JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

PREPARATION AND EVALUATION OF MECHANICAL PROPERTIES OF ALUMINUM7068 WITH GRAPHITE NANO PARTICULATES METAL MATRIX COMPOSITES

Prashant S N[1], K.V.Sharma[2]

[1]Research Scholar, Department of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, india.

[2]Professor Deparmental of Mechanical Engineering, UVCE, Bangalore-560001, Karnataka, india

Abstract: Aluminium-based Metal Matrix Composites (MMCs) have received increasing attention in recent decades as engineering materials. The introduction of a ceramic material into a metal matrix produces a composite material that results in an attractive combination of physical and mechanical properties which cannot be obtained with monolithic alloys [1]. The aluminum based composites are increasingly being used in the transport, aerospace, marine, automobile and mineral processing industries. The various reinforcements that have been tried out to develop aluminium matrix composites(AMCs) are graphite, silicon carbide, titanium carbide, tungsten, boron, Al_20_3, fly-ash, Zr, TiB_2 Addition of hard reinforcements such as silicon carbide, alumina, and titanium carbide improves hardness, strength and wear resistance of the composites [1, 2-4]. The ceramic nano particles reinforced aluminum composites are termed as new generation material and these can be tailored and engineered with specific required properties for specific application requirements. The metal matrix composites are cost efficient and they are also known for excellent heat and wear resistance applications [3]. In this paper it is aimed to present the experimental results of the studies conducted regarding hardness and Density and tensile strength of Al7068-Graphite nano particulates. The composites are prepared using the liquid metallurgy technique in which 3-9 wt.% age of particulates were dispersed in the base matrix in steps of 3. The obtained cast composites of Al7068- nano Graphite and the castings of the base alloys were carefully machined to prepare the test specimens for density, hardness and as well as mechanical studies as per ASTM standards.

Keywords: Al7068, Graphite nano particulate (Nano Gr), Metal matrix composites, Mechanical properties.

I. INTRODUCTION

Metal Matrix Composites (MMCs) are increasingly becoming attractive materials for advanced aerospace applications because their properties can be tailored through the addition of selected reinforcements [1]. Metal matrix composites have a market potential for various applications, particularly in the automotive industry where the pressure to use light weight materials has increased because of environmental issues. Examples of components that have been manufactured using metal matrix composites include pistons for diesel engines and connecting rods [2]. These materials have also been shown to possess great potential for applications in the brake disks for railway brake equipment [3]. Aluminium alloys are still the subjects of intense studies, as their low density gives additional advantages in several applications. These alloys have started to replace cast iron and bronze, to manufacture wear resistant parts[4]. Previous studies have shown that mechanical properties of Al-matrix composites would be enhanced with particulate reinforcement [5]. The particulate reinforced MMCs is mainly used due to easy availability of particles and economic processing technique adopted for producing the particulate reinforced MMCs. Al alloy has been commonly used as a base metal for MMCs reinforced with a variety of fibres, particles and whiskers [6-7]. Amongst different kinds of the recently developed composites, particle-reinforced metal matrix composites and in particular Aluminium base materials have already emerged as candidates for industrial applications [8-9].

In the present work the matrix material used is Al7068-alloy with Graphite nano particle as reinforcements. The addition level of reinforcement is varied from of 3wt.%-9wt.% in steps of 3%. And the reinforcement is added in to matrix in 2 steps. Melt stirring technique has been used for the preparation of composites. Mechanical properties were evaluated as per ASTM Standards.

II. EXPERIMENTAL DETAILS

The following section highlights the materials used its properties and method of composite preparation and evaluation of mechanical properties.

A. Material Used

The matrix material for present study is Al7068. The below Table 1 gives the chemical composition of Al7068. Table 2 gives the details of the physical and mechanical properties of Al7068. The reinforcing material selected is Gr nano particle. Table 3 gives the details of the physical and mechanical properties of Graphite nano particulates [10].

Table 1 Shows the chemical composition of 7068Aluminum Alloy

Si	Cu	Fe	Mn	Mg	Zn	Cr	Ti	Zr	Others	Al
0.12	1.6-2.4	0.15	0.10	2.2-3.0	7.3-8.3	0.05	0.10	0.05-0.15	0.05	balance

Table 2 shows the Physical and Mechanical properties of 7068Aluminum Alloy				
Elastic Modulus (GPa)	Poisson's Ratio	Density (g/cc)	Tensile Strength (MPa)	Hardness
76-83	0.33	2.85	641(T)	60-68

Table 3 shows the mechanical properties of Graphite nano particles				
Reinforcement	Density	Elastic Modulus	Poission's ratio	Hardness
Graphite Nanoparticulars	2.25	8-15	0.14	1.7mohs scale

B. Preparation of composites

The liquid metallurgy route has been adopted to prepare the cast composites as described below. Preheated of Graphite nano powdered particle size <100nm were introduced into the vortex of the molten alloy after effective degassing. Mechanical stirring of the molten alloy for duration of 10 min was achieved by using ceramic coated steel impeller. A speed of 400 rpm was maintained. A pouring temperature of 730°C was adopted and the molten composite was poured into graphite moulds. The extent of incorporation of Graphite in the matrix alloy was varied from 0 to 9 wt% in the steps of 3%. Thus composites containing particles 0 to 9 wt% were obtained in the form of cylinders of diameter 25mm and length 220mm.

C. Testing of composites

The cast composites were machined and the specimen for the measurement of hardness as well as for mechanical behavior were prepared as per ASTM standards. Brinell's hardness tester was used to measure the Hardnes [11]. The mechanical properties were evaluated in Advanced Metallurgical Laboratory, Bangalore.

III. RESULTS AND DISCUSSION

The test results of Al7068 and its composites containing nano Gr particulates with various weight percentages are presented in these sections.

A. Effect of Graphite on the mechanical properties

The mechanical properties such as hardness, tensile strength test results of Al7068 and its composites containing Nano Graphite at various weight percentages are presented in these sections.

DENSITY MEASUREMENTS

From the study of Table 4 it can be seen that the comparison of theoretical density obtained by rule of mixture and measured density values by experiment for both the composites studied for different wt% of Reinforcement. Further the density Decreases with increased percentage of filler content in the composites. Further it can be observed that the Experimental densities of composite are less than when compared to the theoretical density. This could be due to the presence of porosity.

Table 4 Comparison of theoretical and experimental densities of the A17068-nano graphite composites.

Material	Density (g/cc)	Weight % Reinforcement			
		0	3	6	9
Al7068-Nano Graphite	Theoretical Density	2.85	2.82	2.80	2.78
	Experimental Density	2.78	2.74	2.71	2.64

HARDNESS

From the Figure 1 it is clear that addition of Graphite to the 7068Al matrix has resulted in decrease in hardness of the 7068Al matrix. Further, the increasing addition level of Graphite has resulted in continuous decrease in the hardness of the matrix.

It can be seen that as the graphite content increases, the hardness of the matrix material decreases monotonically by significant amounts. This drop in the hardness is due to softness of the graphite particles, which being soft dispersed do not contribute to the hardness of the composite as it cannot act as barriers to the movement of dislocations within the matrix [12-13]. The graphite particles being softer than the metal matrix which cause reduction in the hardness by about 22%.

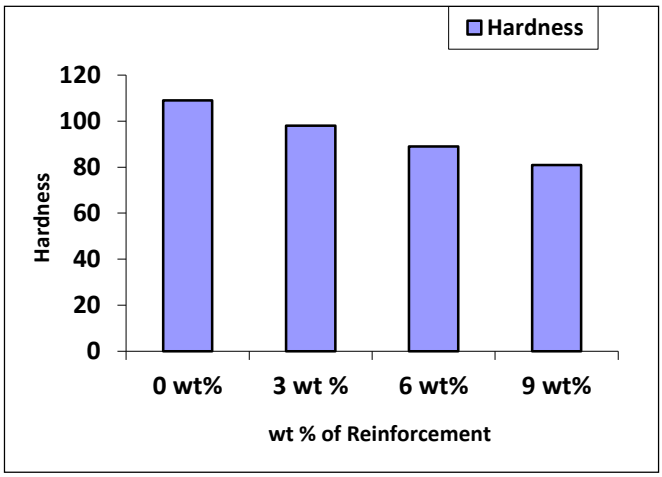

Figure 1 shows the variations in hardness of 7068Al before and after addition of different wt.% of Nano Gr particulates.

TENSILE PROPERTIES

Tensile properties of the both 7068Al-alloy and prepared composites with different wt.% of Graphite nano particles were evaluated using a computerized uni-axial testing machine. The dimension of the test specimen was prepared according to the American Standard Testing Materials (ASTM) [14-15]. Three test specimens were used for each test and average value is reported.

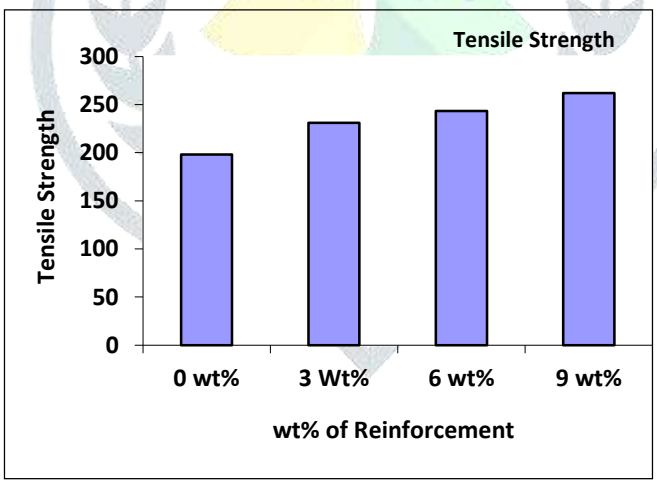

Figure 2 Showing the tensile properties of 7068Al-Nano Gr composites with different wt.% of reinforcing particulates.

From the Figure 2 it can be seen that the tensile strength increase with increase percentage of graphite. From graph it can be observed that the tensile strength of the composites is higher than that of the matrix alloy, it can be observed that the increase in the filer content contributes in increasing the tensile strength of the composite. This imporvement in tensille strength of the composite may be attributed to the fact that the filler graphite possesses higher strength and also may be due to the better bonding strength.

CONCLUSION

The conclusions based on the present work on Al7068-Gr nano particulates metal matrix composites are as follows.

1. The liquid metallurgy technique was successfully adopted in the preparation of Al7068-Gr nano composites.

2. Al7068-Gr nano particles composites are prepared using stir casting method with filler contents up to 9 wt%.

3. The experimental densities of composites are less than when compared to the theoretical density.

4. Hardness of the composite Decrease with increasing amount of Gr nano particulate in 7068Al Alloy.

5. The addition of Gr nano particulates has resulted in increase in tensile strength of Al7068 alloy when compared to unreinforced alloy.

REFERENCE

1. A. Baradeswaran "Effect of Graphite Content on Tribological behaviour of Aluminium alloy - Graphite Composite", European Journal of Scientific Research, Vol.53 No.2 (2011), pp.163- 170.
2. K. R. Suresh, H.B. Niranjan, P. Martin Jabraj, M.P. Chowdaiah. 2003. Tensile and wear properties of aluminium composites. Wear. 255: 638-642.
3. D.M. Aylor. 1982. Metals Hand Book V-13 & Vol. 19. ASM Metals Park, OH. pp. 859-863.
4. T.V.Christy, N.Murugan and S.Kumar, "A Comparative Study on the Microstructures and Mechanical Properties of Al 6061 Alloy and the MMC Al 6061/TiB2/12P", Journal of Minerals & Materials Characterization & Engineering, 2010 Vol. 9, No.1, pp.57-65.
5. Rakesh Kumar Yadav[1], Nabi Hasan[2], Ashu Yadav[3] "Studies on Mechanical Properties of Al - Based Cast Composites" , IJCSMS International Journal of Computer Science and Management Studies, Vol. 11, Aug 2011, Issue 02.
6. Jinfeng Leng,[a*] Gaohui Wu,[a] Qingbo Zhou,[b] Zuoyong Doua and XiaoLi Huanga , "Mechanical properties of SiC/Gr/Al composites fabricated by squeeze casting technology", sciencedirect Received 11 January 2008; revised 24 April 2008; accepted 14 May 2008.
7. A. R. K. Swamy[1] , A. Ramesha[2] , G.B. Veeresh Kumar[3*], J. N. Prakash[4] "Effect of Particulate Reinforcements on the Mechanical Properties of Al6061-WC and Al6061-Gr MMCs", Journal of Minerals & Materials Characterization & Engineering, Vol. 10, No.12,(2011), pp.1141-1152.

8. B.K. Prasad, "Investigation into sliding wear performance of zinc-based alloy reinforced with SiC particles in dry and lubricated conditions", Wear 262 (2007), pp.262–273
9. H.C. How, T.N. Baker, "Dry sliding wear behaviour of Saffil-reinforced AA6061 composites", Wear 210 (1997), pp.263-272.
10. Liang, Y. N., Ma, Z. Y., Li, S. Z., Li, S. and Bi, J., "Effect of particle size on wear behaviour of SiC particulate-reinforced aluminum alloy composites", Journal of Materials Science Letters, 1995, 14, pp.114- 116.
11. Pandey P C (2004), Learning Materials on Composites, Department of Civil Engineering, IISc Bangalore.
12. R. Mehrabian, R.G. Riek and M. . . Flemings, "preparation and casting of Metal-Particulate Non-Metal composites," Metall. Trans, V ol. 5A, 1974, pp 1899-1905.
13. L.M.Manocha & A.R. Bunsell "Advances in composite materials", Pergamon Press, Oxford, 1980, Vol.2, p 1233-1240.
14. R.E.Smallaman and R.G.Bishop,"Modern Physical Metallurgy and Materials Engineering", Sixth edition 1999, pp.21-22.
15. K.K.Chawla, "Composite materials–Science and Engineering", (1987) New York Springer Verlag, pp. 67-72.