ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 3, March 2015

A Survey of Aluminium Metal Matrix Composites Using Powder Metallurgy Technique

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Abstract: - Aluminium metal matrix composites have gained importance in various industries because of their good mechanical properties. Aluminium metal matrix composites are preferred in the fields of aerospace, military, automotive, marine and in other domestic applications. The different reinforcements with aluminium metal matrix composites by powder metallurgy technique results in improved mechanical properties such as ultimate tensile strength, compressive strength, hardness, wear rate. Powder metallurgy is an ideal method of fabrication for MMCs because of the ability to produce near net shapes and little material waste associated with this process. In this survey an attempt has been made to consolidate some of the aspects of mechanical properties of Aluminium MMCs fabricated using Powder Metallurgy Technique.

Keywords: Metal matrix composites, Aluminium metal matrix composites, Powder metallurgy, Mechanical Properties

I. Introduction

Aluminium based composite materials are leading ones in this area, they are fabricated using many methods, including powder metallurgy processes. Powder metallurgy is the process of making components with required properties and shape by mixing metal and non-metal powders. Powder metal products are manufactured by the various procedures such as manufacturing of metal powders, blending, compacting, sintering, finishing and sizing. Light metal matrix composite materials with ceramic particles as reinforcements have received widespread studies during the past decades because of their superior mechanical properties. Based, on the detailed literature survey the reinforcements such alumina, titania, zirconia when mixed with AMMCs fabricated by using powder metallurgy have good mechanical properties. The material distribution can be analyzed by using SEM & TEM technique. Finally the mechanical properties can be analyzed by Universal testing machine and hardness tester. The characterization of the powder particles can be analyzed by X-ray diffraction analysis (XRD) and Energy dispersive X-ray analysis (EDAX).

II. LITERATURE REVIEW

Vanitha et al [1]. Studied the mechanical properties of aluminium and aluminium based titania composites by powder metallurgy technique with different particulates weight percentage (6 and 12%). The density of the composite is increased whenever weight percent was increased. The tensile strength of the composite was increased with increase in the weight percentage of the titania composites.

Ravichandran et al [2]. Synthesized and studied the forming behavior of aluminium-based hybrid powder metallurgic composites. Aluminium-based metal matrix composites were synthesized from Al-TiO_2-Gr powder mixtures using the powder metallurgy technique and their forming characteristics were studied during cold upsetting.

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Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. II, Issue I, January 2015

The addition of both TiO_2 and Gr reduces the densification and deformation characteristics of the sintered preforms during cold upsetting.

Wiodarczyk-Fligier et al [3]. Fabricate the aluminium metal matrix composite material reinforced with Al_2O_3 particles. This manufacturing method shows the manufacturing of aluminium metal matrix composites with any reinforcement can be easily fabricated by powder metallurgy technique with required structure joining positive properties composite materials components.

Asif et al [4]. Development of aluminium based hybrid metal matrix composites for heavy duty applications. This paper shows the investigations on dry sliding wear behavior of aluminium based composites, reinforced with silicon carbide particles and solid lubricants such as graphite/antimony tri sulphide (Sb2S3). Both composites were mixed and fabricated by powder metallurgy technique. Final results shows that the proposed composites have lower friction coefficient, less temperature rise and low noise level; however they have little higher wear rate.

Mahboob et al [5]. Investigates the influence of nanosized Al_2O_3 weight percentage on microstructure and mechanical properties of Al–matrix nanocomposite by powder metallurgy technique. In their research, the morphological, micro structural and mechanical properties changes during nanosized alumina increment to Al powder were studied. The process was carried out for different weight percentage Al–(0–20) wt-%Al_2O_3. Their results showed that the strength, ductility and hardness were increased by increasing the reinforcement nano particles weight percentage.

Shanta et al [6]. Investigates the processing, microstructure and properties of hybrid metallic and ceramic reinforced aluminium composites via P/M technique. In this work the combined Ti (micro) and Al_2O_3 (micro or nano) particles reinforced commercially with pure Al matrix composites have been developed via powder metallurgy route.A detailed microstructural characterization and the evaluation of mechanical properties including wear and corrosion behaviour have been carried out.The composites reinforced with the ceramic particles (micro or nano) alone exhibited higher hardness values. Micro structural characterization revealed that there is a uniform distribution in the composites. The hybrid composites exhibit a better wear resistance than the composite reinforced with individuals particles owing to their higher hardness as compared to that of the other composites.

Gokce et al [7]. Investigations on mechanical and physical properties of sintered aluminum powders through powder metallurgy route. In this study green and theoretical density increased with the increment of compaction pressure. The mechanical performance is very good for both pressures during the transverse rupture (three point bending test) owing to enhanced diffusion in the mentioned sintering process.

Sujit Das et al [8]. Experimental Analysis of Density of Sintered SiCp Reinforced AMMCS Using the Response Surface Method. The paper aim is to fabricate Al-SiCp composites by powder metallurgy (P/M) processing route. An experimental investigation have been undertaken in order to understand the variation of density with respect to the variation of process parameters viz., variation of silicon carbide proportion, compacting pressure and sintering time. The relation among the various process parameters with density has been studied. A mathematical model has been developed using second order response surface model (RSM) with central composite design (CCD) considering the above mentioned process parameters. The model shows increase in density due to change in wt% of SiCp (x1) and sintering time for compaction load from 40-93.63586 Ton at a fixed sintering time of 40 minutes and for a fixed value of compacting pressure (x2). The response variable, density (R1) shows linear increase when it is plotted against sintering time (x3) and compacting pressure (x2) for a fixed value of wt% of SiCp (x1) and the prediction of density variation from the mathematical model developed in this study matches closely with the observed data (R^2 = 89.8 %). The microstructure shows the uniform distribution of particles.

Dinesh Kumar Koli et al [9]. Properties and Characterization of Al-Al_2O_3 Composites Processed Powder Metallurgy Routes. This paper shows the characterization of mechanical properties with production routes of powder metallurgy for aluminium matrix-Al_2O_3composites.A uniform distribution of the Al_2O_3reinforcement phase in the Al matrix can be obtained by high-energy ball milling of Al– Al_2O_3blends. Nearly 92% increase in the hardness and 57% increase in the tensile strength were obtained in the nano-composites as compared to the commercially pure aluminium.

Siddhartha Tiwari et al [10]. Densification Behavior in the Fabrication of Al-Fe Metal Matrix Composite Using Powder Metallurgy Route. This papers deals with the densification behavior of Al-Fe powder particles during compaction and sintering in order to fabricate the Al-Fe metal matrix composites by powder metallurgy route. Green compacts of Al-6.23wt.% Fe powder particles were fabricated under varying compaction pressures, and these fabricated green compacts were sintered over a series of temperatures (430°C–590°C). The sintered products have been characterized with the help of X-ray diffraction (XRD) and scanning electron microscope attached with energy dispersive spectroscopy (EDS). Sintered density increases with increasing sintering temperature up to 550°C whereas a drop in sintered density is perceived at 590°C. This decrease in sintered density is considered to occur due to swelling which has been explained on the basis of the Kirkendall effect. The XRD and EDS analyses of sintered products indicated the presence of Al and Fe particles with the trace amount of intermetallics. The obtained results were briefly explained to understand the mechanisms involved during the densification under compaction and sintering.

III. CONCLUSION

From literature review related to the aluminium metal matrix composite material using powder metallurgy technique we concluded that, the pure aluminium mixed with various reinforcements through powder metallurgy fabrication technique it will results in increasing better mechanical properties such as ultimate tensile strength, compressive strength, hardness and reduction in weight.

IV. ACKNOWLEDGEMENT

The author's would like to thank the previous researchers for their contribution in the area of Powder Metallurgy and their valuable references.

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Vol. II, Issue I, January 2015

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