ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

DEVELOPMENT OF AA2218-Al_2O_3 MMCs AND CHARACTERISATION FOR MECHANICAL PROPERTIES

VivekKumar[1],Pradeep Kumar[1], Puneet Kumar[2]

UG Student, Department of Mechanical Engineering, M.I.T. Moradabad (U.P.), India[1]

Assistant Professor, Department of Mechanical Engineering, M.I.T. Moradabad(U.P.), India[2]

Abstract: The experiment is done to find out the behaviour of Metal Matrix Composite made by casting using raw material of aluminium alloy 2218 with alumina (Al_2O_3) with variable speed of stirrer. Metal Matrix Composite is made by melting the aluminium alloy 2218 at 850^0C in muffle furnace by adding Al_2O_3 using stirrer at different speed in the preheated solid state. Addition of Al_2O_3 is used to increase the mechanical strength. Hardness and toughness both can be increased by adding Al_2O_3. Microstructure is also checked to know the location of the additive particles in the aluminium alloy 2218. Tensile strength of MMCs is checked on tensometer, hardness is tested on Vicker hardness testing machine, toughness is tested by charpy test.

Keywords: Metal Matrix Composites, Stir casting, Al_2O_3 particles, American Standards for Testing Material.

I. INTRODUCTION

Now a days we need of materials having good mechanical properties and resistance to withstand with high temperature applications such as composites.
Composites are the materials manufactured by adding two or more materials which are in physically and/or chemically distinct phases[2].The need of metal matrix composite in the real word is used to produce where high application of mechanical properties like high tensile strength , hardness, toughness[2]. 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[2][5].

II. EXPERIMENTAL PROCEDURE

A. MICROSTRUCTURE:

We are seeing the microstructure of the sample of casting made on the certain specified parameters, such as speed of stirrer, additive as Al_2O_3.
By seeing the microstructure of the sample made we can clearly say that how fine the additive is distributed in the base material or the matrix property of the casting.
Specimen made for microstructure is made using grinding and polishing .Firstly there is rough grinding took place on one phase of the work piece, then finishing is done with the help of emery papers of the size 320, 400, 600 .The finishing of the surface is done in only one direction. The next direction will 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 micro level and to remove silicon layer[3].In polishing process the coolant is used to prevent heating of sample due to friction offered by the sample and balvet 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.Here in our experiment we took the 100 times resolution of the sample showing in figure.This image is obtained by linking the microscope to computer.Black dots are showing the distribution of the Al_2O_3 particles throughout.

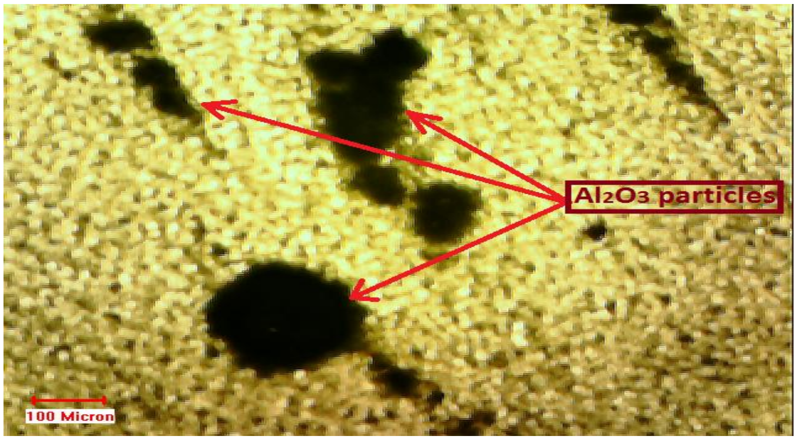


Fig:1 Showing Al_2O_3 particles distribution.

B. TENSILE TEST:

Here we have used tensometer to determine the tensile strength, proof strength and ductility of the prepared specimens. A tensometer is a device used to evaluate the Young's modulus (how much it stretches under strain) of a material and other tensile properties of materials, such as tensile strength. It is usually a universal testing machine loaded with a sample between 2 grips that are either adjusted manually or automatically to apply 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 [1] have been machined out form each section of cast ingot and the mean of the readings, if close, has been reported. Standard deviations have not been shown in the figures.

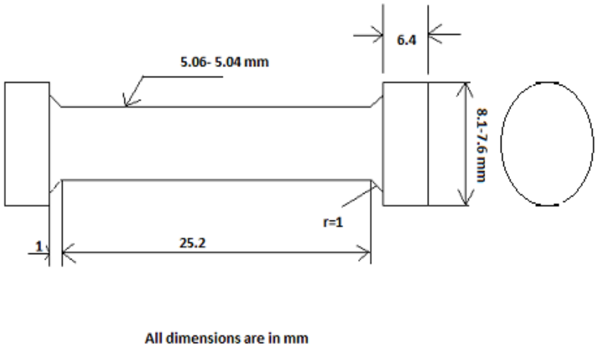


Fig:2 Schematic diagram of tensile specimen as per standard ASTM E 8M-89B.

C. HARDNESS TEST:

The basic principle, as with all common measures of hardness, is to observe the questioned 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) or Diamond Pyramid Hardness (DPH).

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

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

The indent positions on 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 as the time delay in sample preparation was inevitable.

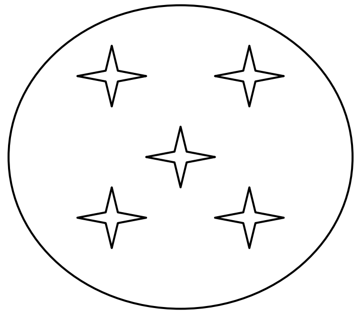


Fig:3 Schematic diagram showing indent positions employed in this specimen of circular cross section.

D. CHARPYTEST :

Charpy test is performed to evaluate the toughness of the materials,here it is metal matrix composite using toughness testing machine.
The specimen is made according to the ASME. This standard size is 10mm×10mm×55mm. the V notch is made in the middle (27.5 mm from any side) of the work piece of 2 mm depth along the length.[1]
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 representing toughness.
This procedure is repeated for each and every casting to evaluate its toughness.

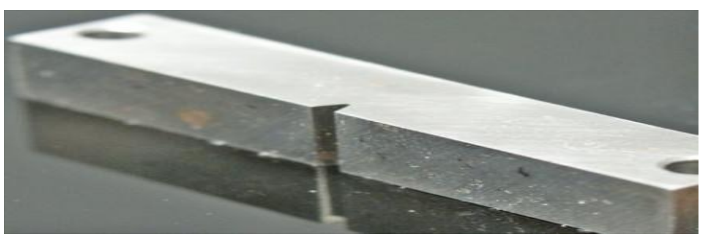


Fig:4 Picture of Specimen for Charpy Test.

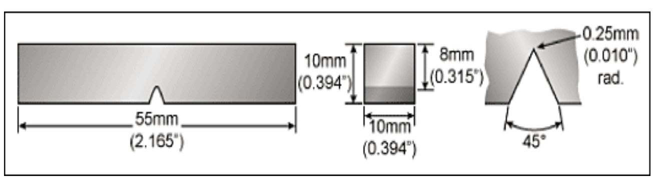


Fig:5 Specimen for Charpy Test

III. EXPERIMENTAL DETAILS

We are using aluminium alloy 2218 as the base material. This alloy having the chemical composition[4] as-

Table: 1 Chemical composition of AA 2218 by weight percentage.

Chemicalcomposition	Al	Cu	Ni	Mg
AA 2218	92.5	4	2	1.5

This alloy is placed in the crucible at 750^0C to 850^0C in the resistance furnace until it got melt completely. When this molten alloy is achieved, the additive(Al_2O_3) is added in it after preheating them at the temperature about 70^0C[6]. These additives are added with the help of stirrer at different speeds placed in the middle of the crucible[7][8]. The matrix of the

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

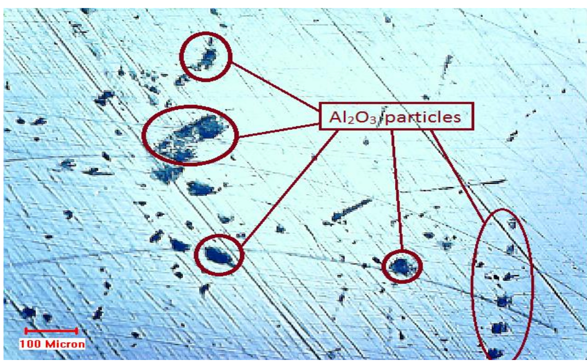
base metal is formed this metal matrix composite is poured in the mould and the casting is found after solidification. Firstly the casting is made of Al_2O_3MMC.
After getting such casting the specimen are prepared according to the standards made for particular testing and the microstructure specimens are made. The tests performed are tensile test, hardness test, toughness test.

Table:2 Showing the identity no. and description for particular speed.

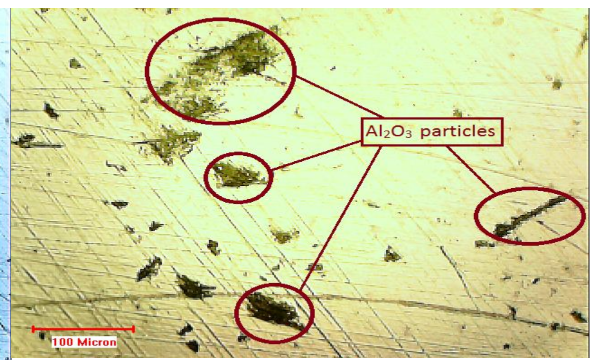
ID NO.	Composite	Stirrer speed (rpm)	Temperature (˚C)	Group Assigned
A1	AA2218 (1000gm)+Al_2O_3(5 gm)	180	850	A
A2	AA2218(1000gm)+Al_2O_3(5 gm)	250	850	A
A3	AA2218(1000gm)+ Al_2O_3(5 gm)	400	850	A
A4	AA2218(1140gm)+Al_2O_3(10gm)	1400	850	A

IV. RESULTS AND DISCUSSION

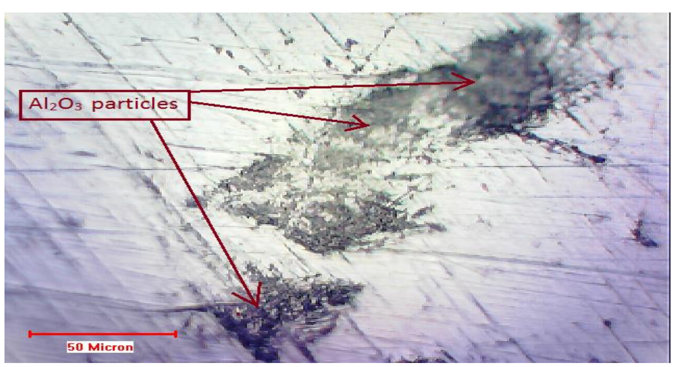
Microstructure of the casting performed are as follows at different speeds of stirrer.Microstructure shows the distribution of the additive particles throughout the base material.



(a1)



(b1)

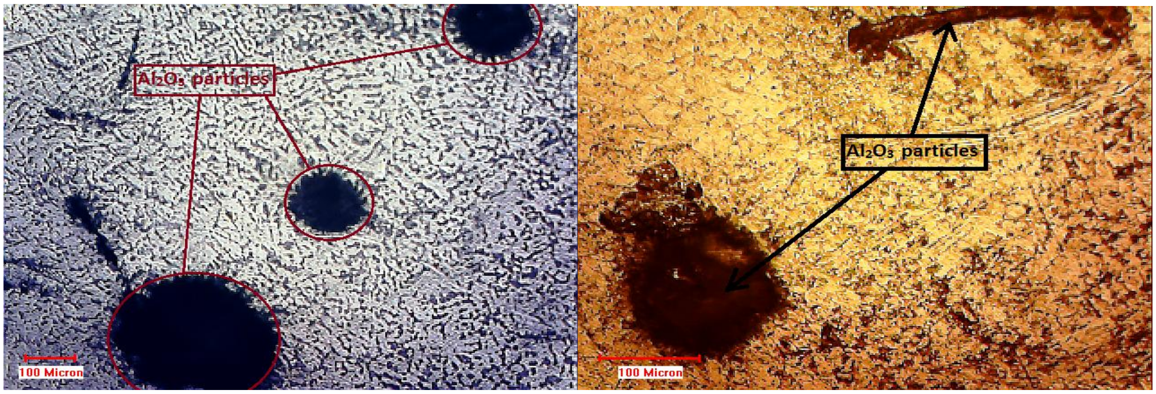


(c1)

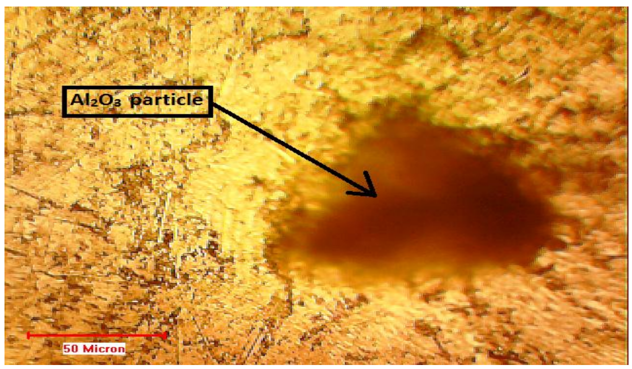
Fig:6 Microstructures of A1 showing distribution of Al_2O_3 particles at 100x(a1), 200x(b1) and 500x(c1) respectively.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

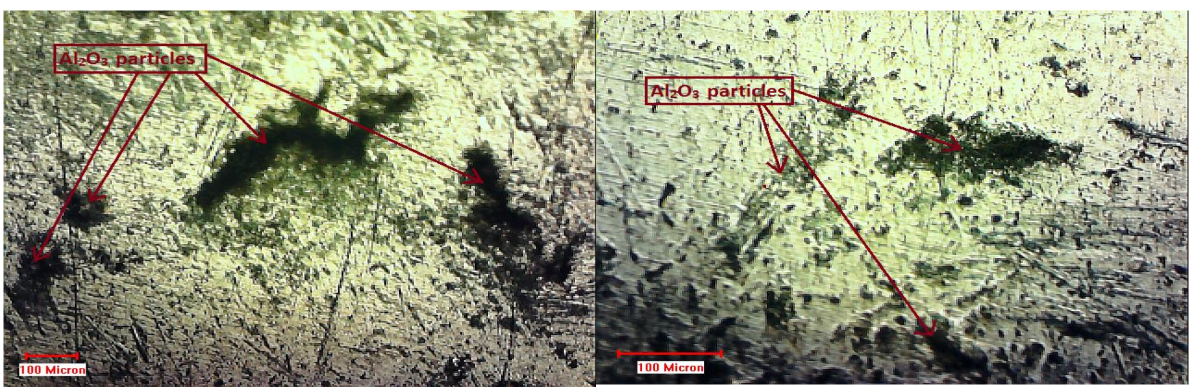


(a2) (b2)



(c2)

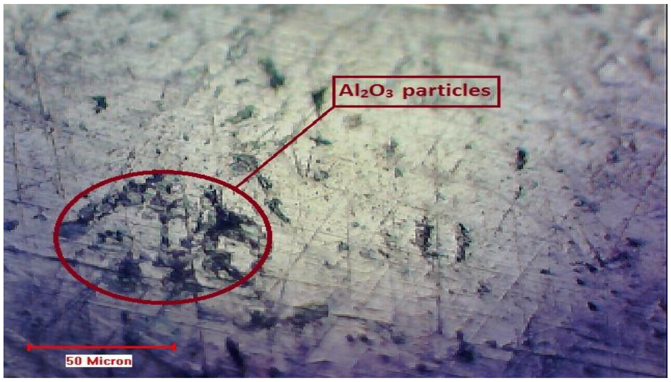
Fig:7 Microstructures of A2 showing distribution of Al_2O_3 particles at 100x(a2), 200x(b2) and 500x(c2) respectively.



(a3) (b3)

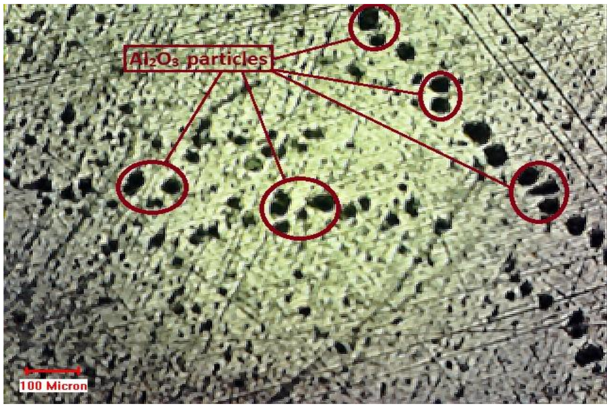
ISSN: 2319-8753

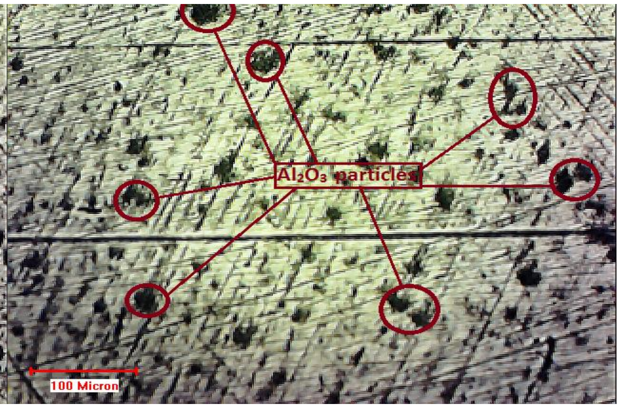
International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013



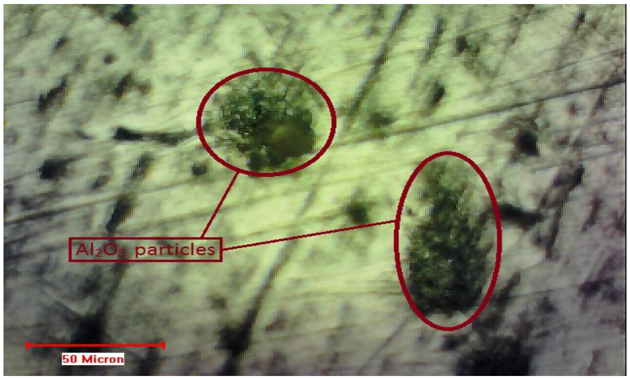
(c3)

Fig:8 Microstructures of A3 showing distribution of Al_2O_3 particles at 100x(a3), 200x(b3) and 500x(c3) respectively.





(a4) (b4)



(c4)

Fig:9 Microstructures of A4 showing distribution of Al_2O_3 particles at 100x(a4), 200x(b4) and 500x(c4)respectively.

The mechanical testing performed on the samples made by the casting . These tests performed on test provided the mechanical properties at different speeds. The table is showing list of such values.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

Table:3 Showing the values of mechanical properties at different speeds.

ID NO.	Ultimate Tensile Strength (MPa)	Hardness (VHN)	Toughness (Joule)
A1	4.6	56.067	58
A2	209.9	251	10
A3	82.9	168	92
A4	50.8	64.56	50

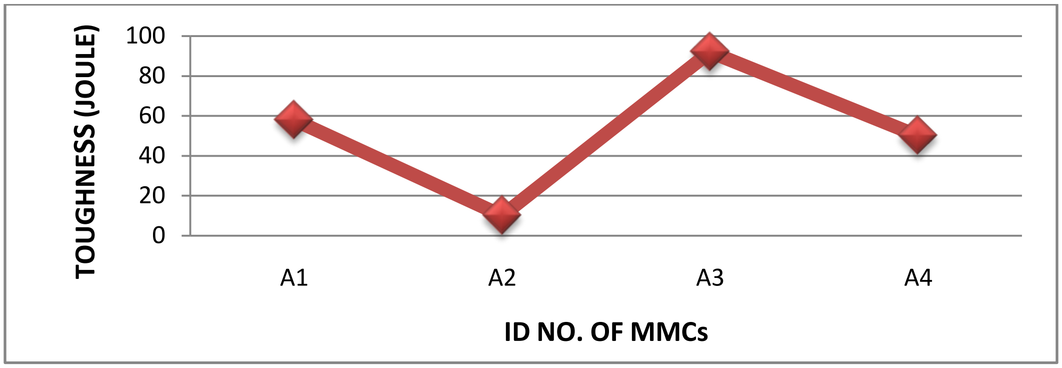


Fig:10 Showing graph plotted between toughness and stirrer speed.

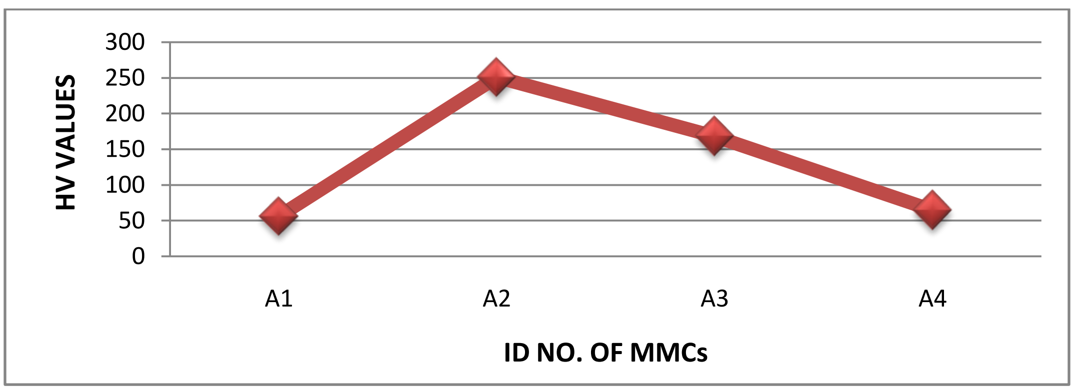


Fig:11 Showing graph plotted between hardness and stirrer speed.

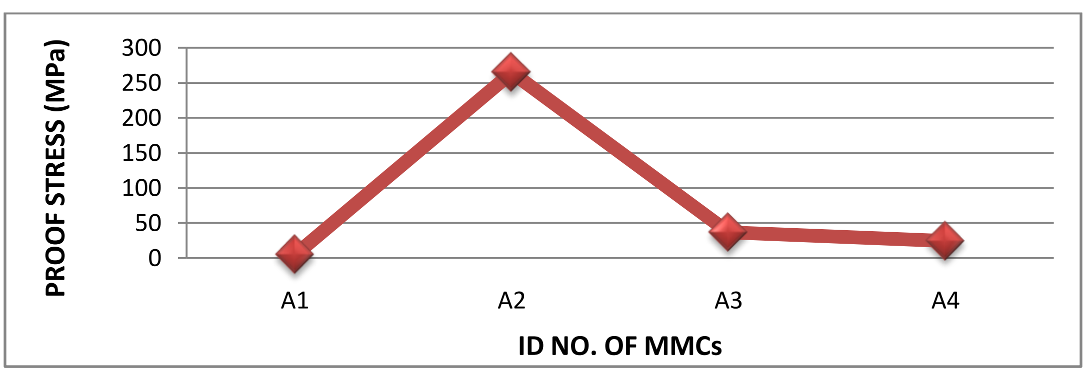


Fig:12 Showing graph plotted between proof stress and stirrer speed.

ISSN: 2319-8753

International Journal of Innovative Research in Science, Engineering and Technology
Vol. 2, Issue 5, May 2013

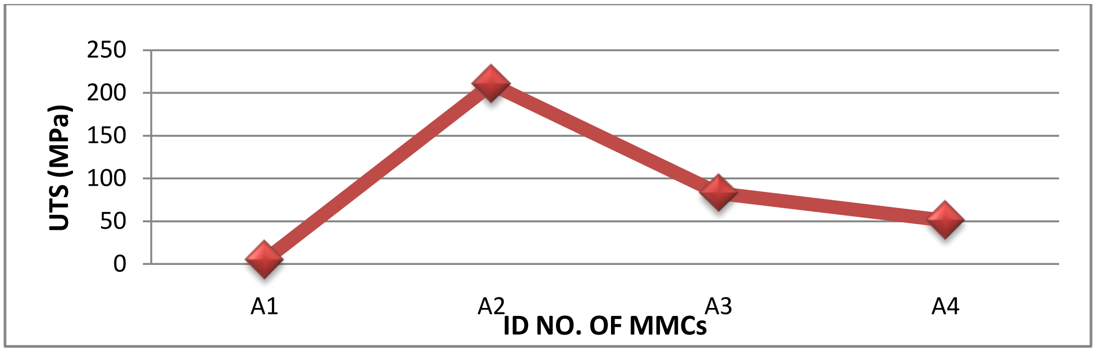


Fig:13 Showing graph plotted between ultimate tensile stress and stirrer speed.

V. CONCLUSION

It is seen that the distribution of Al_2O_3 particles in AA2218 are different at different speeds. This distribution is uniform and non-uniform also at the different speeds and there is the change in the mechanical properties also along with the change of the stirrer speed. With the help of Lagrange's Interpolation Formula, that we evaluated for the maximum numeric value of that. Using this result we can cast and prepare the MMCs of required mechanical property by setting up the stirrer for mixing of Al_2O_3 particles.

REFERENCES

(1) ASM Handbook, Vol. 8, " Mechanical Testing And Evaluation",pp- 169,221,598,(2000).
(2) ASM Handbook ,Vol. 21, " Composites", pp-1,5,6,8,11,(2007).
(3) ASM Handbook Vol. 9, "Metallography and Microstructure" pp-726,728,(2004).
(4) ASM Handbook , Vol. 2 "Properties And Selection: Nonferrous Alloys And Special Purpose Material" pp-4,47,52,54,(2000).
(5) B.Abbasipour,B.Niroumand, S.M.Vaghefi,"Copocasting of A356-CNT Composite" Science Direct, pp-1,(2010).
(6) P.K.GHOSH, S.RAY, "Influence of annealing on the mechanical properties of compocast Al(Mg)-Al_2O_3"Science Direct pp-1,(1993).
(7) Mr. Amol D. Sable, Dr. S.D. Deshmukh, "Preparation of MMCs By Stir Casting Method" IJMET, pp-3,(2012).
(8) S.N. Aqida , M. I. Ghazali, J. Hashim, "The Effects of Stirring Speed and Reinforcement Particles on Porosity Formation in Cast MMC" pp-1,2.