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ADVANCEMENT OF AL-SiC COMPOSITEMATERIAL BY POWDER METALLURGY METHOD AND SYNTHESIZE ON EDM

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Abstract *— In recent year, aluminum alloy based matrix composites (MMC) are gaining importance in several aerospace and automobile applications. Aluminum has been used matrix material owing of its excellent mechanical properties coupled with good formability. Addition of SiC as reinforcement in aluminum system improves mechanical properties of composites. In the present investigation Al-SiC composite was prepared by powder metallurgy route. Powder metallurgy homogeneously distributes the reinforcement in the matrix with no internal reaction and with less porosity. SiC particles containing different weight fractions (10, 15 and 18 %) and mesh size (320) are used as reinforcement. Though Al-SiC possess superior mechanical properties, the high abrasiveness of the SiC particles obstacle the wide application. Al-SiC composite has the widest application in the aerospace industry due to high hardness and light weight material. After the development of material that specimens were tested the under the micro hardness, density and scanning electron microscopic (SEM).*

Keywords-Composite Material, Al-SiC, Powder Metallurgy,MMC

I. INTRODUCTION

Attractive physical and mechanical properties can be obtained with metal matrix composite which combine metallic properties with those of ceramics. One of the major problems encountered in the production of metal matrix by powder metallurgy route is the agglomeration of reinforcement particles due to size difference between the powders for the matrix and the reinforced particles. To resolved this problem different methods are use e.g ball milling or mechanical alloying technique. Mechanical Alloying or ball milling enables metallic material to coat the surface of ceramic powder particles. Reinforcement material in metal matrix composite material is carbides, nitrides, oxides and other element material. Composite materials are used in the aerospace etc. The important properties are low specific gravity, high wear resistance and strength. By understanding the property, it is possible to develop the new composite reinforced material, which gives better physical and mechanical property. The constituent powder particles are repeatedly fractured and cold welded by continuous milling so that powder particles with very fine size can be obtained. The milling process largely depends on the types of ball mill and the rotation speed of the mill.

II. REVIEW AND RESEARCH WORK:

Neelima Devi. Et al.[1] [2011] In this paper tensile strength experimental have been conducted by varying mass fraction of SiC(5%,10%,15% and 20%)with Aluminium.The maximum tensile strength archive at15% SiCratio and mechanical and corrosion behavior of Al alloys are studied. This is also obvers that the effects of temperature of both the media and concentration of the acid medium were also investigated .The corrosion behavior was evaluated using electrochemical method.This consist the uniform corrosion at the base metal also composite were found to corrode faster than the base alloy and that result more pits.

This paper is also investigates for the tensile test of the specimen on the universal testing machine at room temperature. Test result shows that with the increasing the % of the SiC it also increased the tensile strength but up to 15% of SiC but above this value of SiC it decrease the tensile strength of specimen.

Charanjit Singh et al. [2] [2014] It has been investigate varied the weight of percentage of SiC with respect to the Al (4%, 6%, 8% and 10%) while keeping all parameters have been constant. Friction and wear characteristics of Al-SiC composite have been under dry sliding condition. Dry sliding wear test have been carried out using pin-on –wear test rate normal load of 10,20,30,40 and 50N and at constant sliding velocity of 1.6m/s.

Under the following parameters the present experimentation was performed:

- Types of mill: **High-Energy mill(Attrition Ball Mill)**
- The material of milling tool**: Stainless Steel**
- Types of milling media**: Balls**
- Milling atmosphere**: Air**
- Milling environment**: Dry milling**
- Milling to media –to-powder weight ratio**:10:1**
- Milling time**:7 hr per sample**
- **Jeevan. vat el.[3][2013]**in this paper they are investigated the process for material development by powder metallurgy route with different % ratio of SiC with Al alloy. The composition ratio is developed up to 5 % of

SiC.From the graph it is has been investigate that with increasing the weight % of SiC micro hardness and compressive strength also increase After development of that composite material different type of tests are to be investigated like micro hardness, compressive strength, and microstructure. From the microstructure study they are conclude that the uniform distribution of SiC particles in the aluminum matrix and some clustering of silicon carbide arise reinforcement in the matrix.

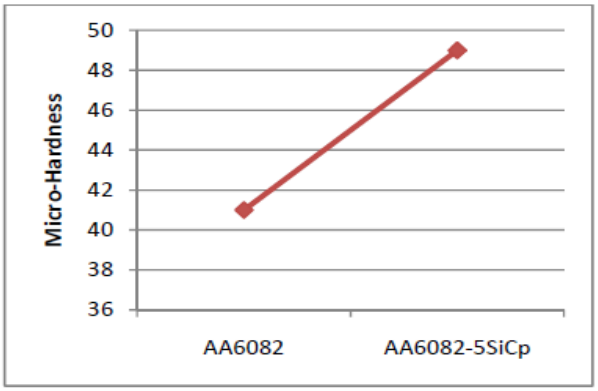

Fig.1.1 Micro Hardness-Sic

IIeanaNicoleta et al.[3][2010] The aim of this paper is to produce the Al-Cu/SiC composites by powder metallurgy processing. Powder was developed under the different combination (5-20%wt) in this composite the different effect of this varied parameters1) Characteristics the mixer of powder.2) Press densification with different pressure(50-450MPa).3)The porosity and hardness testing of the different sample. The sample investigate for sintering temperature is of 520-548˚C and in the liquid phase is 548-620˚C.
In this paper the sintering temperature is range from 520˚C to 620˚ C and investigated result shown in below Table.at the 15% of SiCat the 620˚C it give the good hardness but with increasing the percentage of SiC it reduce the hardness of the parts. It was found that the best densification was obtained at temperatures of 600˚C and 620˚C in the presence of a sufficient quantity of eutectic liquid phase when the lowest values of porosity was 4.39% and 3.53% for composites with 5% SiC. The best characteristics of composite was obtained at 10 and 15% wt. SiC, pressed at 450 MPa, presented between 300 and 400˚C, for 30 min and sintered at 620˚C/60 min in protective atmosphere.

Sintering Temp T c	Brinell Hardness				
	Al-4 Cu 0% SiC	Al-4Cu 5% SiC	Al-4Cu 10% SiC	`Al-4Cu 15% SiC	Al-4CU 20%SiC
520	30	28	28.5	30	27.5
540	36	29	27.5	28	29
560	40	45	38	36	35
580	33	29.5	26	28	28.54
600	50.5	52	51	55	52
620	58	57	59	62	59

Table 1.1 Brinell Hardness

II.I Review and research work for machining the parts on EDM.

Rajesh Purohit et al.[4][2012]in this paper they are investigated the machining characterization of EDM on Al-Alloy-20 % SiC_Pusing copper electrode.The present work report on the effect of pulse-on –time(T_{on}),pulse current(I_p), and gap voltage (V_g) on the metal removal rate (MMR),Tool wear rate (TWR) and radial over cut(ROC) during machining of Al-alloy-20 wt % SiC.The experiments was conducted on EDM machine with 20 mm copper electrode diameter. Three level 3 factors dull factorial design of experiment technique was used for the anaylsis.Analysis of variance (ANOVA) was also performed .A mathematical model was also developed to relate the input and output.
The three level full factorial designs is to be used and that is to be written as a 3^k factorial design. it means k factorial considered each at 3 levels. These are referred to as low, intermediate and high levels normally -1, 0, 1.From the design of experiment they conclude that the MRR increase with increase in gap voltage, current and pulse duration.

Kaushal R. Patel et al. [5]: The factors that affect the microstructure like- type, size, and distribution of reinforcement, matrix and secondary phase interfacial characteristics, and stirrer specification like speed, angle of blade, position are studied. Some research work carried out by centrifugal casting to develop uniformly distributed reinforcement particles and examined effects of mould rotation and % volume fraction on the mechanical properties and microstructure. Electrical Discharge Machining (EDM) studies were conducted on various composite work piece and also studied the effect of EDM parameters namely polarity, current, electrode, pulse duration, and rotation of electrode on metal removal rate (MRR), tool wear rate (TWR), surface roughness (SR).

Sang Won Lee et al.[6]: This study investigates the characteristics of the dry electrical discharge machining (EDM) process. Dry wire EDM experiments of thin work pieces were conducted in air, which was used as the dielectric fluid. The relationships among spark cycle (I), spark on-time (To"), air flow, thickness of work pieces and work material were studied in the cases of wet and dry EDM conditions. The material removal rate (MRR), in general, in dry EDM was much lower than that in wet EDM, and the effects of various EDM parameters on MRR were comparatively investigated in the cases of dry and wet wire EDM processes. The thickness of workpiece and work-material were critical ones to influence on the MRR. Die-sinking dry EDM process was also investigated by developing the miniaturized desktop dry EDM machine tool. The aluminum workpiece was dry-EDM with the copper tubular electrode under the conditions of no air, air blowing and suction, and the machined results were compared. The experimental results showed that sucking was the most effective to machine the aluminum workpiece in terms of MRR and machining accuracy.

S Charles et al.[7] [2004]In this paper they are work on the comparison of the two methods one is stir casting and other is powder metrology process and then after investigate the machining on EDM by changing the different parameters. Different volume of SiC with (10, 15,20) and fixed volume of flyash (10%) were used for the synthesis the ultimate goal of this paper is 1)comparison of the property of the specimen that produce by the stir casting and Powder metallurgy route .2)study of the effect of the % SiC,current and plus duration on the MRR and Tool Wear rate on the EDM.3)To develop the mathematical model that predict the MRR AND TWR on the different parameters.

2.2 Identified gaps from literature

After a complete study of the existing literature, a number of gaps have been observed:

1. The composition variation of Al with respect to the SiC is 5,10,15,20 and 30% but less work has been done on the composition ratio with 8,15 and 22 % of SiC.
2. All researchers are using same diameter ball and stainless steel materials balls but less work has been found for different ball diameter and with tungsten (WC) balls material.
3. In the powder methodology most research found the sintering temperature at the range of more than 520˚C to 620˚ C but still no research work found for the stating temperature for sintering of 550˚C
4. The machining is done on the EDM by changing different parameters but still less work has been done on optimization with GENERAL method of parameters by using optimization method.
5. High energy ball milling has been done most of on the dry milling but less work has been done on wet milling for the Al-SiC Composite material.
6. Above all researcher work for ball milling time is more than 25 hour (78Rpm)and ball milling speed max up to 350 rpm but still no work has been found at for the speed more than 450 rpm.
7. As per the literature review the most researcher work on the stir casting process for the development of the composite material but still less work has been found by the powder metallurgy methodology.

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