EXPERIMENTAL INVESTIGATION ON MECHANICAL PROPERTIES OF ALUMINUM 8090 REINFORCED WITH SiC

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Abstract— Use of Aluminum composites is increased in the defense and aerospace industries. Al–Li based composite have gained increasing importance in the recent years due to their low density coupled with high strength and stiffness. The objective of this work is manufacturing of aluminum (8090) based composite reinforced with SiC. A stir casting technique is used to produce new class of composite. This composite have light weight with superior mechanical properties. In this study we are estimating various mechanical properties like tensile strength, impact strength, hardness and compressive strength with increase in weight percentage of SiC.

Index Terms - *Al-Li composites, Stir casting, tensile strength, impact strength, hardness and compressive strength.*

I. INTRODUCTION

We have a great need of materials to processing the every object with special required properties for the emerging new technology. But the conventional materials are unable to meet these special properties like high strength to weight ratio. To reach these special properties we are preparing the new materials with the combination of two or more insoluble materials called as composites.

A number of processing routes have been developed for fabrication of Al based MMCs. Widespread use of many of these methods is limited by the high cost associated with them. Melt stirring or stir casting technique is a simple and cost effective fabrication route for the manufacture of composites. However, a large number of process variables must be controlled in stir casting technique to achieve a high degree of micro-structural integrity. Use of non-optimal parameters could lead to low density and low-quality microstructures and this will in turn lead to poor mechanical properties. Al–Li alloys have gained increasing importance in the recent years due to their low density coupled with high strength and stiffness.

Among the many ceramic reinforcements SiC particle has been found to have excellent compability with the Al-matrix. The incorporation of SiC particulates into the aluminium matrix results in increase of strength and young's modulus, thus improving the specific properties of the material. Al-Li-SiC composite exhibits superior mechanical properties compared with the unreinforced alloy.

II. SAMPLES PREPARATION

There are numerous methods for fabricating the composites. Some methods have been borrowed, but many were developed to meet specific design or manufacturing challenges.

Stir casting technique involves incorporation of ceramic particulate into liquid aluminum melt and allowing the mixture to solidify. Here, the crucial thing is to create good wetting between the particulate reinforcement and the liquid aluminum alloy melt. The simplest and most commercially used technique is known as stir casting technique. The stir casting technique involves the introduction of pretreated ceramic particles into the vortex of molten alloy created by the rotating impeller.

TABLE I: Preparation of Samples with different compositions

Sample No	Matrix	Reinforcement	Total Weight (gms)
	Al 8090 (gms)	SiC (gms)	
1	912 (96%)	38 (4%)	950
2	874 (92%)	76 (8%)	950
3	836 (88%)	114 (12%)	950

Fig 1: Stir Casting Machine

The experimental arrangement consists of the main furnace and components along with three mild steel stirrer blades. The first process in the experiment is preheating. Here, the empty crucible and the reinforcement powder, namely SiC are heated separately to a temperature close to that of the main process temperature. The melting of the aluminum alloy 8090 ingot is carried out in the graphite crucible inside the furnace. Initially, the ingot was preheated for 4–5 hours at 560°C. At the same time silicon carbide powder are also preheated to 300^0 C in the muffle furnace. Then, the crucible with aluminum alloy is heated to 840^0 C while the preheated powder is mechanically mixed with each other below their melting points.

Fig 2: Samples of New Composite Materials

We were maintaining the same temperature in the furnace and place the metal matrix. The furnace completely melts the pieces of aluminum alloy and the powder of Silicon Carbide. The stir-ring mechanism is lowered into the crucible inside the furnace and set at the required depth. The vigorous automatic stirring of the material takes place for 10 min with 700 rpm of stirring rate, there-by uniformly dispersing the additive powder in the aluminum alloy matrix.

III. TESTING OF COMPOSITES

1) Tensile Test:

The ductility of a sample is determined by conducting a tensile strength test on a Universal Testing Machine (UTM). During the this process, the equipment measures the force applied to the sample, and the displacement of the sample (s); along with the original cross sectional area of the sample (A_o) and the original length (L_o), an engineering Stress-Strain Curve can be generated.

Fig 3: Samples after Tensile Testing

2) Brinell Hardness Test:

Brinell hardness is calculated by means of penetrating the indenter into the new composite surface and find the indentation diameter which results the Brinell Hardness Number.

Fig 4: Samples after Brinell Hardness Test

3) Charpy Impact Test:

Impact tests are used to determine amount of energy that the material stores up to fracture. Low Impact strength for brittle materials.

Fig 5: Samples after Charpy Impact Test

4) Compressive Test:

Compressive test is to determine the compressive strength of material. Compression strength is ability of material to withstand the compressive loads to reduce the size of the component.

Fig 6: Samples after Compression Test

IV. RESULTS AND DISCUSSIONS

1) Tensile Test:

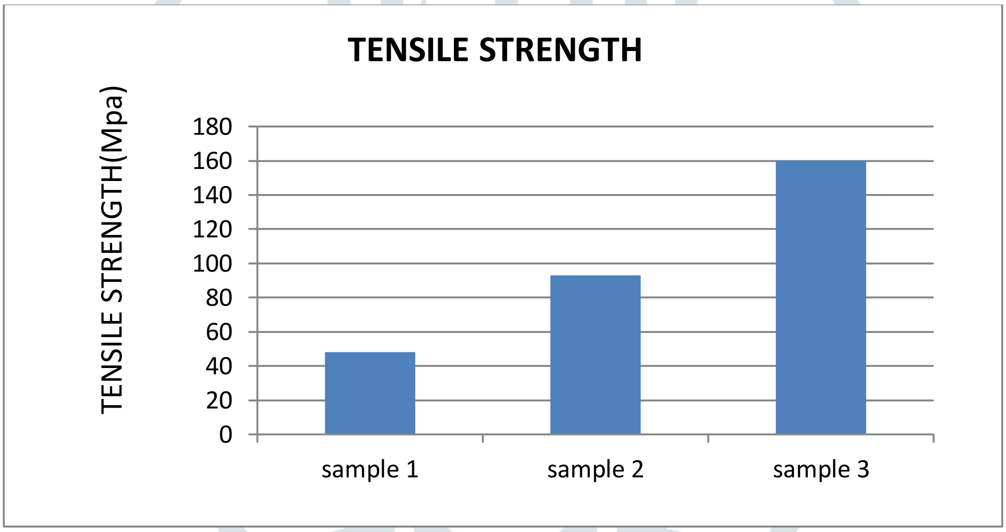

Fig 7: Tensile Test Values of Composites

2) Brinell Hardness Test:

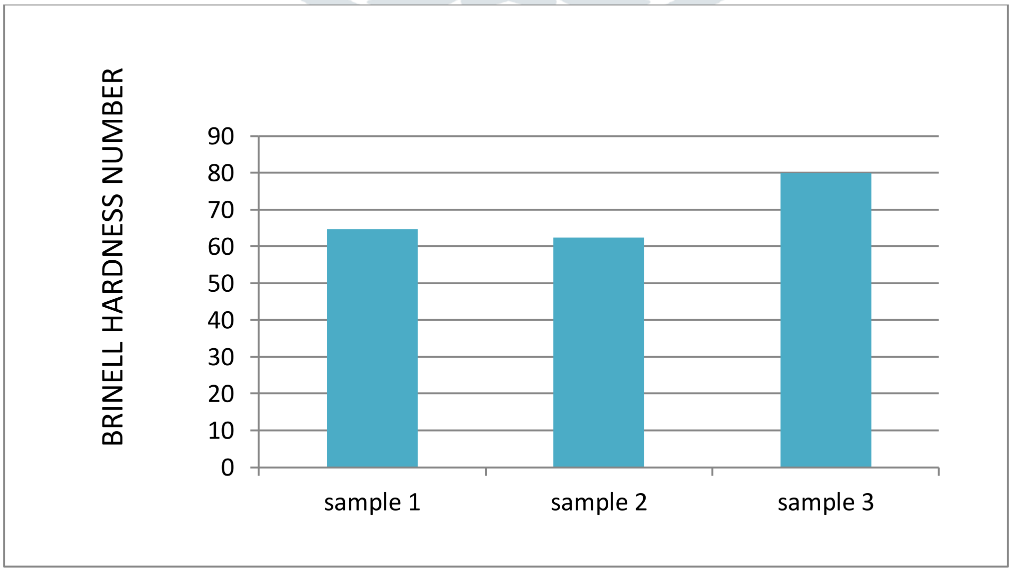

Fig 8: Brinell Hardness Test Values of Composites

3) Charpy Impact Test:

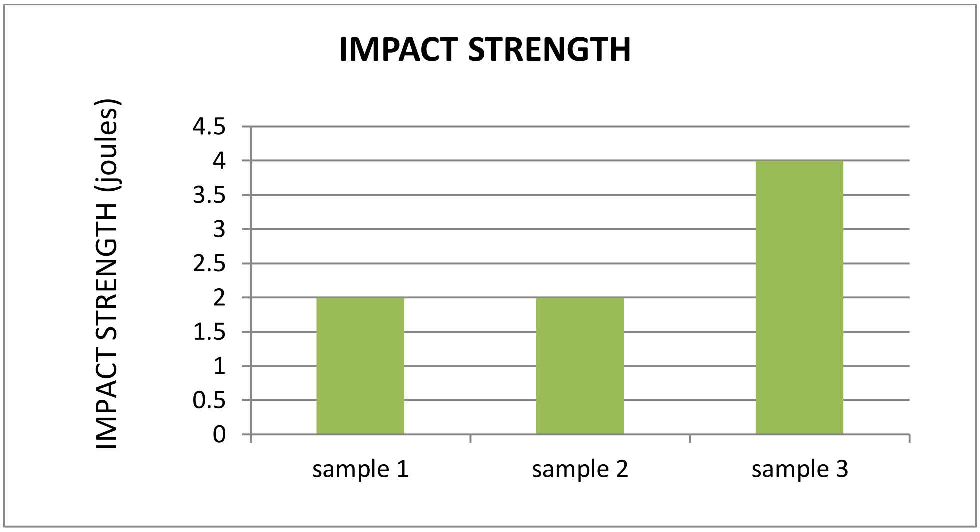

Fig 9: Charpy Impact Test Values of Composites

4) Compressive Test:

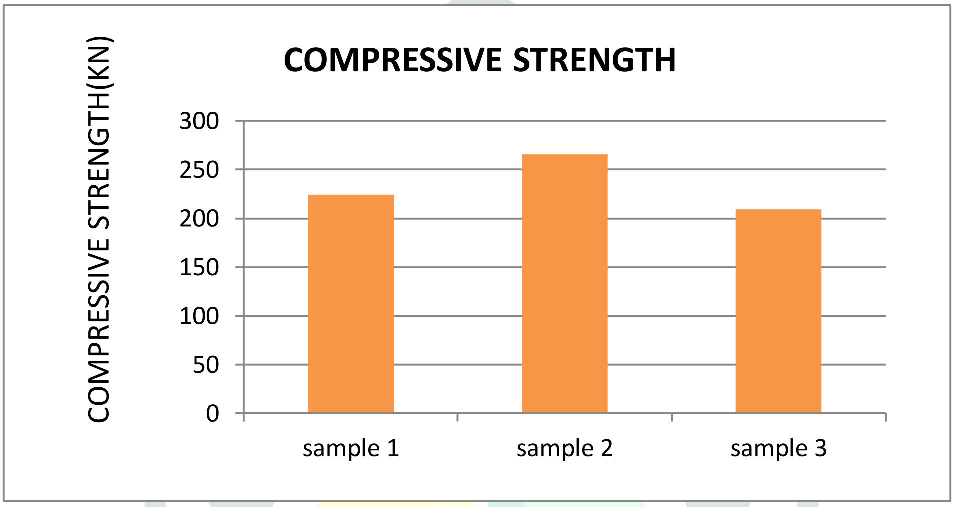

Fig 10: Compressive Test Values of Composites

V. CONCLUSIONS

1. The successful fabrication of a new class of aluminum alloy based composite reinforced with SiC have been done.
2. It been observed that the tensile strength is maximum for sample 3 i.e., 160Mpa which is greater than the samples 1&2 i.e., 48 & 93Mpa. However, the abundant increase in the tensile strength is due to the applied tensile load transfer to the strongly bonded SiC reinforcements in Al matrix, increased dislocation density near matrix-reinforcement interface, and grain refining strengthening effect.
3. However, hardness is found to be more for sample3 of these composites which has a value of 80 BHN. This is due to the presence of harder and well bonded SiC particles in Al matrix that impede the movement of dislocations increases the hardness of AMCs.
4. However, impact strength is found to be more for sample 3 of these composites which has a value of 4 Joules. This due to the aluminum alloy adhesion with the SiC.
5. However, compressive strength is found to be more for sample 2 of these composites which has a value is 266 MPa. This is because SiC being strong material added to Aluminium which requires high strength to compress the AMCs.

REFERENCES

[1] M.Gupta and M.K. Surappa, *"Processing-microstructure-mechanical properties of Al based metal matrix composites synthesized using casting route"*, International Journal of Engineering Materials, Vol. 104107, pp. 259–274, 1995.

[2] D.J.Lloyd, "*Particle reinforced aluminium and magnesium matrix composites",* International Journal of Materials, Vol. 39, pp. 1–23, 1994.

[3] R.J. Arsenault, L. Wang and C.R. Feng, *"Strengthening of composites due to micro structural changes in the matrix"*, International Journal of Metallurgy and Materials, Vol. 39, pp. 47–57, 1991.

[4] Ranjit Bauri and M.K. Surappa, *"Processing and properties of Al-LiSiCp composites",* International Journal of Science and Technology of Advanced Materials, Vol. 8, pp. 494–502, 2007.