

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Vol. 9, Issue 2, February 2020

A Review of Aluminum (Al7075) SiC & TiO₂ with Stir Casting

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ABSTRACT: In this project work, appropriate combination of matrix material leads to a new material that can be made to exactly meet the requirements for a specific application. The scope of this research includes developing Aluminium based hybrid composite material using Al7075 as matrix and SiC and TiO₂ as by stir casting method. Silicon carbide possesses high density, high hardness, high fracture toughness and excellent strength over a wide range of temperature and titanium dioxide posses' good thermal shock and chemical resistance. Developed composites were subjected for microstructure and SEM/EDAX studies and hardness and tensile characterization. Microstructure shows, Sic & TiO₂ particles are uniformly distributed throughout the matrix. Mechanical studies of Al7075 + SiC + TiO₂ have exhibited higher hardness and tensile strength with excellent one.

KEYWORDS: Aluminium Al7075, Silicon carbide, Titanium dioxide, body of aircraft, Composite material.

I. INTRODUCTION

In this project Stir casting of metal matrix composites (MMC) was initiated in 1968, when S. Ray introduced alumina particles into aluminium melt by stirring molten aluminium alloys containing the ceramic powders. In a stir casting process, the reinforcing phases are distributed into molten matrix by mechanical stirrer. Mechanical stirring in the furnace is a ceramic particles, can then be used for die casting, permanent mould casting, or sand casting. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement. The cast composites are sometime extruded to reduce porosity, refine the microstructure. A major concern associated with the stir casting process is the segregation of reinforcing particles which is caused by the surfacing or settling of the reinforcement particles during the melting and casting processes. The final distribution of the particles in the solid depends on material properties and process parameters. A goal of our project to improve the hardness of aluminium with use of high hardness material to withstand the hardness of outer body structure of aircraft applications etc....

Testing Process

Aluminium-Al7075

Aluminium 7075 is an aluminium alloy, is a primary alloying element. Al7075 alloy's composition roughly includes 5-10% silicon carbide, titanium dioxide 2.5-7.5%, and then half a percentage of other metals.

Silicon Carbide-SiC

Silicon Carbide 5-10%, add with aluminium 7075 90% to the composition of this material.

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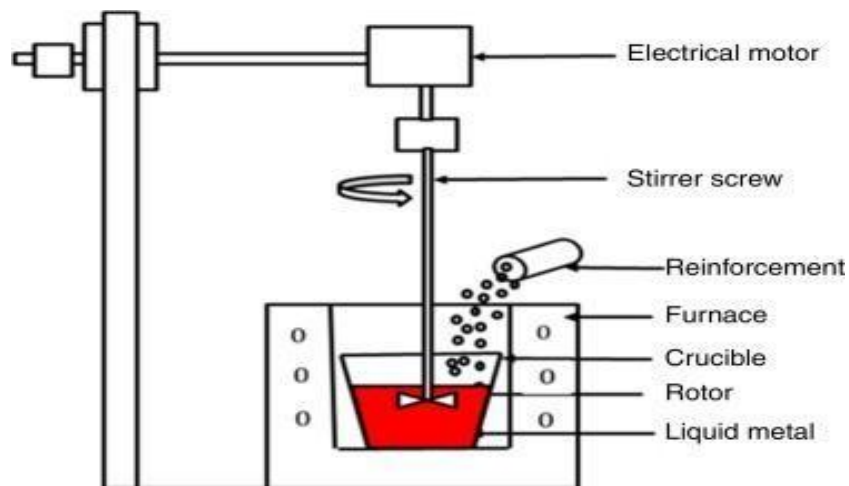
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Titanium Dioxide-TiO₂

Titanium dioxide 2.5-7.5%, add with aluminium 7075 90% to the composition of this material.

Stir Casting Machine Process

Stir casting is an economical process for the fabrication of aluminium matrix composites. There are many parameters in this process, which affect the final microstructure and mechanical properties of the composites. In this study micronized SiC & TiO₂ particles were used as reinforcement were used as reinforcement to fabricate Al-7075 SiC & TiO₂ composites at two casting temperatures (680 and 850 °C) and stirring period (2 and 6 min). The higher stirring temperature (850 °C) also leads to improved ceramic incorporation, In some cases, shrinkage porosity and intensive formation. Finally the mechanical properties of the composites were evaluated.



Fig(a). Stir Casting

Hardness test methods

Hardness is resistance of material to plastic deformation caused by indentation.

Brinell Hardness Test

Dr. J. A. Brinell invented the Brinell test in Sweden in 1900. The oldest of the hardness test methods in common use today, the Brinell test is frequently used to determine the hardness of forgings and castings that have a grain structure too coarse for Rockwell or Vickers testing. Therefore, Brinell tests are frequently done on large parts. By varying the test force and ball size, nearly all metals can be tested using a Brinell test. Brinell values are considered test force independent as long as the ball size/test force relationship is the same. In the USA, Brinell testing is typically done on iron and steel castings using a 3000 Kg test force and a 10 mm diameter carbide ball. Aluminum and other softer alloys are frequently tested using a 500 Kg test force and a 10 or 5mm carbide ball. Therefore the typical range of Brinell testing in this country is 500 to 3000kg with 5 or 10mm carbide balls. In Europe Brinell testing is done using a much wider range of forces and ball sizes. It's common in Europe to perform Brinell tests on small parts using a 1 mm carbide ball and a test force as low as 1kg. These low load tests are commonly referred to as baby Brinell tests. Standards Brinell Test methods are defined in the following standards

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Standards

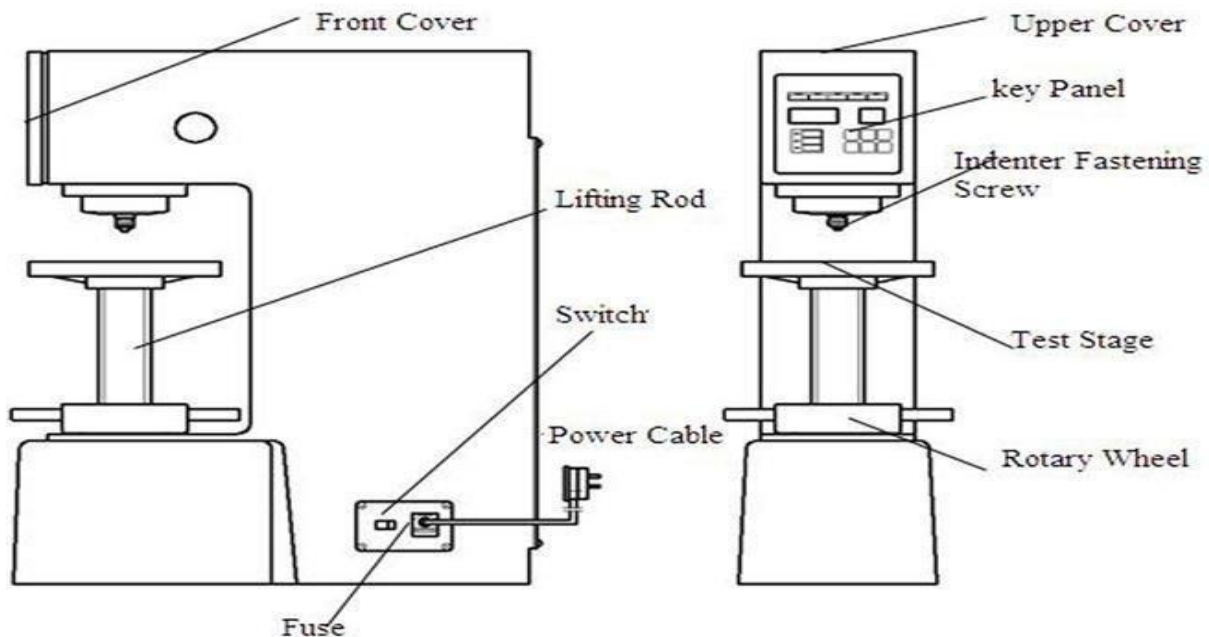
Brinell Test methods are defined in the following standards:

- ASTM E10 ; ISO 6506

Brinell test method

All Brinell tests use a carbide ball indenter. The test procedure is as follows:

- The indenter is pressed into the sample by an accurately controlled test force.
- The force is maintained for a specific dwell time, normally 10 - 15 seconds.
- After the dwell time is complete, the indenter is removed leaving a round indent in the sample.
- The size of the indent is determined optically by measuring two diagonals of the round indent using either a portable microscope or one that is integrated with the load application device.
- The Brinell hardness number is a function of the test force divided by the curved surface area of the indent. The indentation is considered to be spherical with a radius equal to half the diameter of the ball. The average of the two diagonals is used in the following formula to calculate the Brinell hardness. where: HB = the Brinell hardness number F = the imposed load in kg D = the diameter of the spherical indenter in mm d = diameter of the resulting indenter impression in mm The Brinell number, which normally ranges from HB 50 to HB 750 for metals, will increase as the sample gets harder. Tables are available to make the calculation simple.



II. EXPERIMENTAL PROCEDURE

Mechanical stir casting is a liquid state method for the fabrication of composite materials, in which a different dispersed phase is mixing with a metal matrix by means of mechanical stirring. Stir casting is the simplest and the most cost effective method of liquid state fabrication. The stir casting set-up is shown in Fig(a). Three combinations of mixing

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material(5%, 2.5%, 5%, 7.5% of SiC & TiO₂) are fabricated with aluminium metal matrix. The aluminium is a light metal so mixing two hard to improve the hardness of aluminium that improve hardness and use for aircraft body, ships etc...

STIR CASTING METHODOLOGY FOR AL 7075 ALLOY STIR CASTING ROUTE FOR FABRICATION OF MMC

Preparation of Casting:

The base material used is Al7075 alloy. The required amount of Al 7075 alloy was placed in crucible in an electric heating furnace to a temperature of about 750-800o C maintained. The base metal Al7075 taken as 5.5kg for a casting and 5% of Silicon Carbide and the reinforcement Titanium Dioxide material with 0 vol.%, 2 vol.%, 4vol.% & 6vol.% of composites was prepared.The molten alloy was degassed (to prevent hydrogen gasses) and after a few minutes the slag formed was removed. The stirrer was carefully placed at a required depth in the crucible and stirred at 650rpm to form a vortex. The reinforcement material added in to vortex and stirred for about 5-10min to obtain a homogenous mixture. The molten mixture carefully poured into the moulds box to obtain the castings, which are later allowed to cool and checked for any defects in the castings.Further samples were prepared as per the ASTM standards for the evaluation of mechanical properties of proposed composites.Stir casting furnace After it is cooled down to temperature between liquid and solidus state means it is in a semi-solid state. Then preheated reinforcement particles are added to molten matrix and again heated to fully liquid state and are stirred thoroughly for a homogeneous mixture with the matrix alloy. In this method, the particles get accumulated often; the accumulated particles can be dissolved at higher temperature by vigorous stirring. The liquid composite materials is then poured into the sand/die casting mould and then allowed to solidify. Stir casting is suitable for manufacturing composites with up to 30% volume fractions of reinforcement. A major concern in associated with the stir casting is segregation of reinforcement particles due to various process parameters and material properties result in the non- homogeneous metal distribution. Melting the 7075 Al alloy at 900 - 950°C Preheating the (SiC + TiO₂) mixture for 500 °C Mix the preheated mixture in molten metal Stirring is done for 3 - 4 min Molten Metal (MMC's) is poured into the die Stir casting technique implemented Varying process parameters done Cast the solid component Samples are prepared Specimen preparation as per the ASTM standards Metallurgical & Mechanical properties ofMMC (Microstructure, SEM, Hardness, Tensile).

Tabulation of testing parameters

SI No	Testing Parameter of SiC & TiO ₂	Values
1.	Hardness	600 & 9330
2.	Strength	240 & 333.3
3.	Wear	4.1 & 4.8
4.	Density	4.3 & 3.97

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Journal paper

From the above practically observed results and the table it can be this paper discusses how to improve the hardness of aluminium using some materials to withstand the hardness of aircraft and other applications.

International Journal of Scientific and Research of Publications, volume. 6, Issue 6, June - 2014

Applications

1. High strength to Density ratio: Transport, Aviation, Marine, Automotive.
2. The strength and lightweight characteristics enhances the applications in other fields.
3. Excellent corrosion resistance
4. Heat treatable and High hardness

III. CONCLUSION

From the result and analysis of the investigation the following conclusions MMCs(AI7075+SiC+TiO₂).

1. From the liquid metallurgy techniques AI7075 base alloy, AI7075+SiC+TiO₂ composites were prepared successfully.
2. The hardness of as cast AI7075-2.5%TiO₂+5%SiC MMCs is increased by and 40% when compared with AI7075 base alloy.
3. In this study of composites are used to increase the hardness of aerospace outer body in this all materials SiC & TiO₂ the two materials have high hardness to improve the outer surface part of all automotive vehicles.
4. From the investigation it was concluded that, composites containing 5wt% Titanium Dioxide and 5wt% Silicon Carbide reinforcements exhibited superior mechanical properties.

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