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Fabrication and Characterization of Discontinuous Type Metal Matrix Composites: A Review

Authors

Tushar B. Bhosale[1], Prof. T.B. Sonawane[2]

[1]P.G. Research Scholar in Mechanical Engineering, Flora Institute of Technology, Savitribai Phule Pune University, India.

[2]Professor in Mechanical Engineering, Flora Institute of Technology, Savitribai Phule Pune University, India

Email: tbb.bhosale@gmail.com sonawane.yuram@gmail.com

ABSTRACT

This review paper presents a study of various Metal Matrix Composites (MMCs) reinforced with different materials produced by different production technology and improvements in their mechanical properties. Composites are most successful materials used for recent works in the industry. The Aluminium alloy has excellent properties such as high thermal conductivity and low density. These properties make its application wide in the field of automotive, aerospace and mineral processing industries to make their products but the main drawback of aluminium alloys are poor wear resistance behavior, harness and tensile strength. To overcome this drawback, these types of alloys are reinforced with some other materials so that its mechanical properties like hardness, tensile strength, and wear resistance can increased upto some desired limit.

Keywords – *Metal Matrix Composite (MMCs), Wear, Hardness, Tensile Strength, Aluminium Alloy, Density.*

INTRODUCTION

Metal matrix composite (MMC) is combination of the metal (Matrix) and hardparticle/ceramic (Reinforcement). The composite generally has superior characteristics than those of each of the individual components. When the matrix is a metal, the composite is termed a metal-matrix composite (MMC). In MMCs, the reinforcement can be in the form of particles, whiskers, short fibers, or continuous fibers. Aluminum is the most popular matrix for the metal matrix composites (MMCs). The Al alloys are quite attractive due to their low density, capability to be strengthened by precipitation, good corrosion resistance, high thermal and electrical conductivity, and high damping capacity. Aluminium matrix composites (AMCs) are widely used in the industries due to their excellent mechanical properties.

In recent years the metal-matrix composite (MMC) materials are widely used because of their lightness, higher specific strength and wear resistance properties. The composite material are widely used in aeronautic–aerospace transport, the automotive industry, because of their good strength-to-weight ratio, ease of fabrication with reasonable cost, excellent combination of low density and high thermal conductivity. Metal–matrix composites are conventionally fabricated using different techniques such as power metallurgy, squeeze casting, and the stir casting. Stir casting is cost effective. Powder metallurgy is expensive.

LITERATURE REVIEW

Zhang Peng, Li Fuguo (2008) They studied the deformation mechanism of SiC particle reinforced metal matrix composites. They used material of aluminum alloy reinforced with 15% volume of silicon carbide particles with an average size of 12 micron. The material was produced by blending SiC particles and Al powder followed by compacting

and hot pressing them into blanks, which were then extruded into cylinders at1016 K and with a ratio of 20:1. They conclude on experiment basis plastic deformation is large at elevated temperature. The effects of deformation parameters, such as temperature and strain rate play a minor role in affecting strengthening behavior.

Yuan Zhanwei, Li Fuguo, Zhang Peng, Chen Bo, Xue Fengmei (2013) They studied the micro-hardness and Young's modulus of SiC particles reinforced aluminum matrix composites with micro-compression- tester (MCT). The micro-indentation experiments were performed with different maximum loads and loading speeds. The Young's modulus and microhardness at particle, matrix and interface were highly dependent on the loading conditions and the locations of indentation. Hardness decreased with the depth of indentation increasing.

Madeva Nagaral1, Bharath V and V Auradi (2013) They studied the tensile strength and wear resistance of 6061Al- Al2O3 composites produced by liquid metallurgy technique and pin-on disc method respectively. They conclude on experiment basis the 6061Al- Al2O3 composites have a higher tensile strength and superior wear resistance than 6061 aluminium alloy with reduced ductility.

Deepak Singla, S.R. Mediratta (2013) They produced the Al 7075-Fly Ash Composites by using Stir Casting method and conclude on experiment basis composite has good toughness, hardness, tensile strength and also having the low density comparatively alloys without reinforcement. So that these composites could be used in those sectors where light weight and good mechanical properties are required as like in automobile and space industries.

H.M.Zakaria (2014) They studied the microstructural and corrosion behavior of Al/SiC metal matrix composites (MMCs) by changing the size and volume fraction of SiC particulates on experiment basis. The Al/SiC MMCs were fabricated using the conventional powder metallurgy (PM) route. Increasing the volume fraction and reducing the SiC particles size increased the corrosion resistance of the Al/SiC composites. Increasing the duration exposure reduces the corrosion rate. The Al/SiC composites exhibited higher densities than the pure Al matrix. The density of the composites increased with the increase in particulate volume fraction.

W.Li, H.Liang, J.Chen, S.Q.Zhu, Y.L.Chen (2014) They studied the fatigue crack growth behavior of SiC particulate-reinforced Al-Si alloy composites produced by spray forming method has advantage of rapid solidification. They conclude on experiment basis composite containing small SiC particles (4.5 micron) exhibited a superior resistance to fatigue crack growth as compared to the composite with 20 micron SiC particles and the unreinforced alloy.

Mohan Vanarotti, Shrishail P, B.R.Shridhar, K.V.Venkateswarlu and S.A.Kori (2014) They studied the increase in SiC content in A356-SiC MMC's resulted an improvement of hardness and tensile properties respectively on experiment basis. Aluminium alloy (356)- Silicon carbide (SiC) metal matrix composites were fabricated using liquid metallurgy technique. The Sliding wear performance of A356 and A356-SiC suggest that SiC content was responsible for improved wear results. Residual stress was compressive and its magnitude decreased as SiC content was increased. Residual stress is compressive in all cases except in A356-15SiC composites. A356 alloys displays higher wear than that of the composite A356-SiC. Hence A356 is accompanied by large amount of plastic deformation as compared to the composites. Higher the plastic deformation, larger the residual stress.

Siddesh Kumar N G, V.M.Ravidranath, G.S.Shiva Shankar (2014) They develop and characterize A12219 reinforced with Boron Carbide and Molybdenum disulfide hybrid composite by Liquid metallurgy route (stir casting technique). On

experiment basis they conclude that density and microhardness of A12219 is relatively low as compared to hybrid composites. Microhardness increases with increase in percentage of reinforcement, this is because of hard Boron carbide particles and secondary reinforcement Molybdenum disulfide distributed in the soft matrix material. The addition of Boron carbide particles and Molybdenum disulfide decreases the wear rate of hybrid composites and increases the wear resistance of the composites.

Pradeep R, B.S Praveen Kumar. and Prashanth B (2014) They produced aluminium alloy 7075 reinforced with silicon carbide and red mud composite by stir casting technique. They conclude on experiment basis improvement in mechanical properties like tensile strength, compressive strength, hardness and yield strength. Also microstructure studies indicate the presence of Aluminium dendrite structure with fine inter metallic particles SiC and Red mud reinforced in between.

Vinitha, B. S. Motgi (2014) They produced Al 7075 Alloy reinforced with flyash, SiC and redmud Composites by stir casting technique. They conclude on experiment basis tensile strength in Al7075-SiC-Flyash samples, is found to increase by maintaining the constant percentage of SiC and Fly ash. In Al7075-SiC-redmud samples, increase in the red mud content increases the tensile strength. Higher tensile strength was observed in Al7075-SiC-Redmud composite than Al7075-SiC-Flyash. The wear resistance of the composite Al7075-SiC-Flyash, is found to be higher by maintaining the constant weight percentages of SiC and Fly ash while it decreases by increasing the weight percentage of Fly ash. In Al7075-SiC-Redmud, wear resistance increases with increase in Red mud content.

Bhaskar Chandra Kandpal, Jatinder Kumar, Hari Singh (2014) They studied the different Metal matrix composites production technologies like stir casting, powder metallurgy, infiltration, etc. They conclude the use of metal matrix composites is increasing day by day dueto their characteristics of behaviour with their high strength to weight ratio. Every industry like automobile, sports, aerospace, construction, marine, etc. utilizes the benefits of composites especially metal matrix composites.

Vencl, A. Rac, I. Bobic, Z. Miskovic (2006) They produced composite of Al-Si alloy A356 , with 3 wt. % Al2O3 reinforcement and studied the tribological properties of Al-Si alloy A356 (EN-Al Si7Mg0.3), with and without 3 wt. % Al2O3 reinforcement and conclude wear rate decreases for composite material.

Rajesh Kumar Bhushan & Sudhir Kumar & S. Das (2012) They studied fabrication and microstructural investigations of AA7075–SiCp MMCs. 7075 Al alloy is reinforced with 10 and 15 wt.% SiCp of size 20–40 μm by stir casting process and conclude distribution of reinforcement particles is homogeneous composites can be successfully used for applications where temperature does not exceed beyond 1,250 °C. These composites are suitable for automobile, aircraft, and space applications.

Jaspreet Singh, Deepak Narang, N.K. Batra (2013) They studied the Mechanical and Tribological behaviour of Al matrix composites reinforced with SiC and Gr particulate up to 10% and conclude that the hardness, tensile strength of Al-SiC composite is greater than that of Al-Gr composite because of highhardness of SiC particulates. % reinforcement, sliding distance and sliding speed affects the wear and mechanical properties like tensile strength and hardness etc.

Manoj Kumar Gupta, Pawan kumar Rakesh (2014) They presents an overview of different reinforced materials in Aluminium Metal Matric Composites (AMMCs) system and their effect on different properties. The properties of aluminuim metal matrix composite depend upon the various parameters such as process rout, temperature, alloys

elements of matrix materials, types of reinforcement materials with their shape, size, wettibility, wt and volume percentage and reaction during composite preparation. The SiC and Al2O3 reinforcemets are commonly used because they are reactive with aluminium and high affinity to temperature and their percentage volume in matrix material.

CONCLUSION

Metal Matrix Composites produced successfully by various fabricatin technologies like stir casting, powder metallurgy, spray forming. The use of metal matrix composites in every industry like automobile, sports, aerospace, construction, marine, etc. is increasing day by day due to their improved mechanical properties like tensile strength, compressive strength, wear rate, microhardness, corrosion resistance, percentage elongation with their high strength to weight ratio.

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BIOGRAPHIES.

Bhosale Tushar Bhiva

ME-Design, II year, Flora Institute of Technology, Savitribai Phule Pune University, Pune-411011,India.

Interest: - Composite Materials

Prof. Sonawane T.B.

Professor in Mechanical Engineering, Flora Institute of Technology, Savitribai Phule Pune University, Pune-411011, India.

Interest: - Composite Materials