VOL. 10, NO. 13, JULY 2015 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

EXPERIMENTAL INVESTIGATION OF TENSILE AND IMPACT BEHAVIOR OF ALUMINIUM METAL MATRIX COMPOSITE FOR TURBOCHARGER

T. Mohan and N. Manoharan
AMET University, Kanathur, Chennai, Tamil Nadu, India

ABSTRACT

Recent developments in material technology help to find and fabricate new materials which may replace existing materials for various applications. Among those, composite materials play a vital role which is combination of two or more materials with different physical and chemical properties. This work focuses on developing an Aluminium metal matrix composite (AMMC) material for turbocharger components made by wrought aluminium alloy with various weight fractions of aluminium oxide in order to make five different forms of composites. In this work stir casting process is used. The fabricated composites are tested for their tensile and impact properties. The result shows that composite with higher percentage of aluminium oxide has high tensile strength than other composites.

Keywords: wrought aluminium alloy, titanium carbide, composites, stir casting process.

1. INTRODUCTION

Nowadays automotive industries are focusing on developing new materials in order to increase the life and durability of the products. Hence, lot of research is also going on in developing new materials. Karamis *et al*. [1] examined the wear behavior of different aluminium matrix composites namely Al5083 and Al6063 with different proportions of silicon carbide and concluded that the frictional behavior of the composite is influenced by the contact between projectile and the matrix. Ozden *et al*. [2] studied the impact behavior of Al matrix composites reinforced with Sic particles under different temperature conditions varying from -176º to 300 ˚C using Charpy impact test with different sizes of silicon carbide and found that impact strength increases with the increase in particle size. Ezuber *et al*. [3] studied the corrosion behavior of two aluminium alloys AA1100 and AA5083 in sea water and found that AA1100 alloy having better corrosion resistance than AA5083.Vijaya Ramnath *et al*. [4] evaluated the mechanical properties of Aluminium alloy-Alumina-Boron Carbide MMCs fabricated by stir casting with three different compositions of alumina and boron carbide and concluded that aluminium with 2% alumina-3% boron carbide have tensile strength. El-Sabbagh et al. [5] studied the effect of rolling and heat treatment on the tensile behavior of wrought Al/SiC particle metal matrix composite produced by stir casting and found that annealing improves percentage elongation at break. Padmavathi and Ramakrishnan [6] studied the tribological behavior of the AMMC using Al6061 alloy with MWCNT and SiC particles prepared by stir casting method followed by die casting. They found that CNTs could have a negative impact on the wear characteristics. Bharath et al. [7] prepared Al6061-Al_2O_3 metal matrix composite by using stir casting technique and evaluated the mechanical and wear properties of the same and they concluded that increase in the amount of reinforcements increased the hardness and tensile strengths. Abhishek Kumar et al. [8] fabricated A359/Al2O3 MMC using electromagnetic stir casting method and found that hardness and tensile strength increased linearly with increase in weight % of alumina. Vijaya Ramnath et al. [9] reviewed work done on aluminium metal matrix composites. Dimensional analysis is a technique in which the parameters of a physical system like material properties, processing conditions and geometry are grouped in dimensionless numbers [10,11]. Vijaya Ramnath *et al*. [13] reviewed CNT based aluminum matrix composite and also conducted experiment on it. [12,13].

2. EXPERIMENTAL SETUP

In this section, materials used, experimental details and composition of composites are discussed.

a) Materials used

In this work wrought aluminum alloy is taken as matrix metal and aluminium Oxide is taken as reinforcement. Their properties are furnished in Table-1.

Table-1. Properties of Al and Al_2O_3.

Properties	Aluminium (Al)	Aluminium Oxide (Al_2O_3)
Density (gm/cm^3)	2.70	3.98
Tensile Strength (MPa)	185	416.0
Coefficient of thermal expansion (10^{-6}/°C)	23	7.4
Modulus of Elasticity (GPa)	70	380

b) Fabrication method

In this work stir casting method is used for fabricating metal matrix composites. In this process, reinforcement is heated separately nearer to main process temperature of 450°C. Wrought aluminium alloy also is melted in a crucible in an induction furnace to a temperature of 830°C. Now, the preheated reinforcement is mechanically mixed with the molten aluminium and reinforcement is distributed into molten matrix by vigorous mechanical stirring. Then the mixture (composite) is poured in a steel die. The casting is allowed to solidify for 24 hours for complete transformation of liquid into solid. The composite is then machined into specimen for tensile and impact test. The Composition of matrix and reinforcement is given in Table-2.

Table-2. Composition of matrix and reinforcement.

Samples	Al in %	Al_2O_3 in %
1	99	1
2	98	2
3	97	3
4	96	4
5	95	5

3. TESTING

The tensile and impact tests are performed on the aluminium metal matrix composite as per ASTM standard to find their mechanical properties. For tensile test, Universal testing machine is used and the test samples are prepared as per ASTM: B557M, while the samples are prepared as per IS: 1757 standard for carrying out impact test.

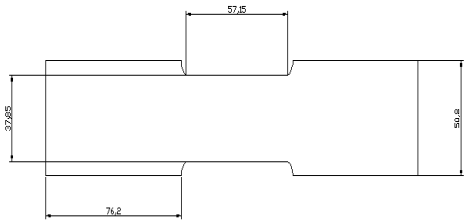

Figure-1. Tensile test specimen- ASTM.

4. RESULTS AND DISCUSSIONS

a) Tensile test

Tensile test is performed by holding and loading the specimen up to fracture. The tensile properties are tabulated in Table-3 and also in Figure-2 and 3. From the graphs, it is concluded that the tensile strength increases with increase in percentage weight of alumina.

Table-3. Tensile properties.

Sample	Break load (kN)	Tensile strength (MPa)
Sample 1	3.23	38.50
Sample 2	3.42	42.3
Sample 3	6.3	89.6
Sample 4	6.42	91.2
Sample 5	6.52	93.3

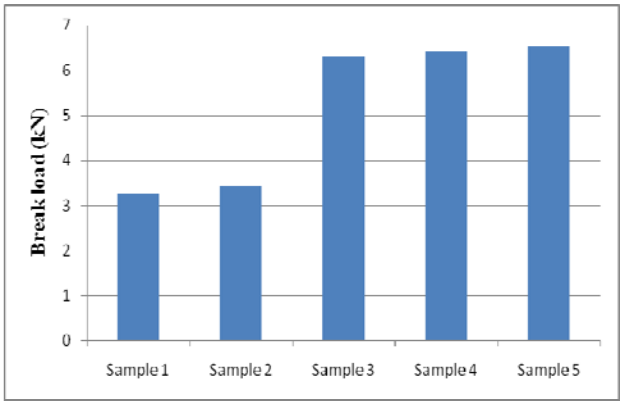

Figure-2. Break load of samples.

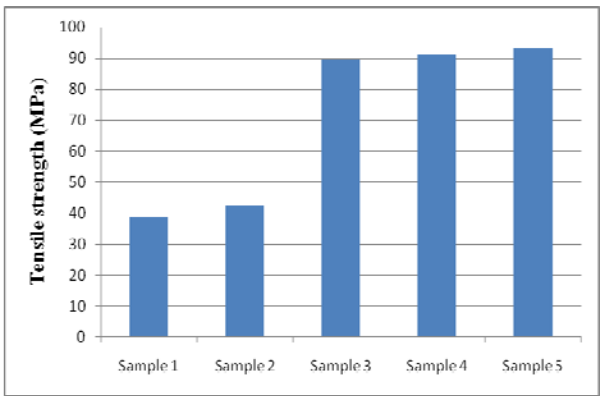

Figure-3. Tensile strength of samples.

b) Impact test

The Charpy test is performed by preparing the specimen as per IS: 1757 standard. The impact property is shown in Table-4 and shown in Figure-4. From Table-4, it is found that the sample 2 absorbs more energy than other four samples since it contains less amount of alumina.

Table-4. Impact property of composites.

Sample	**Energy absorbed** (J)
Sample 1	3.54
Sample 2	3.69
Sample 3	3.63
Sample 4	2.42
Sample 5	2.13

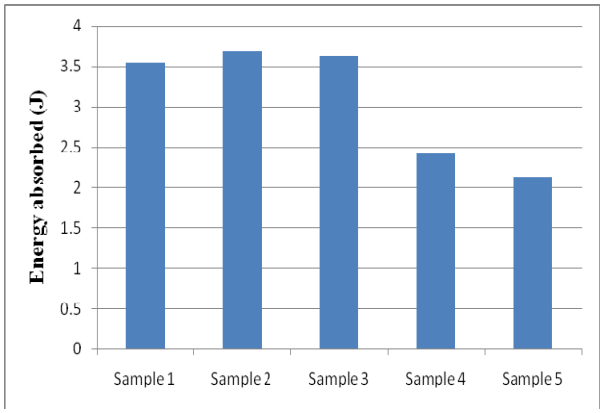

Figure-4. Impact test result of samples.

5. CONCLUSIONS

In this paper, hybrid composite is fabricated by stir casting process with different proportions of Alumina.. It is concluded that the tensile strength of the sample 5 is greater than other four samples. Sample 2 absorbs more energy than other samples.

REFERENCES

[1] M.B. Karamis, A. Tasdemirci and F. Nair. 2003. Failure and tribological behaviour of the AA5083 and AA6063composites reinforced by SiC particles under ballistic impact, Composites: Part A, Vol. 34, pp. 217–226.

[2] Sedat Ozden, Recep Ekici and Fehmi Nair. 2007. Investigation of impact behaviour of aluminium based SiCparticle reinforced metal–matrix composites, Composites: Part A, Vol. 38, pp. 484–494.

[3] Hosni Ezuber, A. El-Houd and F. El-Shawesh. 2008. A study on the corrosion behavior of aluminum alloys in seawater, Materials and Design, Vol. 29, pp. 801–805.

[4] B. Vijaya Ramnath, C. Elanchezhian, M. Jaivignesh, S. Rajesh, C. Parswajinan and A. Siddique Ahmed Ghias. 2014. Evaluation of mechanical properties of aluminium alloy–alumina–boroncarbide metal matrix composites, Materials and Design, Vol. 58, pp. 332–338.

[5] Ahmed M. El-Sabbagh, Mohamed Soliman, Mohamed A. Taha and Heinz Palkowski. 2013. Effect of rolling and heat treatment on tensile behaviour of wrought Al-SiCp composites prepared by stir-casting, Journal of Materials Processing Technology Vol. 213, pp. 1669– 1681.

[6] K. R. Padmavathi and R. Ramakrishnan. 2014. Tribological behaviour of Aluminium Hybrid Metal Matrix Composite, Procedia Engineering, Vol. 97, pp. 660 – 667.

[7] Bharath V., Madev Nagaral, V. Auradi and S. A. Kori. 2014. Preparation of 6061Al-Al2O3 MMC's by Stir Casting and Evaluation of Mechanical and Wear Properties, Procedia Materials Science, Vol.6, pp. 1658–1667.

[8] Abhishek Kumar, Shyam Lal and Sudhir Kumar. 2013. Fabrication and characterization of A359/Al2O3 metal matrix composite using electromagnetic stir casting method, J Mater Res Technol. Vol. 2, No. 3, pp. 250–254.

[9] B. Vijaya Ramnath, C. Elanchezhian, RM. Annamalai, S. Aravind, T. Sri Ananda Atreya, V. Vignesh and C. Subramanian. "Aluminium metal matrix composites – a review", Reviews on advanced material science, Vol. 38, pp. 55-60.

[10] Zlokarnik M. 1998. Problems in the application of dimensional analysis and scale-up of mixing operations. Chemical Engineering Science Vol. 53, pp. 3023–30.

[11] Osswald TA and Hernández-Ortiz JP. 2006. Polymer processing: modeling and simulation. München, Germany: Carl Hanser Verlag.

[12] B. Vijaya Ramnath, C. Parswajinan, C. Elanchezhian, S. V. Pragadeesh, P. R. Ramkishore and V. Sabarish. 2014. "A Review on CNT Reinforced Aluminium and Magnesium Matrix Composites', International Journal Applied Mechanics and Materials, Vol. 591, June, pp. 120-123.

[13] B. Vijaya Ramnath, C. Parswajinan, C. Elanchezhian, S. V. Pragadeesh, C. Kavin, P. R. Ramkishore and V. Sabarish. 2014. "Experimental Investigation on Compression and Chemical Properties of Aluminium Nano Composite', International Journal Applied Mechanics and Materials, Vol. 680, July, pp. 7-10.