Fabrication and Analysis of Al/Ilmenite Nanocomposite Using Liquid Metallurgy Method

Dr.L.Rasidhar, P.Srinivasa Rao, Sai Ankit Tripathi

Abstract— Aluminum MMCS reinforced with FeTio3 particulates were fabricated successfully using stir casting method. Composites with 1-5% FeTio3 particles as reinforcement are obtained. Micro structural characterization of the Al/Ilmenite nanocomposites shows near uniform distribution. Ilmenite particles in the matrix the results revealed that the Al/Ilmenite nanocomposite shows better mechanical properties than the pure Aluminum.

Index Terms— Ilmenite, Hardness, MMC's, Porosity, SEM, XRD,

1 Introduction

Particle reinforced composites are known for their attractive physical and mechanical properties such as hardness, tensile strength and good wear resistance.[1] A uniform reinforcement distribution in such Aluminum based composites is essential to avoid agglomeration or inhomogeneous distribution of reinforcement which can lead to lower the mechanical properties [2]. The particulates reinforcement such as Sic, Al2O3 and Aluminized [3] are generally preferred to impart higher hardness.

Recently, many processes have been suggested for fabrication of metal matrix composites formed by ceramic reinforcing phases and Al, such as stir casting[4] and squeeze casting[5] technique is a process for fabrication of metal matrix composites (MMC) by vortex in the molten metal with the help of stirrer in the crucible. During stirring particles are fed in to the crucible. Although there is no clear relation between mechanical properties of the composites volume fraction type of reinforcement [6,7] and surface nature of reinforcement [8], the reduced size of the reinforcement particles [9]. is believed to be effective in improving the strength of the composites wear behavior of AZ91reinforced with micro-particles of SiC was investigated by Lim.et.al.[10] In their study, a range of mechanisms including abrasion, oxidation, delamination, adhesion, thermal softening and melting were discussed. The purpose of this study is to fabricate synthesis the nano particles and evaluate the mechanical properties of Al-based metal matrix composites.

2Experimental details:

2.1 Raw Materials and Experimental Set Up:

The raw materials used in this work were Fe_2Tio_3(Ilmenite) and Al whose proportions are listed in table 1

Table 1. Properties & starting reagent

Sl.No	Material	Vendor	Particle size (μm)	Purity (%)
1	Al	NALCO	-	99.7
2	Fe_2Tio_3	Tri max sands Pvt.Ltd	45	-

The matrix material (pure Al) was reinforced with 1,2,3,4 and 5% of Fe_2Tio_3 (ilmenite) by using stir casting technique. The production & Al / Ilmenite composite with different wt % is as follows:

High energy milling was carried out in a laboratory planetary ball mill employing constant rotating speed of 400 rpm for different milling times (24 hr and 48 hr). Fe_2Tio_3 particles were preheated to 400^0c and then it was added to the molten Aluminum matrix material at 750^0c. Argon atmosphere was maintained over the melt to reduce oxidation. Stirring is carried at a speed of 350 rpm during the addition & preheated Ilmenite particles to the molten metal and then composite slurry was poured into a preheated permanent iron die which is also preheated to 500^0c . X- ray diffractometry (XRD) was used to follow the structural changes & powder after milling. Scanning Electron Microscope (SEM) linked with an Energy Dispersive Spectra meter (EDS) was used for Morphological characterization and chemical analysis is the starting reagents. The hardness of the composites is calculated using Vicker's hardness testing machine. The amount of porosity in the cast alloy and the composite was determined by comparing the measured density with that is their theoretical density.

3.RESULTS AND DISCUSSION:

The Ilmenite nano particles are brought to nano size(60-80nm) with the help of high energy ball mill. The Al/Ilmenite nanocomposites with various percentages of reinforcement are fa-

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bricated using stir-casting method. Secondary phase $FeAl_3$ is observed during Microstructure evaluation by Scanning Electron Microscope Fig.1.

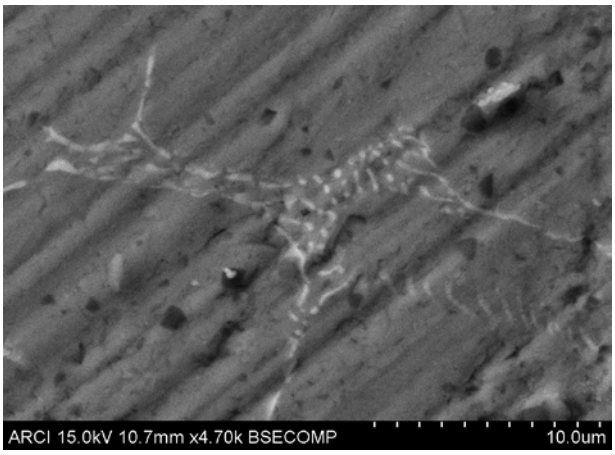

Fig.1. Secondary phase $FeAl_3$

3.1Hardness

The hardness of a material is a physical parameter indicating the ability of resisting local plastic deformation. As the amount of reinforcement of nano $FeTiO_3$ particles increases the hardness of the composite also increases, this can be attributed primarily to the refined grain structure of matrix, reinforcement of harder $FeTiO_3$ nano particle and due to the formation of hard $FeAl_3$ phase in the matrix. However the hardness of the composites with higher wt% reinforcement shows decreased values. Fig. 2.

Fig.2. Variation of hardness with wt% of Reinforcement

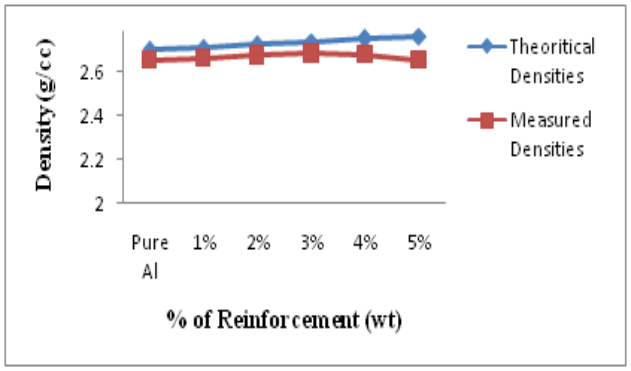

Fig.3.a. Variation of Densities with wt % of Reinforcement

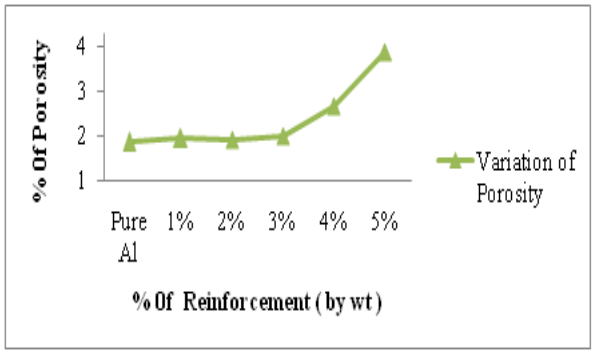

Fig.3.b Variation of Porosity with wt % of Reinforcement

4.CONCLUSION

The Ilmenite nano particles are brought to nano size(60-100nm) with the help of high energy ball mill. The Al-Ilmenite nanocomposite with various percentages of reinforcement are fabricated using stir-casting method. Microstructures reveals that fair distribution of nano particles, however there is an agglomeration of particles at a higher % of reinforcement. The formation of secondary phase iron - alumunide ($FeAl_3$) in the composite. Mechanical properties like hardness, increases with increase in percentage of reinforcement, however better properties are shown for 3 % of reinforced nanocomposite.

REFERENCES

[1] KAC 2 Mar UJw, Pietr 2ak k, Wlosinski W. The production and application of metal matrix composites materials J Mater process Technol 2000; 106: 58-67.

[2] Tekmen, C., Ozdemir, I., Cocen, U., Onel, K., 2003. The mechanical response of Al-Si-Mg/ SiCp composite. Influences of porosity. Mater. Sci. Eng. 360, 365-371.

[3] F.M. Husking, F.Folgar portillo, R.Wunderlin R.Mehrabian. "Composites of Aluminum alloys; Fabrication and wear behavior", J. Mater. Sci. 17(1982) 477-498.

[4]. Hashim, J.,Loones, L.,Hashim, M.S.J., Metal Matrix composites: production by stir casting method, J.Mater. Process. Technol., 1997, vol:92-93, pp. 1-7.

[5] 2hao, M., Wu, G., Dou, Z., and Jiang, L., TiB_2/Al Composites. Fabricated by squeeze casting technique, Mater.Sci.Eng.A,2004, Vol. 374, No's. 1-2, pp. 303-306.

[6] T.Miyajima, 4. Iwai., " Effects of reinforcements on sliding wear behavior of aluminum matrix composites." Wear 255 (2003) 606-616.

[7] M.D. Bermudez, G. Matinez- Nicolas, F.J. Carrion, I.Martinez – Mateo, J.A.Rodriguez, E.J.Herrera, "Dry and lubricated wear resistance of mechanically alloyed. Aluminum – base sintered composites." Wear 248 (2001) 178-186.

[8] H. Ribes, M. suery, G.L[3] Esperance, J.G.Legoux, "Microscopic examination of the interface region in 6061-AlSic. Composites reinforced with as received and oxidized SiC Particles.", Metallurgical and materials Transactions A, 21(1990) 2489-2496.

[9] Ma 2y, T.Jong SC. In site ceramic particle- reinforced aluminum matrix composites fabricated by reaction pressing in the Tio_2 (Ti)-Al-B(B_2O_3) systems. Metal Matter. Trans. 1997, 28(A): 1931-42.

[10] C.Y.H.Lim, S.C.Lim, M.Gupta, wear behavior of SiCp-reinforced magnesium matrix composites: wear 255 (2003) 629-637.