International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-8 Issue-6, August 2019

Evaluation of Mechanical Properties of AA7075 /Al2O3/Mg Hybrid Composites

Manu Khare, Ravi Kant Gupta, Rahul Goyal

Abstract*: *The present work was planned to evaluate the mechanical properties of alumina reinforced aluminium alloy such hardness and compression behavior of al2o3 /aa7075 alloy metal matrix composites. Both, experimental and finite element analyses were carried out to establish tensile behaviour of the composites with different weight percentage of al2o3 fabricated by the stir casting process. The results concluded that addition of alumina to the aa7075 improves the mechanical properties of the composite. Further the results of FEA simulation of the composites are close to the actual results which shows that cost and time can be reduced if FEA is performed.

Keywords* : *Hybrid Composites, Mechanical Properties etc.

I. INTRODUCTION

Composite materials are the materials of interest. Currently these materials have wide range of applicability as these materials are replacing the monolithic materials. Currently these materials are widely used in automobile, aerospace and several other industries.[1] AMCs are replacing monolithic materials like aluminium, ferrous, titanium alloys and polymer matrix composites for many applications.[2]. Aluminium 7075 alloy has high strength, toughness and thus highly used in aerospace and automobile industries [3]

In aluminium composite aluminium acts as percolating network which is the base material and the constituent added can be ceramic, fibre and is known as reinforcement. The ceramic particulate improves the abrasive resistance of the base material or alloy.[4] Kumar et al. [5] investigated the mechanical and tribological properties of Al6061 and Al7075 composites reinforced with alumina and silicon carbide respectively. The results concluded density, tensile strength and micro hardness have increase significantly with reinforcement. Baradeswaran and perumal [6] investigated the wear and mechanical properties of Al 7075 hybrid composites reinforce with alumina and graphite.

Revised Manuscript Received on August 30, 2019.

* Correspondence Author

Manu Khare*, Department of Mechanical Engineering, Manipal University Jaipur, India.

Ravi Kant Gupta, Department of Mechanical Engineering, Manipal University Jaipur, India.

Rahul Goyal, Department of Mechanical Engineering, Manipal University Jaipur, India.

The results confirmed that with increase in reinforcement (% weight) the mechanical properties increased. Reddy et al. [7] studied Al 6061 composite with varying amount of silicon and boron carbide using stir casting . The composites have better hardness, tensile and flexural strength than base alloy. Quan and Zhou [8] studied mechanism for tool wear by cutting SiC particulate reinforced aluminium composite and concluded that abrasive wear is the cause of major damage is due to abrasive wear on flank edge of the tool and volume fractions of SiC particles affects the tool life. Vijaya et al. [9] investigated the mechanical properties of LM25 aluminium composite reinforced with alumina and boron carbide. The results concluded that boron carbide has increased the fracture toughness and hardness of the alloy. Madhavan et al. [10] investigated AA 6061- SiC composites and performed fatigue tests on composites considering different aging temperature and solutionizing time. Narayana Murty et al. [11], studied 6061Al–SiC and 6061–Al2O3 reinforced composites on the hot working characteristics for the development of processing maps .To determine the amount of plastic deformation Ziegler's continuum principles is used by deriving a simple instability condition in a work piece.

The finite element method is currently the most commonly used numerical solution for engineering problems that can be expressed in the form of partial derivative equation systems. [12]

II. EXPERIMENTAL PROCEDURE

2.1 Methodology

Aluminium 7075 alloy is used as the matrix material. The chemical composition in wt% of the alloy is given in table 1. The reinforcement used in present work is alumina powder of average particle size of 50 micorons.

Fabrication of metal is done using liquid metallurgy technique. In MMCs, for achieving excellent mechanical properties there must be incorporation of dispersed phase order. Stir casting is one of the prominent an economical method for developing of metal matrix composite. Karthikeyan and Nallusamy [13] studied the mechanical properties of aluminum 6063 and silicon carbide reinforced composite fabricated using stir casting process. Harnby et.al[14] state that the distribution of the particles in the molten metal depends on various factors such as mechanical stirrer, stirring parameters, melting temperature etc.

The aluminum metal matrix composite were fabricated using stir casting method . The schematic diagram of the stir casting is shown in Fig.1.

Approx 1 kg of matrix metal was melted at 800 °C in an electrical induction furnace . Then measured amount of alumina powder was preheated at 300 °C for 2 hours in preheating furnace to remove the moisture content and then added to the melt. Then the melt was stirred inside the furnace to uniformly disperse the particles in the melt.

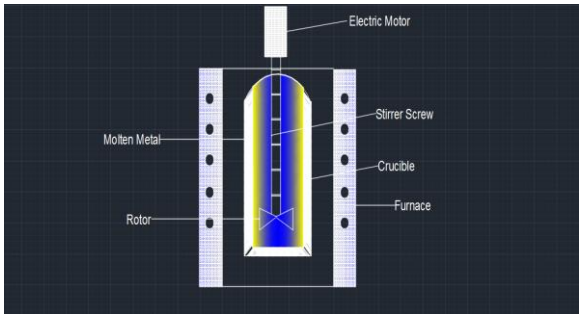

Fig.1. Fabrication of MMC using stir casting method

III. MECHANICAL TESTS

3.1. Tensile test

Evaluation of the fundamental properties and to develop new composite mechanical testing plays an important role.. The tensile test is performed on universal testing machine. ASTM E08-8 standards are used to prepare the samples. The tensile strength was measured at cross head speed of 2.5 mm/min.

TABLE 1. TENSILE STRENGTH OF COMPOSITES

% wt of Al_2O_3	Tensile Modulus (MPa)	Tensile Strength (MPa)
0	90436	210
1.5	90537	219
3	90813	231
4.5	10100	233

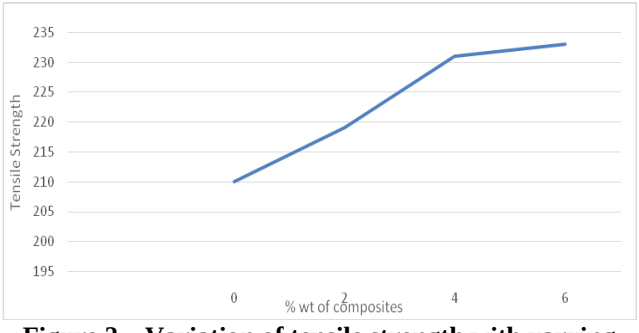

Figure 2. Variation of tensile strength with varying content of Al2O

3.1.2. Finite Element Analysis

The Finite Element Analyses is a technique to solve problems using partial differential equation. The FEA is applied using meshing system. Meshing is division of domain occupied by the body to be analysed into small parts or regions called finite elements. In this paper samples are analysed using ABAQUS software. The objective of the analysis is to determine the deformation and stress state of the composite

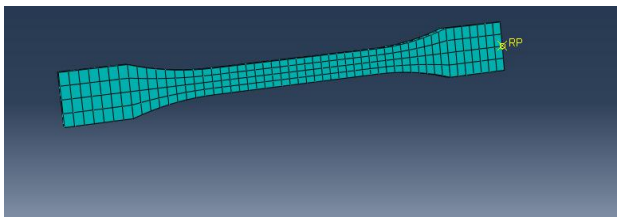

Figure 3. Finite element meshing of tensile testing specimen

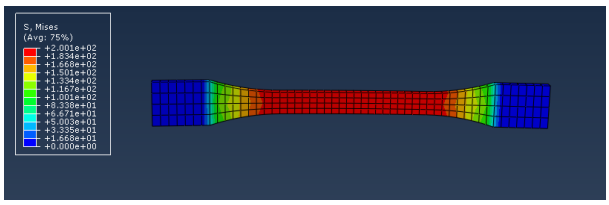

Figure 4. Distribution of von Mises equivalent stress when 0 % wt of Al2O3 is added .

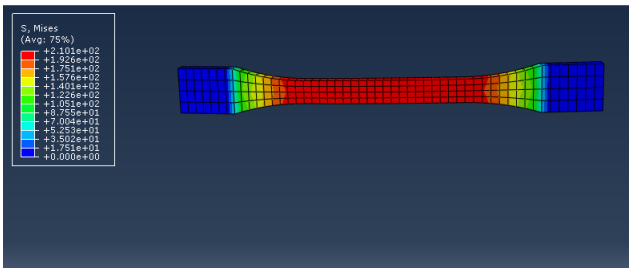

Figure 5. Distribution of von Mises equivalent stress when 1.5 % wt of Al2O3 is added .

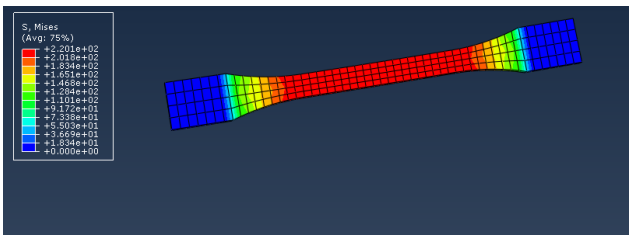

Figure 6. Distribution of von Mises equivalent stress when 3% wt of Al2O3 is added .

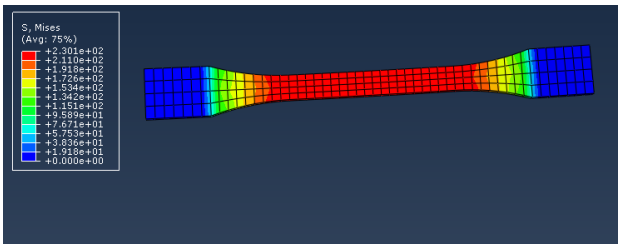

Figure 7. Distribution of von Mises equivalent stress when 4.5 % wt of Al2O3 is added

3.3. Compression test

ASTM E9-09 standards were used for testing compressive strength of the composites. The test were performed on UTM with a cross head speed of 10 mm/minute. The results for the compression test are shown in Figure 8. .

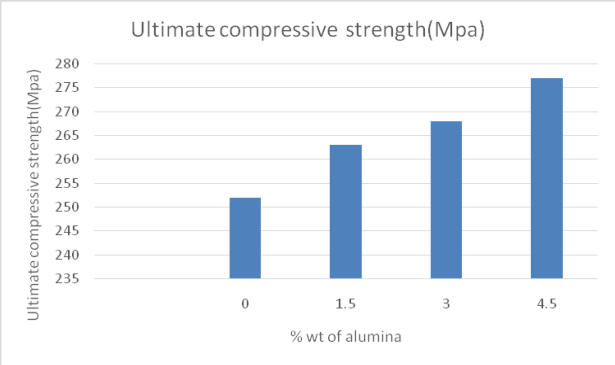

Figure 8. Compressive Strength Of Composites

3.4. Hardness test

The hardness test are performed on Brinell Hardness testing machine under a constant load . The three tests are performed to get the accurate results and then average of the three results is considered. The results are tabulated in Table 2.

TABLE 2. Hardness (BHN) of Composites

% wt of Al_2O_3	Trial 1	Trial 2	Trial 3	Average Hardness
0	119	117	119	118.3
1.5	121	120	122	121
3	123	123	124	123.3
4.5	125	125	127	125.7

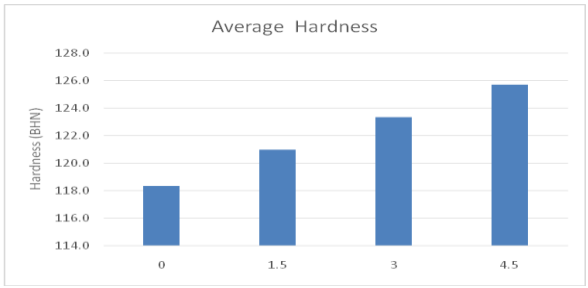

Figure. 9. Hardness of Composites

IV. CONCLUSION

This paper studies the mechanical properties like hardness, compression and tensile of Al2O3 reinforced AA7075 composites. The tensile properties of the composite is analysed both by finite element simulation and practically. The results shows that mechanical properties of the composite depends on the reinforcement added as a % weight. The hardness, tensile and compressive strength increase as the weight percentage of the composite increases. On comparing the results of simulation and practical test the simulation results are close to actual values thus we can reduce the cost of manufacturing cost of prototype and save time and development costs.

REFERENCES

1. E. J. Barbero, Introduction to Composite Materials Design, Third Edition. CRC Press, 2017.
2. R. S. P. R. Das Rana and S, "Reviews on the Influences of Alloying elements on the Microstructure and Mechanical Properties of Aluminum Alloys and Aluminum Alloy Composites," Text. Res. J., vol. 82, no. 16, pp. 1703–1710, 2012.
3. J. Kaufman, Properties of aluminum alloys: tensile, creep, and fatigue data at high and low temperatures. 1999.
4. U. K. Annigeri and G. B. Veeresh Kumar, "Method of stir casting of Aluminum metal matrix Composites: A review," Mater. Today Proc., vol. 4, no. 2, pp. 1140–1146, 2017.
5. M. S. Bhagyashekar, G. B. Veeresh Kumar, C. S. P Rao, N. Selvaraj, and M. S. Bhagyashekar Vol, "Studies on Al6061-SiC and Al7075-Al2O3 Metal Matrix Composites Studies on Al6061-SiC and Al7075-Al 2 O 3 Metal Matrix Composites," J. Miner. Mater. Charact. Eng., vol. 9, no. 1, p. 43, 2010.
6. A. Baradeswaran and A. Elaya Perumal, "Study on mechanical and wear properties of Al 7075/Al2O3/graphite hybrid composites," Compos. Part B Eng., vol. 56, pp. 464–471, 2014.
7. P. S. Reddy, R. Kesavan, and B. Vijaya Ramnath, "Investigation of Mechanical Properties of Aluminium 6061-Silicon Carbide, Boron Carbide Metal Matrix Composite," Silicon, no. 6061, 2017.
8. X.-P. Zhang, L. Ye, Y.-W. Mai, G.-F. Quan, and W. Wei, "Investigation on diffusion bonding characteristics of SiC particulate reinforced aluminium metal matrix composites (Al/SiCp-MMC)," Compos. Part A Appl. Sci. Manuf., vol. 30, no. 12, pp. 1415–1421, Dec. 1999.
9. B. Vijaya Ramnath, C. Elanchezhian, M. Jaivignesh, S. Rajesh, C. Parswajinan, and A. Siddique Ahmed Ghias, "Evaluation of mechanical properties of aluminium alloy–alumina–boron carbide metal matrix composites," Mater. Des., vol. 58, pp. 332–338, Jun. 2014.
10. K. Mahadevan, K. Raghukandan, B. C. Pai, and U. T. S. Pillai, "Influence of precipitation hardening parameters on the fatigue strength of AA 6061-SiCp composite," J. Mater. Process. Technol., vol. 198, no. 1–3, pp. 241–247, Mar. 2008.
11. S. Murty, B. Rao, B. K.-C. science and technology, and undefined 2003, "On the hot working characteristics of 6061Al–SiC and 6061–Al2O3 particulate reinforced metal matrix composites," Elsevier.
12. David V. Hutton, Fundamentals Of Finite Element Analysis. .
13. A. Karthikeyan and S. Nallusamy, "Experimental Analysis on Sliding Wear Behaviour of Aluminium-6063 with SiC Particulate Composites," Int. J. Eng. Res. Africa, vol. 31, pp. 36–43, Jul. 2017.
14. A. Nienow, M. EDWARDS, and N. Harnby, Mixing in the process industries. 1997.
15. Deswal S, Narang R, Chhabra D. Modeling and parametric optimization of FDM 3D printing process using hybrid techniques for enhancing dimensional preciseness. International Journal on Interactive Design and Manufacturing (IJIDeM). 2019:1-8.