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Fabrication and Characterization of Discontinuous Type Metal Matrix Composites

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ABSTRACT

It has been seen there are certain main composites manufacturing processes which are used presently in laboratories as well as in industries are diffusion bonding, the powder metallurgy route, liquid-metal infiltration, squeeze casting, spray co-deposition, stir casting and compo casting. The widely used reinforcing materials for these composites are silicon carbide, aluminium oxide and graphite in form of particle or whiskers. Metal matrix composites have evoked a keen interest in recent times for potential application in many areas especially aerospace & automotive industries owing to their superior strength to weight ratio. A particle reinforce metal matrix composite consist of uniform distribution of strengthening ceramic particle embedded within metal matrix. The aluminium-based composites are increasingly being used, owing to their improved strength, stiffness and wear resistance properties. This composite material finds application in aviation industries, automobile industries, in the transport, marine & mineral processing industries such as brake drums, piston crown, piston rings, and connecting rods. This paper presents the Synthesis of Al7075 based metal matrix composites reinforced with Al2O3 particles by liquid metallurgy technique by varying the composition of Al2O3 particles in the matrix. Obtained composites will be examined for wear rate, hardness, coefficient of friction, tesile strength and reduction in percentage elongation

.***Keywords*— open cell cellular structure, Natural Convection, Porosity.**

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I. INTRODUCTION

A composite material is a material consisting of two or more physically and/or chemically distinct phases. The composites posses improved physical and mechanical properties such as superior strength to weight ratio, good ductility, high strength and modulus, low thermal expansion coefficient, excellent wear resistance, corrosion resistance, high temperature creep resistance and better fatigue strength. Usually the reinforcing component is distributed in the continuous or matrix component. When the matrix is a metal, the composite is termed a metal-matrix composite (MMC). In MMCs, the reinforcement usually takes 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, their capability to be strengthened by precipitation, their good corrosion resistance, high thermal and electrical conductivity, and their high damping capacity [1].

Aluminum matrix composites (AMCs) have been widely studied since the 1920s and are now used in sporting goods, electronic packaging, armours, military, electricity, aircraft and automotive industries because of improved mechanical properties. Aluminium matrix composites (AMCs) have excellent mechanical properties in industries by its competent materials. In Aluminum matrix composites (AMCs) the ceramic reinforcements are generally oxides or carbides or borides (Al_2O_3 or SiC or TiB_2) [3].

Some of the industrial AMCs applications are given bellow.

(a) brake rotors for high speed train
(b) automotive braking systems
(c) automotive pushrods
(d) cors for HV electrical wires

II. 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 [1].

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 [2].

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 [3].

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 [4].

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 [5].

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 [6].

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 [7].

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 [8].

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 [9].

III. PROBLEM STATEMENT

Synthesis of Al7075 based metal matrix composites reinforced with Al2O3 particles by liquid metallurgy technique (Stir casting technique) by varying the composition of Al2O3 particles in the matrix. Obtained composites will be examined for wear rate, hardness, coefficient of friction, tesile strength and reduction in percentage elongation.

III. METHODOLOGY

1. Fabrication of Al7075 based metal matrix composites reinforced with Al2O3 by stir casting route. Fig.1 shows the Stir casting technique which is most simplest and cost effective method to fabricate metal matrix composites which has been adopted by many researchers. This method is most economical to fabricate composites with discontinuous fibres and particulates and was used in this work to obtain the as cast specimens. Care is taken to maintain an optimum casting parameter of pouring temperature (650°C) and stirring time (15 min). The reinforcements are preheated prior to their addition in the aluminium alloy melt. Degassing agent used to reduce gas porosities. The molten metal is then poured into a permanent cast iron mould and then die is released after 6 hours and the cast specimens were taken out.

2. Microstructural analysis using optical microscopy and chemical composition by spectroscopy analysis will be carried out for obtained composites.
3. The fabricated composites will be tested for micro-hardness test and tensile strength using hardness tester and tensile testing machine..
4. Evaluation of wear rate and coefficient of friction will be conducted on Pin-on-Disc method. Fig.2 shows the Pin-on-disc tribometer. Tribological tests are carried out on the pin-on-disc tribometer under dry sliding conditions, in ambient air at room temperature (≈ 25 °C). Cylindrical pins used as wear test samples.

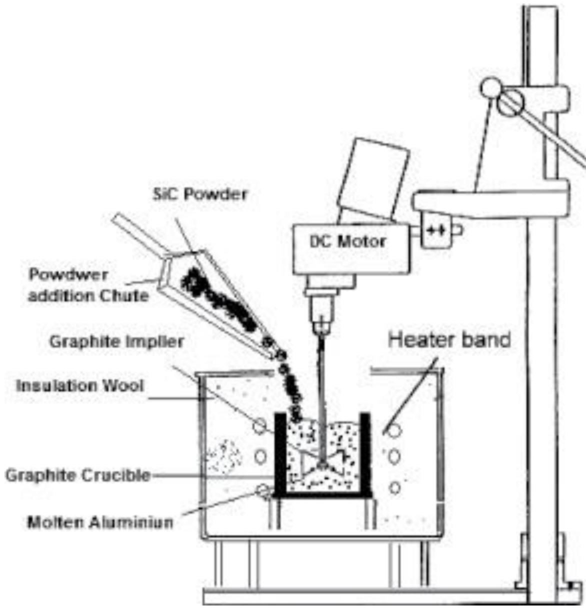

Fig.1 Stir Casting by Vortex Method [10]

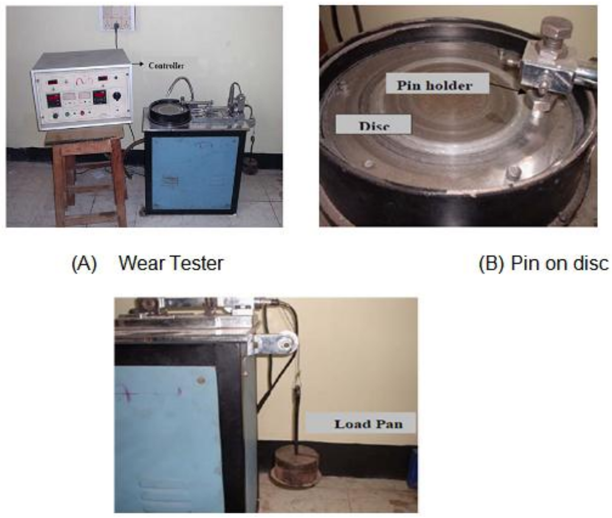

Fig.2 Pin-on-disc tribometer [11]

V. EXPECTED RESULTS

1. Increase in micro-hardness value of Al7075– Al2O3 composites.
2. Decrease in wear rate of Al7075– Al2O3 composites.
3. Improvement in tensile strength and reduction in percentage elongation of Al7075– Al2O3 composites.

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