiC metal matrix Composites are as follows.

1. Stir casted Al7075 reinforced with SiC were successfully adopted in the preparation of Al7075-SiC composites containing the filler contents from 0% to 8 wt % of SiC.
2. The microstructure topography of the reinforced matrix surface revealed the uniform distribution of the particles in the matrix system.
3. The tensile strength properties of the composites are found higher than that of base Al7075 alloy.
4. Improved compressive values obtained with increase in the weight percentage of SiC.
5. It was also observed that hardness value showed better improvement with higher BHN
6. Images of the samples taken from scanning electron microscope suggests uniform distribution of SiC
7. From the studies in overall it can be concluded that Al7075-SiC exhibits superior mechanical properties.
8. Improved results can be worked out by different fabrication methods and also by using different sizes of nano SiC particles.

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