Effect of Processes Parameter on Mechanical Properties in Aa2218-Fe2o3 MMCS Processed by Stir Casting

Puneet Kumar
Assistant Professor
Department of Mechanical Engineering
MIT Moradabad
Moradabad, India
puneetmit1984@gmail.com

***Abstract*:** The experiment is done to find out the behavior of MMCs by stir casting using raw material as AA2218 with Iron oxide (Fe_2O_3). In AA2218 material Fe_2O_3 is mixed at different stirrer speeds such as 180, 250 & 400 rpm. After casting is done the specimens are prepared for testing microstructures are taken out and compared with the stirrer cast MMCs microstructures. The mechanical properties are evaluated such as hardness test, tensile strength test and toughness test. The effect of stirring speed and particle content on microstructure, mechanical properties of the composites such as hardness and tensile strength are reported and discussed.

Keywords- *Metal Matrix Composites, Stir casting, Fe_2O_3 particles, American Standards for Testing Material.*

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I. INTRODUCTION

In present time there is a need of material having good mechanical properties and with the low weight and density and can resist at high temperature such as composites.

Composites are the materials manufactured by adding two or more materials which are in physically and/or chemically distinct phases. In present study, authors have investigated the effect of stirring speed on retention of Fe_2O_3 particles in AA2218 aluminum alloy matrix by stir casting. Stir-casting set-up is currently the simplest and most commercially viable method of production of MMCs.

The need of metal matrix composites in the real word is used to produce where wide application of mechanical properties like high tensile strength, hardness, toughness. It is important for such applications in aerospace, jet engine exit vanes, blades sleeves of helicopters, parts of space shuttle, piston and cylinder liners, brake drums and discs.

II Experimental Procedure:

A. Microstructure:

The microstructures of the cast MMCs are taken out using the microscope of high resolution. The microstructure of the casting at different stirrer speed is different. The distribution of the Fe_2O_3 particles throughout the base material changes with the speed variation.

Specimen made for microstructure is made using grinding and polishing. Firstly grinding is done on one phase of the work piece, then finishing is carried out with the help of emery papers of the size 320, 400, 600 .The finishing of the surface using emery paper is done in only one direction. The direction of the emery paper should be right perpendicular to the previous surface finish. This action issued to provide better surface finish of the work piece. After this whole process the polishing take place for the finishing of the work surface at microlevel and to remove silicon layer. In polishing process the coolant is used to prevent heating of sample due to friction offered by the sample and polishing cloth. After these all process of the surface finishing the sample is put on the microscope by setting the lenses and resolution we can carried out the clear image of particle distribution of the additive in the base material. In our experiment we took the 100,200 and 400 times resolution of the sample showing in figure. Image of materials are carried out by linking the microscope to computer. Black spots are showing the distribution of the Fe_2O_3particles throughout.

Fig: 1 sample of microstructure specimen prepared from the casting.

B. Tensile Test:

Tensometer is used to determine the tensile strength, proof strength and ductility of the prepared specimens. A tensometer is used to evaluate the Young's modulus of a material.

Properties of materials, such as tensile strength is carries out with tensometer.It is usually a universal testing machine loaded with a sample between 2 grips that are adjusted manually or automatically for the application of force to the specimen. Composites have been tested under uniaxial tension on a computerized Electronic Tensometer PC 2000 (Honsfield type, make-Kudale Instruments Pvt. Ltd., Pune, India) at an extension rate 1 mm/min and the average of readings is reported as the tensile property of the material. The specifications of the machine are given here under:

At least three standard tensile specimens of 5.0 mm gauge diameter and 25 mm gauge length as per ASTM E 8M-89b have been machined out form each section of cast and the mean of the readings, if close, has been reported.

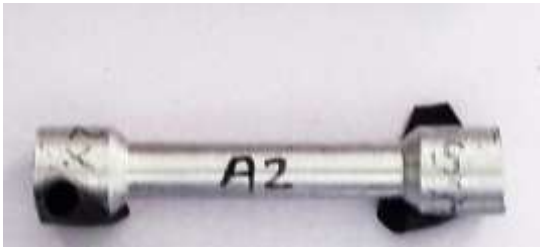

Fig:2 Schematic diagram of tensile specimen as per standard ASTM E 8M-89B.

C. Hardness Test:

Hardness observes the material's ability to resist plastic deformation from a standard source. The Vickers test can be used for all metal sand has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV).

Vicker's hardness testing equipment is used to find out the hardness of the test specimens. Hardness testing was done at 1 Kg load.

The positions of indenton specimen of different cross sections are shown in schematic diagram in Fig: 3. At least three such samples have been tested and the mean result has been reported. All the tests have been conducted within 72 h of casting

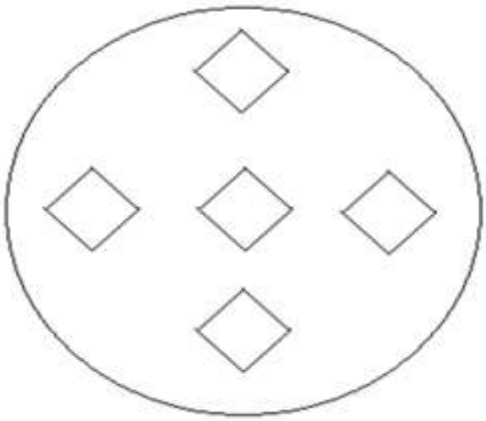

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Fig: 3 Schematic diagram showing indent positions employed in this specimen of circular cross section.

D. Charpy Test:

Charpy test is done to calculate out the toughness of the materials, here we are using it to calculate out the toughness of stir cast AA2218-Fe_2O_3.

The specimen is based on the ASME. This standard size is 10mm×10mm×55mm. the V notch is made in the middle (27.5 mm from each side) of the work piece of 2 mm depth along the length.

The specimen is placed in a simply supported system and hammer strikes on the opposite side of the notch and readings are shown on the circular scale showing toughness.

This procedure is repeated for each and every casting to evaluate its toughness.

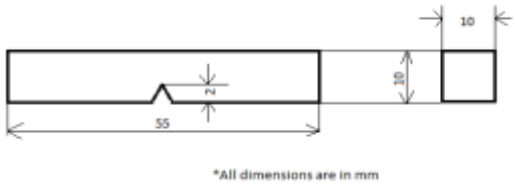


Fig:4 Specimen for Charpy Test

Fig: 5 Picture of Specimen for Charpy Test.

III Experimental Details:

The aluminium alloy 2218 is placed in a crucible which is under the resistance furnace. The furnace is heated at 850^0C for few hours until it got melt then the preheated Fe_2O_3 particles (at70^0C) are mixed at the different stirrer speed such as 180, 250, 400, rpm. The mould in which the molten composite will be poured also preheated with the Fe_2O_3 particles at the same temperature (70^0C) to remove the moisture content present in it.

After few hours until the AA2218's composite got melt. After melting the molten composite is poured in mould and pressed by a stir casting set up. This process provides the Metal Matrix Composites of different stirrer speed.

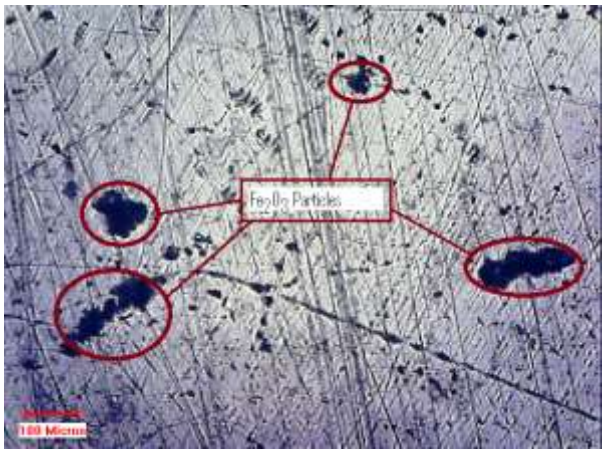
The specimens are made for the mechanical testing such as hardness, tensile strength, toughness tests. The specimens are prepared as per the standards of American Standard for Testing Materials.

Table: 1 Showing the identity no. and description for particular speed.

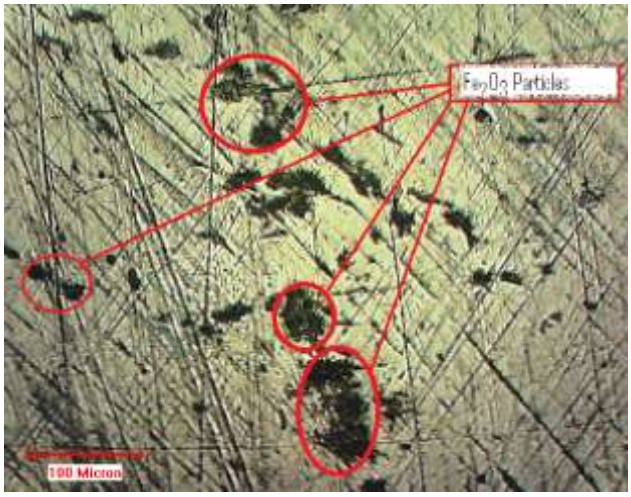
Id No.	Composite	Stirrer speed (rpm)	Temperature (˚C)
S1	AA2218(1000gm) + Fe_2O_3(5 gm)	180	850
S2	AA2218(1000gm) + Fe_2O_3(5 gm)	250	850
S3	AA2218(1000gm) + Fe_2O_3(5 gm)	400	850

IV DISCUSSION:

The microstructure of the stir cast AA2218-Fe_2O_3 MMCs are as follows, here black spots are showing the distribution of Fe_2O_3 particles in the MMCs.



(a1)



(b1)

(c1)

Fig: 6 Microstructures of S1 showing distribution of Fe_2O_3 particles at 100x (a1), 200x (b1) and 500x (c1) respectively after stir casting.

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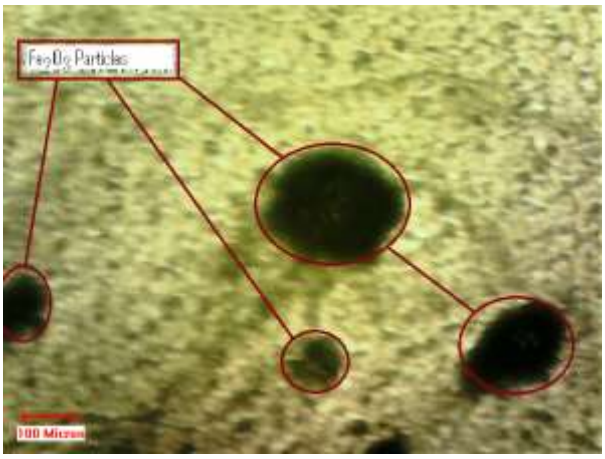
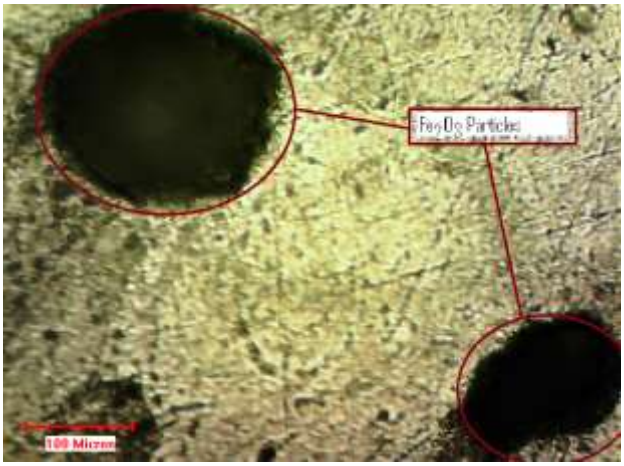
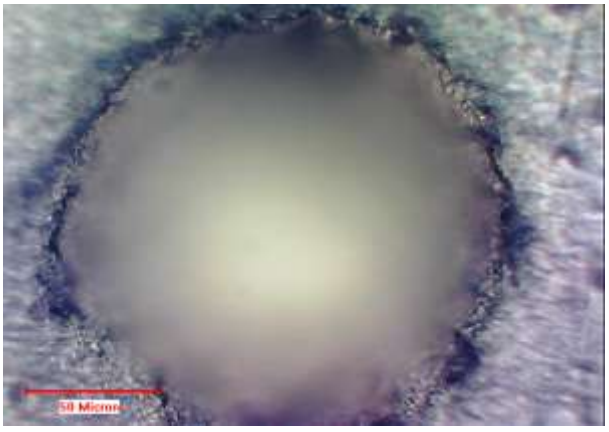


(a2)

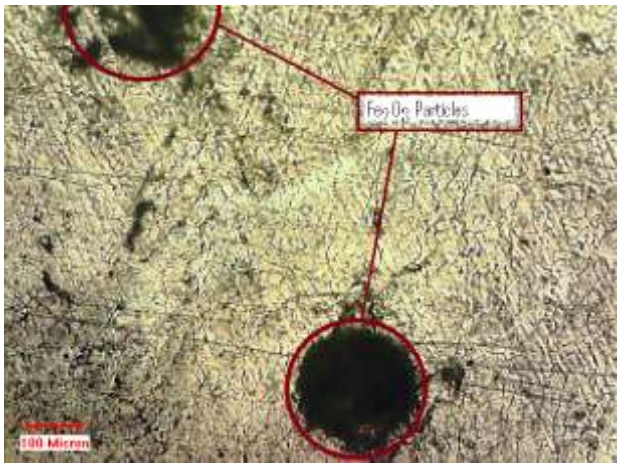


(b2)

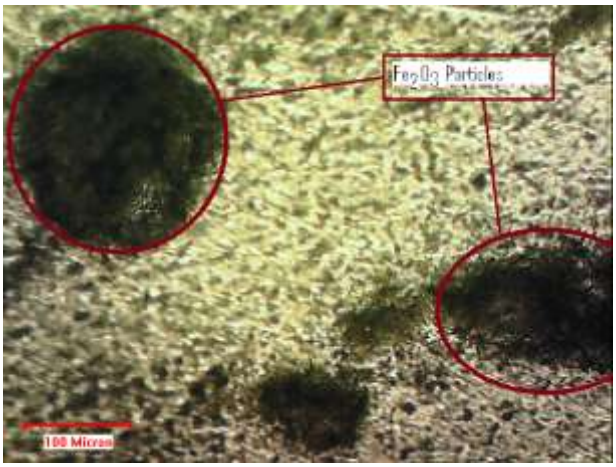


(c2)

Fig: 7 Microstructures of S2 showing distribution of Fe_2O_3 particles at 100x (a2), 200x (b2) and 500x (c2) respectively



(a3)



(b3)

(c3)

Fig: 8 Microstructures of S3 showing distribution of Fe_2O_3 particles at 100x (a3), 200x (b3) and 500x (c3) respectively

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The mechanical properties are tested of the samples made by the stir casting. These tests performed on casting specimens provide the numerical values of mechanical properties at different speeds. The table is showing such values.

Table: 2 showing the values of mechanical properties at the specified stirrer speed.

Id No.	Ultimate Tensile Strength (MPa)	Hardness (VHN)	Toughness (Joule)
S1	8.1	66.8	67
S2	217	269.2	20.6
S3	93.2	181	103

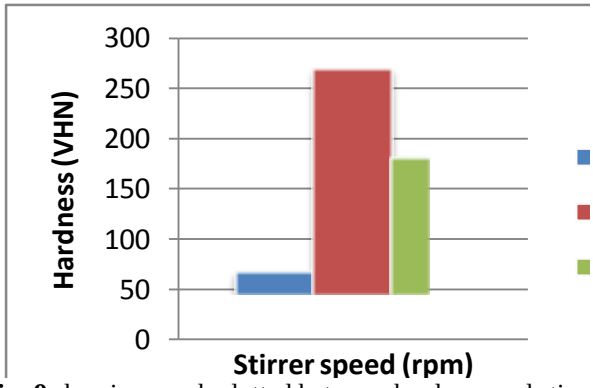

Fig: 9 showing graph plotted between hardness and stirrer speed.

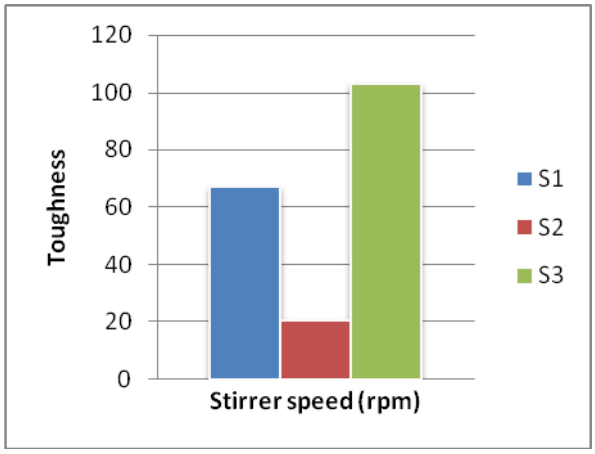

Fig: 10 showing graph plotted between toughness and stirrer speed.

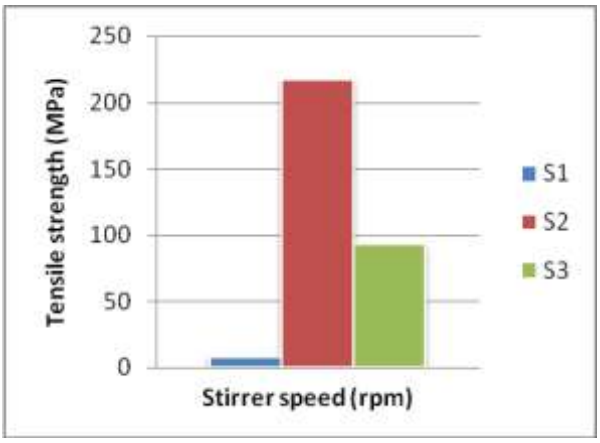

Fig: 11 showing graph plotted between tensile strength and stirrer speed.

V Conclusion:

Following broad conclusions can be drawn from this study.

From Studies on AA2218-Fe_2O_3 Composites:

1. The most remarkable achievement of the above work was the significant improvement in the hardness and the ultimate tensile strength values of the composites formed. It was due to the use of 2218 Al alloy for the preparation of composite.
2. There is good dispersibility of Fe_2O_3 particles in aluminium alloy matrix which improves the hardness of the matrix material and also the tensile strength of the composite.
3. As the number of stirrings is increased, the number of dispersed particles increases, mechanical properties improves but ductility decrease.
4. As the stirring speed is increased, the number of dispersed particles increases, mechanical properties improves.

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