ISSN: 2278-4632
Vol-11 Issue-01 2021

# CHARACTERIZATION OF AL2618 REINFORCED WITH FRIT MMC

**VIJAYAGIRI SRIPAL**
Assistant Professor, Department of Mechanical, St. Martin's Engineering College, Secunderabad, Telangana, India
sripalme@smec.ac.in

**Abstract:**

The present research work is on Aluminum-2618 combined with reinforcement material Frit in different weight percentages of 2%, 4%, 6% and 8%.The specimens can be produced by Stir casting method will be used to produce metal matrix composites. The produced composites will be characterized with respect to mechanical properties. Results obtained from the above investigation, it can be observed that by adding Frit MMC the tensile strength and hardness properties shows excellent values. That will be helpful for the end of users in the field of automobile and aerospace industries.

***Key words: Aluminium, Metal Matrix composites, Stir casting, Mechanical properties***

## I.INTRODUCTION

Metal matrix composites (MMCs) reinforced with Nano-particles, also called Metal Matrix Nano-Composites (MMnC's), are being investigated worldwide in recent years, owing to their promising properties suitable for a large number of functional and structural applications. MMC's have added advantages like superior thermal conductivity, higher transverse strength and excellent electrical conductivity. The MMC's can retain their strength at higher temperatures. MMC's have higher erosion resistance. Due to their high strength to weight ratio, MMC's have find their applications in aerospace, space shuttles and automobiles etc.

An attempt has been made to develop an MMC of Aluminium 2618 as matrix with Frit as reinforcement material. Different compositions of Al-2618 and Frit were fabricated by varying Weight % of Frit particles by stir casting process. The specimens were examined for tensile test and Brinell hardness test to obtain optimum composition of Al-2618 and Frit. Aluminum combined with weight percentages of 2%, 4%, 6% .and 8% of Frit material. The specimens are prepared as per ASTM standards and tested for Tensile strength and hardness to obtain optimum composition.

## II.LITERATURE REVIEW

**Seah et al (2003)** developed Al / quartz particulate composites cast in sand moulds containing metallic and non-metallic chills respectively. During testing, all other factors were kept constant and by the introduction of chills, the faster heat extraction from the molten MMC during casting led to an increase in the ultimate tensile strength and fracture toughness of the castings. In fracture analysis ofthe MMCs, cast using copper and steel chills showed ductile rupture with isolated micro-cracks and a bimodal distribution of dimples on the fracture surface. In contrast, fracture analysis of the MMCs cast without chills revealed brittle failure with separation of the quartz particles from thematrix.

**Riccardo Casati and Maurizio Vedani(2013)** Metal matrix composites reinforced by nano- particles are very promising materials, suitable for a large number of applications. These composites consist of a metal matrix filled with nano-particles featuring physical and mechanical properties very different from those of the matrix.


Copyright @ 2021 Authors

The nano-particles can improve the basematerial

in terms of wear resistance, damping properties and mechanical strength. Different kinds of metals, predominantly Al, Mg and Cu, have been employed for the production of composites reinforced by nano-ceramic particles such as carbides, nitrides, oxides as well as carbon nanotubes. The main issue of concern for the synthesis of these materials consists in the low wettability of the reinforcement phase by the molten metal, which does not allow the synthesis by conventional casting methods. Several alternative routes have been presented in literature for the production of nano-composites. This work is aimed at reviewing the most important manufacturing techniques used for the synthesis of bulk metal matrix Nanocomposites.

**D.siva g. karthikeyan(2016)** It was pragmatic that the hardness of the hybrid composite increased with increasing reinforcement volume fraction and density decreased with increasing particle content. It was also pragmatic that the tensile strength and yield strength increase with an increase in the percent weight fraction of the reinforcement particles, the increase in strength of the hybrid composites is probably due to the increase in dislocation density. Density of the composites decreased by increasing the content of the reinforcement. So these composites can be used in applications where to a great extent weigh reductions are desirable. The hardness of prepared composites are increased by increasing rice husk ash It app ears in this study that tensile strength increases with increases in weight percentage of RHS. These composites can find application in automotive like piston, cylinder liners and connecting rods. These composites can also find application where li weight materials are required with good hardness and strength.

## III.MATERIALS & FABRICATION PROCESS:

### MATRIX AND REINFORCEMENT MATERIALS

**Aluminum Alloy 2618 –**

Aluminium / Aluminum alloys have high ductility and corrosion resistance. At subzero temperatures, their strength can be increased. However, their strength can be reduced at high temperatures of about 200-250°C. Aluminium / Aluminum 2618 alloy is an age hardenable alloy containing magnesium and copper.

'AlCuMgFeNi' based forged alloy is Al-2618 alloy is used in the application fields of aerospace for engine components, as it shows retention of strength at higher temperature upto204$^{0}$C. In the defined alloy purpose of inclusion of 'Ni' and 'Fe' are under high temperature ability to have micro structural stability – obtained due to dispersion hardening and precipitation.Aluminium / Aluminum 2618 alloy is mainly used in manufacturing aircraft engines.


Copyright @ 2021 Authors

ISSN: 2278-4632
Vol-11 Issue-01 2021

**Fig.1:** Al 2618 Material

Mechanical Properties of the matrix alloy are:

| Si No | Properties | Value |
|---|---|---|
| 1 | Density (×1000 kg/m$^3$) | 2.6-2.8 |
| 2 | Elastic Modulus (GPa) | 70-80 |
| 3 | Tensile Strength (MPa) | 440 |
| 4 | Elongation (%) | 10 |
| 5 | Shear Strength (MPa) | 260 |
| 6 | Fatigue Strength (MPa) | 125 |

**Table1**:Chemical composition of Al-2618(Weight%)

| Element | Cu | Mg | Fe | Ni | Si | Ti | Al |
|---|---|---|---|---|---|---|---|
| Wt % | 2.30 | 1.60 | 1.1 | 1.0 | 0.18 | 0.07 | 93.7 |

**Table 2:** Chemical composition of Al-2618 (wt %)

**Frit -** A Frit is a ceramic composition that has been fused, quenched, and granulated. Frits form an important part of the batches used in compounding enamels and ceramic glazes; the purpose of this pre-fusion is to render any soluble and/or toxic components insoluble by causing them to combine with silica and other added oxides. However, not all glass that is fused and quenched in water is frit, as this method of cooling down very hot glass is also widely used in glass manufacture.


Copyright @ 2021 Authors

**Fig2:Frit**

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | CaO | MgO | $Na_2O$ | $K_2O$ | $B_2O_3$ |
|---|---|---|---|---|---|---|---|
| 68.90 | 9.41 | 0.40 | 15.22 | 4.30 | 0.75 | 0.42 | <0.05 |

**Table 3**: Chemical composition of frit (wt %)

**FABRICATION PROCESS:**

**Stir-casting**

It is the simplest fabrication method by casting technique – commercial, comes under liquid phase fabrication method, which also consumes lesser time compared to the solid phase and it also called as vortex or stir casting.

But, before casting process decision on fixing component parameter like Al – is Al2618, and in Frit – (between 0-8%), to get optimum properties. For those results on working on Al2618 with frit is analyzed for Tensile strength and hardness properties.. Both tension and compression tests were performed on computer-interfaced universal testing machine (UTM), with a capacity of 25kN. Data acquisition software, with cable enabled data transfer (RS-230) was used for fetching the data to the computer in this test. For both the tests, the rate of loading was 1 mm/min. and also, harness test was also performed on the specimens prepared in the Vickers cum Brinell hardness tester with model number BV 250.

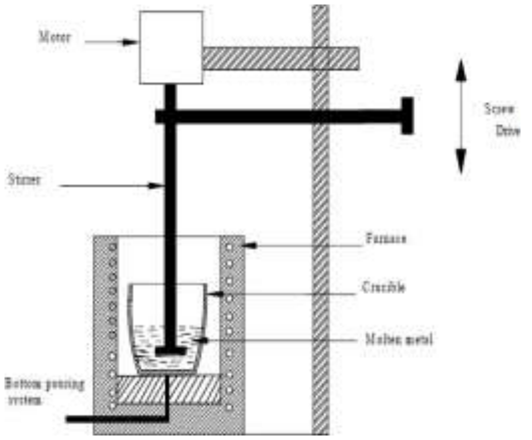


**Fig.3:** Stir Casting Process

**IV.EXPERIMENTAL TESTING:**


Copyright @ 2021 Authors

ISSN: 2278-4632
Vol-11 Issue-01 2021

A set of tests including tensile test, hardness test, were done for finding out the properties. All the tests were carried out in room temperature with ASTM standards. Tensile test is carried out with ASTM E8/82 standard in UTM machine. The Percentage of Elongation, Percentage of Reduction in Area, Young's Modulus and Ultimate Tensile Strength were measured. The Brinhell hardness test and Rockwell hardness test was conducted on specimen.

**TENSION TEST:**

The tension test was carried out on UTM machine. For each composition, five identical specimens were tested as per ASTM standard and average results were reported. The samples were loaded along the longitudinal direction. Load v/s elongation diagrams of the all tested specimens were recorded.

Tensile test was carried out at ambient room temperature ($27^0$C). Tensile tests were carried out using computerized UTM with serial data transfer connection made to RS – 232 and with the data acquisition set up connected to the UTM. Tests were repeated for five times and an average values were considered and final average results were tabulated.The tensile specimens were machined as per the ASTM standard. Figure.6 shows the prepared tensile test specimen.

**Fig.4:** Prepared tensile test specimen

**Hardness test:**

The hardness tests were conducted using Vickers cum Brinell hardness testing system as per ASTM standards. The tests (indentations) were repeated for three Brinell indents using 10mm ball indenter by applying 500kg of load for 30 seconds for each specimen and average values were tabulated and plots have been drawn for all the considered categories. Test sample was ground with arrangement of emery papers down to coarse size of 600 estimated and cleaned with diamond paste of 1-2 micron size. Further the test sample was cleaned through electrolytically and etching was also done.

**Fig.5:** Hardness test specimen


Copyright @ 2021 Authors

ISSN: 2278-4632
Vol-11 Issue-01 2021

## V. RESULTS AND DISCUSSIONS

Aluminum combined with weight percentages of 2%, 4%, 6% and 8% of Frit material. The specimens are prepared as per ASTM standards and tested for Tensile strength and hardness to obtain optimum composition at which the tensile strength and hardness are better.

| Sl. No. | Composition (Wt.%) |
|---|---|
| 1 | Al2618 |
| 2 | Al2618 + 2 % Frit |
| 3 | Al2618 + 4 % Frit |
| 4 | Al2618 + 6 % Frit |
| 5 | Al2618 + 8 % Frit |

**Table 4**: Different combination composites in this work Combination

The Fig.7 shows the hardness values at different compositions of Al-2618 and Frit Weight %and it is observed that addition of 6 % of Frit material increases the hardness property of the composition. Increase of further Frit Wt. % i.e., beyond 6% the hardness starts decreasing due to localized distribution of Frit material.

| Sl. No. | Composition (Wt.%) | Density $gm/cm^3$ |
|---|---|---|
| 1 | Al2618 | 2.70 |
| 2 | Al2618 + 2 % Frit | 2.696 |
| 3 | Al2618 + 4 % Frit | 2.695 |
| 4 | Al2618 + 6 % Frit | 2.688 |
| 5 | Al2618 + 8 % Frit | 2.684 |

**Table 5: Theoretical Density calculation of Aluminium-2618 and Frit**

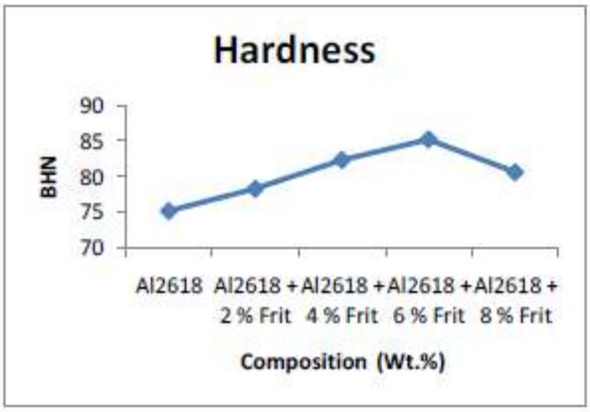


**Fig.6**: Hardness v/s Wt% of Frit particle


Copyright @ 2021 Authors

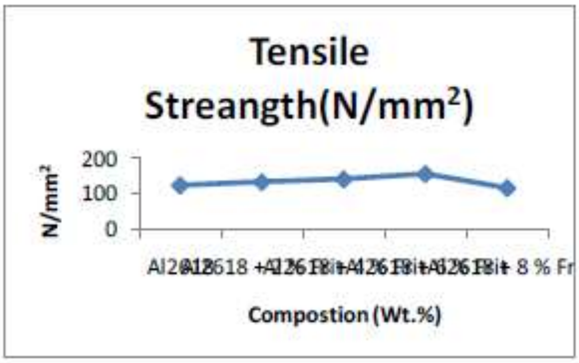


**Fig.7**: Ultimate tensile strength v/s Wt% of Frit particle

From the above Fig.8 work on 6% addition of frit particles in aluminum 2618 matrix shows maximum best combination. The tensile strength increases with addition of Frit particles from 0-6% and starts decreasing after 6% due to increase of brittleness.

## VI. CONCLUSIONS:

From the study we can understand that addition of Frit material will increase the tensile strenghth and hardeness.

1. Frit material can be successfully added to Aluminium by stir casting methods to produce composites.

2.Addition of 6 % of Frit reinforcement material in Aluminium-2618 matrix increases the hardness property by 11% . Increase of further Frit Weight% i.e.,beyond 6% the hardness starts decreasing due to uneven localized distribution of Frit particles in aluminum.

3.Addition of 6 % of Frit reinforcement material in Aluminium-2618 matrix increases the Tensile strength by 20%. Increase of further Frit Weight % i.e., beyond 6% the Tensile strength starts decreasing due to increase in brittleness of the composition.

## VII.REFERENCES:

1).D.siva g. karthikeyan(2016) preparation and characterization of rice husk ash reinforced aluminum metal matrix composites" Journal of Engineering, Scientific Research and Applications (JESRA) ISSN (Online): 2455–3964 & ISSN (Print): 2395–1613Volume 2, Issue 1.

2.Singh et al (2003)"The Effects of Stirring Speed and Reinforcement Particles on Porosity Formation in Cast MMC". JurnalMekanical, 16 (2003) 22-30.

3.Riccardo Casati and Maurizio Vedani(2013) " Metal Matrix Composites Reinforced by Nano-ParticlesA Review" Department of Mechanical Engineering, Polytechnic di Milano, Via La Masa 34, 20156 Milano, Italy,

4.D Ramesh, R P Swamy , T K Chandrashekhar ,"Role of Heat Treatment on Al6061-Frit Particulate Composites", Journal of Minerals and Materials Characterization and Engineering, Vol. 11,No.4, pp.353-363,2012.


Copyright @ 2021 Authors

5.D Ramesh, R P Swamy, T K Chandrashekhar, "Effect of weight percentage on mechanical properties of frit particulate reinforced Al6061 composite", ARPN Journal of Engineering and Applied Sciences Vol. 5, No.1 Jan2010

6.D Ramesh, RageraParameshwarappaSwamy, Tumkur Krishnamurthy Chandrashekhar "Corrosion Behavior of Al6061-Frit Particulate Metal Matrix Composites in Sodium Chloride Solution",Journal of Minerals and Materials Characterization and Engineering, Vol. 1, pp.15-19,2013

7. A.K.Dhingra, "metal replacement by composite", JOM 1986, Vol. 38 (03), p. 17.

8. K.Upadhya, "composite materials for aerospace applications, developments in ceramic and metal matrix composites", KamaleshwarUpadhya, ed.., warrendale, PA: TMS publications, 1992, pp. 3-24.

9. Greg Fisher, "Composite: Engineering the ultimate material", Am. Ceram. Soc, Bull. Vol. 63 (2), pp. 360-364.

10.T.G.Nieh, K.R. Forbes, T.C. Chou and J. Wadsworth, "Microstructure and deformation properties of an Al2O3-Ni3Al composite from room temp to 14000C", High performance Composites for the 1990's Eds. S. K. Das, C. P. Ballard and F. Marikar, TMS-New Jersey, 1990, pp 85-96.

11.T. W. Clyne, An Introductory Overview of MMC System, Types and Developments, in Comprehensive Composite Materials, Vol-3; Metal Matrix Composites, T. W. Clyne (ed), Elsevier, 2000, pp.1-26.

12. L.M.Manocha& A.R. Bunsell "Advances in composite materials", PergamonPress, Oxford, 1980, Vol.2, p 1233-1240.

13. Jartiz, A.E., Design 1965, pp. 18.

14. Kelly, A. (1967) Sci. American 217, (B), 161.

15. Berghezan, A. Nucleus, 8(5), 1966, (Nucleus A. Editeur, 1, the, Chalgrin, Paris,16(e).


Copyright @ 2021 Authors