Journal of Material Science and Mechanical Engineering (JMSME)
Print ISSN: 2393-9095; Online ISSN: 2393-9109; Volume 2, Number 1; January-March, 2015 pp. 57-60

http://www.krishisanskriti.org/jmsme.html

Comparative Study of 6061 Aluminium Alloy and 6061 Aluminium with Nano Sic Composites by Powder Metallurgy Method

G. G. Sozhamannan[1], M. Muttharasan[2], M. Sivaselvam[3], K. Manikandaraj[4], K. Velmurugan[5] and V. S. K. Venkatachalapathy[6]

[1,2,3,4,5,6]*Department of Mechanical Engineering, Sri ManakulaVinayagar Engineering College, Pondicherry-605107*

Abstract—*Nano composites are widely used in many areas such as automotive, aerospace and defense sectors due to their attractive mechanical properties and low weight. Nano composites of SiCp (average size < 50 nm) reinforced in aluminum matrix were fabricated by powder metallurgy method. The particles distribution in matrix was studied by using scanning electron microscope. The mechanical properties were studied by micro hardness tester and compressive universal test machine. The results revealed that mechanical properties are influenced by presence of Nano SiC particle in the Aluminium matrix.*

Keywords: *Aluminium, Nano SiC particle, Powder metallurgy method, SEM*

1. INTRODUCTION

Manufacturing is a very broad discipline and encompasses several processes such as fabrication, machining and joining. The fabrication methodology of a composite part depends mainly on three factors: (i) the characteristics of constituent matrices and reinforcements, (ii) the shapes, sizes and engineering details of products and (iii) end uses. Metal matrix composites (MMCs) strengthened with nano-particles, referred to as Metal Matrix nano-Composites (MMnCs), area unit being investigated worldwide in recent years, and because of their promising properties appropriate for an (insert referred journal) oversized range of practical and structural applications. The reduced size of the reinforcement section all the way down to the nano-scale is specified interaction of particles with dislocations becomes of great importance and, once additional to different strengthening effects usually found in typical MMCs, results in a remarkable improvement of mechanical properties.

Production methods can be divided into three categories such as solid state, liquid state and semi-solid state processes. Solid state processes are generally used to obtain the best mechanical properties in the MMC, particularly in discontinuous MMCs. This is because of reinforcement are distributed uniformly and intermetallic phase formation are lower in these processes than in liquid state processes [1]. Several methods have been used for the fabricate the metal matrix composites such as stir casting [2], mechanical alloying [3], mechanical milling [4] and powder metallurgy [5].

Especially, Powder metallurgy (PM) techniques are widely used because near net shape components are produced and low interfacial reactions [6]. This aspect should reflect on the reduction of the fabrication costs of aluminium products. Depending on the processed used to fabricate the powder, pre-alloyed (PA) and blending elemental (BE) aluminium powders are normally available. The use of master alloys (MA) is a modification of the BE powders and it has been identified as the less expensive method to produce aluminium alloys with both classical and novel compositions [5]. . Aluminium P/M is currently used to produce ultra-high strength and creep resistant alloys beyond the levels possible by conventional ingot metallurgy. Coupled with an improved alloying capability which provides new possibilities for alloy design, this has facilitated the development of materials with exceptional mechanical properties. While these alloys have attractive properties, they are expensive to produce, limiting their use to niche applications, mainly in the aerospace industry. Rana et al is fabricated the AMMCs by powder metallurgy methods.

The presence of reinforcement in matrix is mainly influenced the mechanical behavior of composites. Riccardo Casati and Maurizio Vedani et al suggested that the Nano composites, the strengthening mechanisms responsible for the improvement of mechanical properties of Nano-reinforced metal matrix composites. K. S. Narasimhan et al found that sintering process in powder metallurgy play important role for strengthening the composite materials. Ashuri et al found that increasing percentage reinforcement in matrix are enhancing the mechanical properties of composites. Torralba et al suggested that when increasing sintering time and sintering temperature pores level decreased. In this present work, the 6061Al / Nano SiC composites were fabricated by powder metallurgy method. The microstructures were evaluated by SEM and mechanical properties were evaluated by compressive test and microhardness test. Finally, test results are compared with 6061 aluminium alloy. and mechanical behaviour is studied and correlated with microstructural features obtained.

2. EXPERIMENTAL PROCEDURE

Aluminum powders have been used as matrix. The chemical compositions are shown in Table 1. Nano size Silicon Carbide particulates have been used as reinforcement material. Two percentage SiC Nano particles were added to the aluminium. The average particle sizes are 20 nm (SiCp-b, 99+% pure). Fig 1 shows the SEM image of Nano SiC particles. The powders are mixed by ball mill.

Table 1: Composition of aluminium alloy

Element	Zn	Fe	Ti	Cu	Si	Mn	Mg	Cr	Al
Percent	0. 25	0. 7	0. 15	0. 4	0. 6	0. 15	0. 9	0. 35	96. 5

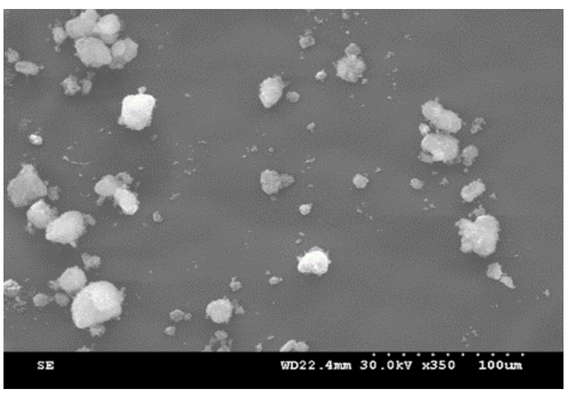

Fig. 1: SEM image of Nano SiCp

A die is placed on the universal testing machine and the powder is poured in the die and compacted at 480Mpa. The samples are ejected carefully. The prepared nano composite specimen is shown in fig. 3

Fig. 2: Universal testing machine

The sample is placed in the muffle furnace (non-inert) for sintering process. The samples are preheated to 150 degree Celsius and maintained at that temperature for 30mins and then temperature is increased to 600 degree for 1hour 30minutes. After that the sample is taken out and cooled in the atmospheric temperature (Normalizing metallurgy).

Fig. 3: Compacted Al/Nano SiCp Composite specimen

3. RESULT AND DISCUSSION

3. 1 Microstructural Characterization

The microstructure analysis was carried out by using SEM. Fig. 4 show micrograph of the fabricated Al alloy. It's observed that Al was bonded well by compacting and sintering process.

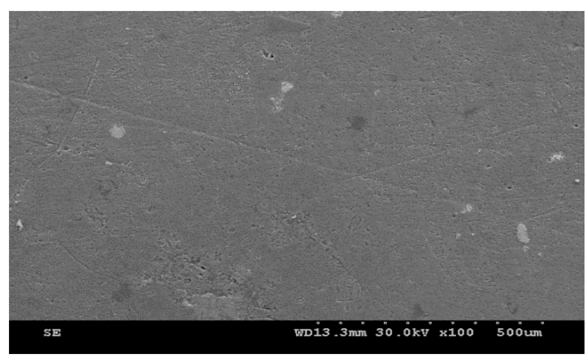

Fig. 4: SEM image of aluminium alloy

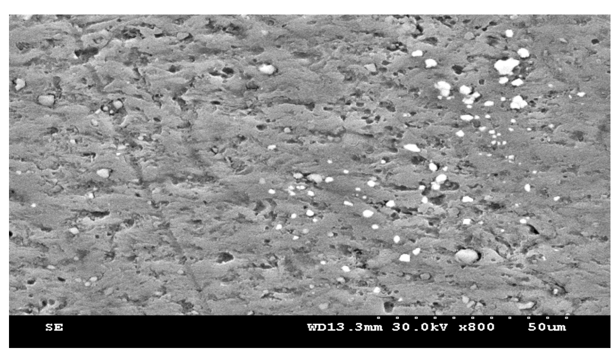

Fig. 5: SEM image of Al / Nano SiCp composite

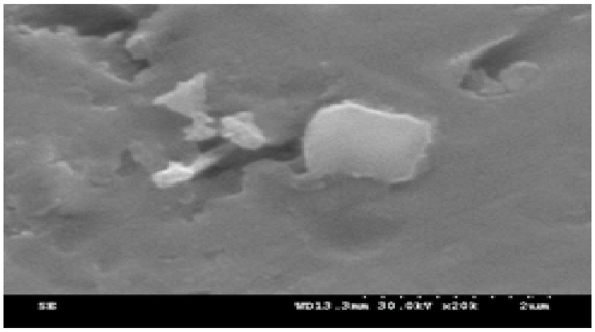

Fig. 6: SEM image shows the presence of Nano SiC particle in the matrix

Fig. 5. Show SEM micrograph of the fabricated Al/Nano Sic composite having constant volume fraction of 2vol% having different size of Nano Sic particulates. Although some clusters of Sic particulates could be observed, the distribution generally appeared to be fairly homogeneous throughout the Aluminium particulates. A typical Nano SiC/Al interface has been obtained. Fig. 6. clearly shows the Nano SiC particles are well bonded with the Al matrix.

3. 2 Micro-Hardness

Fig. 3. Shows the comparison of hardness of Al and Al/Nano SiCp. Micro hardness test was carried out at different location in composite materials and aluminium alloy by using micro hardness test machine. The test results revealed that composites with 2% nano SiCp greater than Al alloy because presence of nano particles are influenced the strengthening mechanism of matrix.

From the graph it is observed that, The Al Alloy have lower hardness. The Al Alloy have different hardness in different point due to presence of pores . The hardness of composites with 2 % Nano SiCp is higher than Al. . Also, the hardness of 2% nano SiCp composites was At Al/nano SiCp, scattering of hardness results increases because of non-uniform distribution of the reinforcement particles. SiCp hard particles acting as obstacles to the motion of dislocation of matrix region.

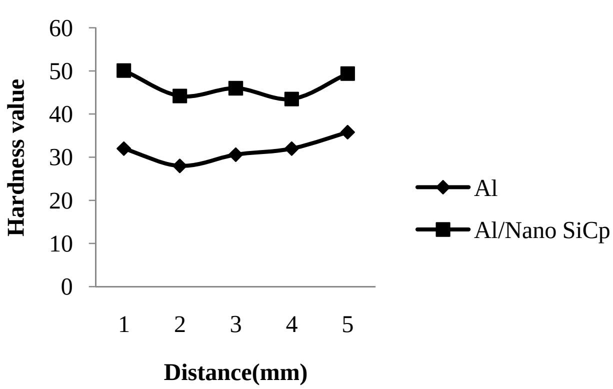

Fig. 7: Comparision of Hardness for Al and Al/Sic

3. 3 Compression Test

Compression test are carried out by Servo controlled Universal Testing Machine. The Al Alloy have the low compressive strength. compressive strength of composites with 2% nano SiCp is higher than Al alloy. The SiCp are very hard and brittle element. Therefore, the presence of nano are restricted the flow of aluminium. Therefore, nano composites are enhanced compressive strength of nano composite materials.

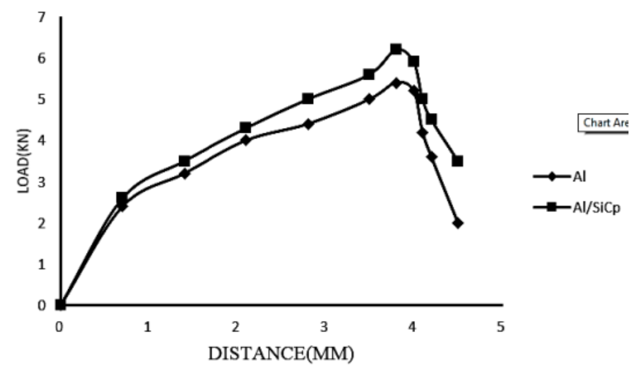

Fig. 8: Comparision of compressive strength for Al and Al/Sic

4. CONCLUSION

Aluminum based nano SiC composite made by powder metallurgy and the results are compared with Aluminium Alloy. This effective method used to produced composites with a homogeneous distribution of particles, which led to maximize the benefits that particle reinforcement brings to the mechanical properties. The presence of Nano SiC reinforcements (<60 nm) contribute to more efficient strengthening of the composites. The sintering process improves strong particle–matrix bonding which allows an effective load transfer that results in an effective improvement in the Micro hardness.

REFERENCE

[1] S. Tahamtan, A. Halvaee, M. Emamy, M. S. Zabihi, Mater. Des. Microstructural examination and properties of premixed Al–Cu–Mg powder metallurgy alloy, *Materials characterization* 49 (2013) 347–359.

[2] M. Kok, The effect of sintering temperature on microstructure and properties of al – sic composites**,** *Composite. Part A* 37 (2006) 457–464.

[3] B. N. Tabrizi, A. Fahami, R. E. Kahrizsangi, A. Khazraei, M. R. Yazdani, M. J. Kajbafzadeh, Effect of Sintering Temperature on Density, Porosity and Hardness of a Powder Metallurgy Component, *Powder Technology*. 243 (2013) 59–70.

[4] A. Canakci, S. Ozsahin, T. Varol, *Powder Technology* 228 (2012) 26–35.

[5] E. Furlani, E. Aneggi, C. de Leitenburg, S. Maschio, *Powder Technology* 254 (2014) 591–596.

[6] T. Varol, A. Canakci, *Powder Technology* 246 (2013) 462–472.

[7] T. Varol, A. Canakci, S. Ozsahin, *International Journal of Emerging Technology and Advanced Engineering* 224–233

[8] Hurless BE, Froes FH. Lowering the cost of titanium. *AMPTIAC Quarterly* 2002;6:3–10.

[9] S. Tahamtan, A. Halvaee, M. Emamy, M. S. Zabihi, *Mater. Des*. 49 (2013) 347–359.

[10] A. Canakci, T. Varol, S. Ozsahin, *Met. Mater. Int.* 19 (2013) 519–526.

[11] N. P. Cheng,, S. M. Zeng , Z. Y. Liu , Preparation, microstructures and deformation behavior of SiCP/6066Al composites produced by PM route, *Journal of materials processing technology*,202,2008,pp. 27-40.

[12] Ali Mazahery, Mohsen Ostad Shabani , Study on microstructure and abrasive wear behavior of sintered Al matrix composites, *Ceramics International* 38 (2012),pp. 4263–4269.

[13] Hossein Abdizadeh , Reza Ebrahimifard , Mohammad Amin Baghchesara , Investigation of microstructure and mechanical properties of nano MgO reinforced Al composites manufactured by stir casting and powder metallurgy methods: A comparative study, *Composites: Part B* 56 (2014) pp. 217–221.

[14] Sean Garner , Elaine Ruiz , John Strong , Antonios Zavaliangos , Mechanisms of crack formation in die compacted powders during unloading and ejection: An experimental and modeling comparison between standard straight and tapered dies, *Powder Technology* 264, (2014) pp. 114–127.

[15] X. Yang , S. J. Guo, B. F. Chen, F. Meng, Y. D. Lian , Electrostatic performance of various lubricant powders in P/M electrostatic die wall lubrication, Powder Technology 164 (2006),pp. 75–81.

[16] G. Elango , B. K. Raghunath , Tribological behavior of Hybrid (LM25Al + SiC + TiO2) *Metal Matrix Composites Procedia Engineering* 64(2013),pp. 671-680.

[17] Dinesh Kumar Kolia , Geeta Agnihotrib , Rajesh Purohitc, A Review on Properties, Behaviour and Processing Methods for AlNano Al2O3 Composites,*Ain shams engineering journal*,(2014) 5,pp. 831-838.