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Effect of Silicon Carbide on Mechanical Properties of Aluminium Alloy (A357) Composite (Al Sic)

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Abstract: -- There are various technical challenges to be solved in today's casting technology. For achieving various challenges that to overcome the difficulties faced throughout, for proper mixing or uniform distribution of reinforcements, with base metal/metal matrix is biggest challenge. This affects directly on various factors such as properties and quality of metal matrix composites developed, etc. In the present work a modest/realistic attempt would be made to develop Aluminium based Silicon Carbide composite (AlSiC) with an aim to develop a composites with the conventional low cost, stir casting method/technique has been used and equivalent/subsequent property analysis has been made to develop the composites . Aluminium (a357) having 7%silicon and SiC (100-grit) have been chosen as metal matrix and reinforcement material respectively. Experiments are planned for conducting varying weight fraction of SiC (from 0%-12% in the steps of 3%) while keeping all other parameters like furnace temperatures & total mass of material mixture constant. In this mechanical string is used for proper mixing of silicon carbide in aluminium hot molten metal. The results were evaluated by Tensile test and Brinell Hardness Test (including micro-structure). The trend of Tensile and hardness with increase in weight percentage of SiC were observed and recommendation made for the potential applications accordingly. By this experimental analysis, it is observed that 12% SiC with Aluminium will give the maximum value among the matrix mixture composites prepared.

Keywords: Aluminium Alloy, Ultimate Tensile Strength, Hardness, Microstructure MMCs (Metal Matrix Composites), SiC (Silicon Carbide

I.INTRODUCTION

A composite material is a material composed of two or more different phases (metal matrix phase and reinforced material phase) which improves the mechanical properties significantly. Usually the reinforcing material is mixed or dispersed in the continuous or matrix component. Metal Matrix Composites (MMC) is composite material with at least two constituent parts, one being a metal. The other material may be a different metal or ceramic or organic compound.

Composite material is a material composed of two or more distinct phases (matrix phase and dispersed phase) and having bulk properties significantly different from those of any of the constituents. They usually consist of a continuous phase called the matrix and discontinuous phase in the form of fibres, called the reinforcement. Composite materials are gaining wide spread acceptance due to their characteristics of (MMCs) is due to the relation of structure to properties such as specific stiffness or specific strength They also provide good design flexibility, high die electric strength, and low tooling cost. These properties make them ideal to be used in transportation industries, aerospace application.

Composites materials are high stiffness and high strength, low density, high temperature stability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, improved wear resistance etc. When designed properly, the new combined material exhibits better strength than would each individual material.

II. PROBLEM DEFINITION

The present proposed work is to evolve a develop a metal matrix composites by achieving, the best mix of the alloying elements using stir castings for AlSiC for deriving / checking out maximum mechanical properties such as tensile and hardness for a given material. Proper mixing of SiC, and identifying any porosity or voids if any is verified by microstructure views.

A. Objectives for Development

The development objectives for light metal composite materials are:

- Increase in yield strength and tensile strength at room temperature and above while maintaining the minimum ductility or rather toughness,
- Improvement of hardness of the material.
- Increase in Young's modulus.

B. Application of MMC

Metal Matrix Composite (MMC) is now becoming a trend to replace the structural material with the composites materials, so that composites material will have its enhanced mechanical properties and various physical

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and chemical properties. Aluminium (Al) and silicon carbide (SiC) is widely used aluminium alloy in the foundry industry, engineering structure and composites, due to their light weight, corrosion resistance and proper castability. It is well know that magnesium is added to Al-Si alloys for increasing tensile strength.

III. EXPERIMENTAL METHODOLOGY

With the use of old traditional experimental set-up we can analyze the data in a real time environment or verify the actual results obtained by other methods. The method used is simpler to visualize and understand, but is tougher challenging in terms of manipulation of the input data for finding the various parameters associated with it compared to the output.
The physical experimentation has been carried out under given input conditions at the lab.

A. Steps involved in Stir Casting

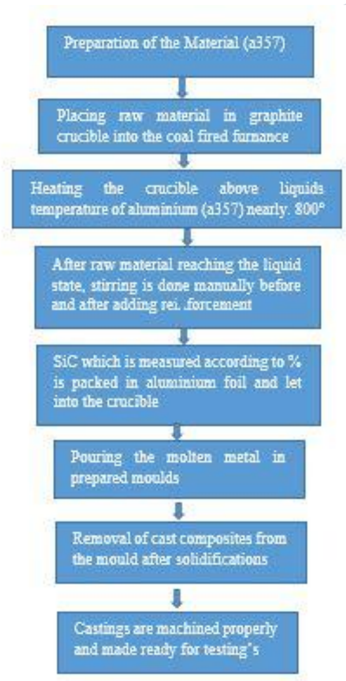

Fig. 1: Flow Chart showing steps involved in Preparing of AlSiC composites in Stir Casting

Aluminium Alloy was melted in a crucible by heating, it in coal fired furnace at 800o C for three to four hours. The SiC particles were preheated at 1000o C for one to two hours to make their surfaces oxidized. Its is then packed in aluminium foil sheet .The furnace was first raised above the liquidus temperature of Aluminium near about 800o C to melt the alloy completely and was cooled down just below the liquidus to keep slurry in Semi solid state. Manual stirring is done for 3-5 min and ensure the proper mixing of the aluminium motel metal in the crucible.
At this stage the preheated SiC reinforcement which is packed inside the aluminium foil let inside the molten metal and again stirred for again 2-3 min. In final mixing process the crucible is maintained at 800o C. While maintaining constant temperature pouring the molten metal in the dies which is prepared by applying chalk powder for its easily removal of the castings.

B. Experimental Procedure:

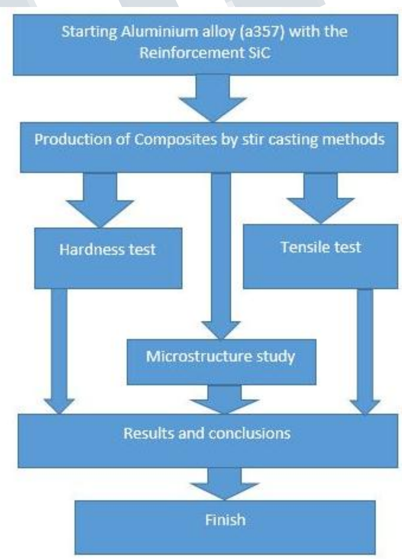

Fig. 2: Flow Chart of Experimental Techniques

C. Steps for Experimental methodology:

Preparation of mould:
Previously prepared cast iron Mould is properly cleaned, to remove dirt and dust on the surface of the mould block,

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after that chalk powder is applied for its easily removal of casting. It acts as a lubricating agent between surface and castings.

Preparation of Specimen of various Compositions:

The alloying element SiC is mixed proportionately by weight in the ratio of 0%, 3%, 6%, 9%, 12%. The percentage of alloying element to be used is determined by literature review and process parameters done previously on this work.

Machining of specimen for test.

- For Tensile Tests , Specimens prepared as per Dimensions, ASTM E9
- For Hardness as per ASTM Ø20 mm and length 20mm
- For microstructure specimens dimensions are Ø20mm and length 20 mm

Ultimate Tensile Test

Tensile test specimens are prepared and tested under tensometer. Tensile test is used to determine the Ultimate tensile load and its displacement, its elongation, etc.

Hardness Test:

Hardness is the resistance of a material to localized deformation. The term can apply to deformation from indentation, scratching, cutting or b ending. Hardness measurements are widely used for the quality control of materials

Microstructure :

Metallographic samples were sectioned from the cylindrical cast bars. A 0.5 % HF solution was used to etch the samples wherever required

Fig. 3: Specimens prepared / machined for tensile test, hardness test and microstructure analysis

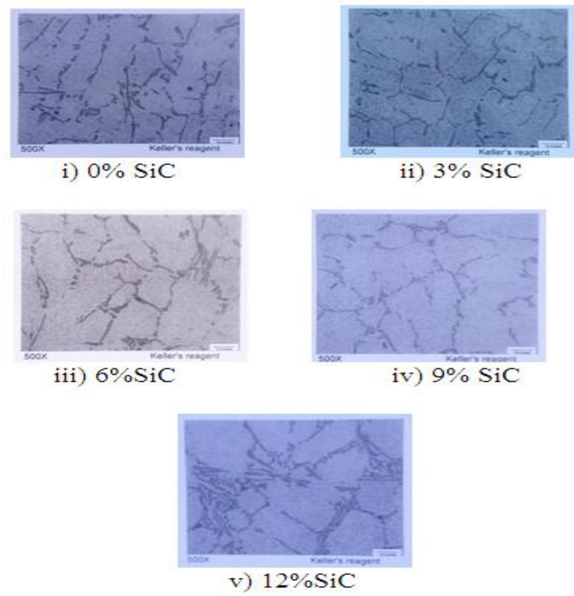

Fig. 4: Optical Micrograph of Al Alloy (A357) - SiC of 16 µm at Resolution 500X

IV. RESULTS AND DISCUSSIONS

The strength values of the material in tensile test are increase, Hardness and wear rate with weight percentage of Sic. The experiments were conducted by varying the weight fraction of Sic from 0% - 12% in the steps of 5 while keeping all the other parameters like furnace temperature, stirring speed and total mass of material mixture in constant.

Table 1: Tensile Test Results

Tensile test		
Perc.	Peak Displacement in mm	Peak Load in N
0%	4.472	4462
3%	3.191	4265.9
6%	3.997	4569.9
9%	2.987	4295.3
12%	4.201	4471.8

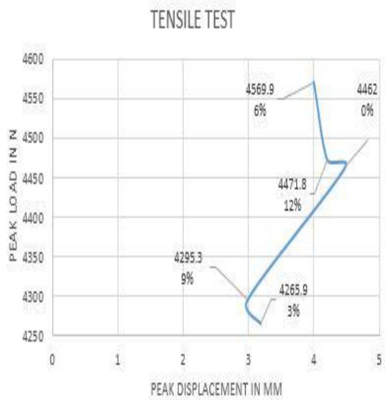

Fig. 5: Graph of tensile test results (A357) - Sic of 16 μm

From the above table and graph it is clear that at Al alloy of 0% SiC it is having peak load of 4462N but after increasing SiC 0% to 3% SiC in peak load slightly decreases to 4265.9N after then it gradually increases up to 12% addition of SiC to its peak load 4471.8 N which it is maximum in the present work compositions.

Table 2: Hardness Test Results

HARDNESS TEST			
Perc.	Applied Load	Average Dia. of Indentation	Brinnell Hardness (HBW 4/250)
0%	250	2.4	51.9
3%		2.46	52.7
6%		2.5	54
9%		2.54	56.3
12%		2.58	57.9

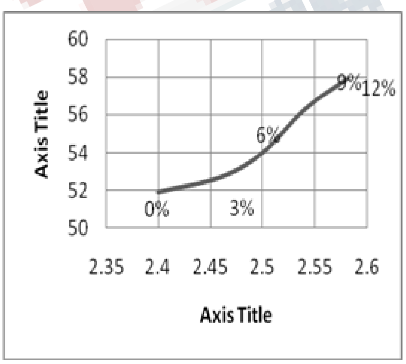

Fig. 6: Graph of tensile test results (A357) - Sic of 16 μm

From the above table and graph it is clear, that hardness value Increases gradually as the reinforcement used here is very small about 16 μm so this composites is applicable for hard area of applications are not supported by adequate data and critical details.

V. CONCLUSION

The experimental study reveals following conclusion:
Microstructure: optical micrographs showed reasonably uniform distribution of SiC particles
Tensile: Tensile strength will gradually increase with peak load v/s peak displacement. UTS increases from 0%to 6% and decreases at 9% so better to use 6% Sic with Al alloy (a357) for better UTS.
Hardness: hardness property in this composite is conducted on Brinell hardness testing machine, so that it gradually increases, so better to use this composite in hard load area applications

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