International Journal on Mechanical and Production Engineering
Volume 4: Issue 2 : May 2018, pp 20 – 22 www.aetsjournal.com *ISSN (Online) : 2395 - 3500*

EFFECT OF HYBRID COMPOSITE (SIC, TIC&Y2O3) REINFORCEMENT ON AL7075 ALLOY USING POWDER METALLURGY

V.PRADEEP , N.MATHIAZHAGAN , T.SENTHILKUMAR

Abstract— Aluminium alloy material found to the best alternative with its unique capacity of designing the material to give required properties. Aluminium alloy metal matrix composites widely used in aerospace and automobile industries because of their low density, high strength and good structural rigidity. In this present work, an attempt has been made to prepare hybrid aluminium metal matrix composite to study its mechanical properties. Preparation of hybrid aluminium metal matrix composite made by reinforcing silicon carbide, titanium carbide and yttrium oxide. The harness test has been carried out to determine the hardness of the composite using Vickers hardness. The hardness test shows the addition of reinforcement SiC and TiC increases hardness value. The internal structure of the composite and reinforcement particle distribution was studied in detail by scanning electron microscopy (SEM).

Keywords -- Hybrid metal matrix composite, powder metallurgy, SiC, TiC, Y2O3.

I. INTRODUCTION

Metal matrix composites are increasingly becoming attractive materials for aerospace, automotive industries because their properties can change through the addition of selected reinforcement [1]. Various effects have been taken to introduce hard ceramic particulates like SiC, Al2O3 and B4C into aluminium based matrix. From the literature study reveals that among the reinforcements SiC is chemically compatible with aluminium and forms an adequate bond with the matrix without developing inter-metallic phase and has other merits such as excellent thermal conductivity, good workability and low cost [2]. In past main focus is given for the development of metal matrix composite with SiC in various proportions and its mechanical and machinability properties have been studied. Recently due to the necessity of engineering materials with high strength, increased wear resistance and enhanced temperature performance hybrid aluminium metal matrix composites are developed. But it has its own demerits like poor wetting behavior with aluminium and more weight percentage leads to increase in porosity [3]. Aluminium based metal matrix composites have received increasing attention in recent decades as engineering materials. The introduction of ceramic material into a metal matrix produce a composite material that results in an attractive combination of the physical and mechanical properties which can not obtained with monolithic alloy [4]. Alloys of Al reinforced with ceramic oxides, carbides, nitrides and mineral silicate particulates possess attractive characteristics such as high specific modulus, high specific strength, low thermal expansion coefficient, light weight and low cost and superior corrosion resistance [5]. A metal matrix composite are composite is a material combinations of two or more materials one of which is a metal where the tailored properties can attain by a systematic combination of different constituents to create strong and stiff materials [6]. It is composed of an element or alloy matrix in which a second phase is embedded and distributed for obtaining some property improvement [7]. Based on the size, shape and amount of the second phase the composite property varies [8].

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II. EXPERIMENTAL DETAILS

1) Material Used

The matrix material for present study is Al7075. The reinforcing material selected was silicon carbide particle size of 25 microns titanium carbide particle size of 10 microns and yttrium oxide particle size of 5 microns.

2)Mixing of composites

In this process first, the aluminium alloy was wet mixed in the laboratory vibratory ball mill the chemical composition of the aluminium alloy is presented in Table 1. After that powder of various wt% of compaction materials were added to the Al 7075 alloy shown in Table 2 and wet mixed in the laboratory vibratory ball mill. The mixing is combined 10 hours thoroughly by using chromium coated steel balls of Dia 12mm and toluene is used as the mixing agent to obtain the uniform distribution of the reinforcement particles in the matrix. The mixed powders were then dried in the air.

TABLE 1: CHEMICAL COMPOSITION OF ALUMINIUM 7075 ALLOY

Powder	Zn	Mg	Cu	Cr	Si	Ti	Al
Wt%	5.5	2.4	1.5	0.2	0.2	0.2	Bal

TABLE 2: VARIOUS COMPOSITIONS IN WT%.

Sample	SiC	TiC	Y2O3	Al 7075
I	5	5	2	88
II	7.5	2.5	2	88
III	2.5	7.5	2	88

3) Compaction

The components were initially compacted at cold state in a die with the diameter of 26mm in the laboratory vertical unidirectional press with a capacity of 40 tonnes. The die is made up of tool steel material the compaction load was given to make the composite is 650 Mpa. The obtained PM compacts was heated up to a temperature of 5400 ^{0}C soaking time is 2 hours for sintering.

Figure 1 a) 5%Sic,5%TiC,2%Y2O3

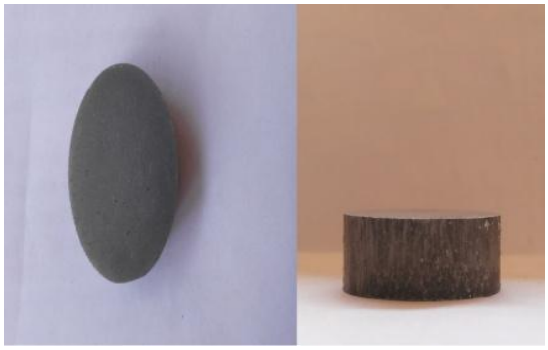

Figure 1 b) 7.5%SiC,2.5%TiC,2%Y2O3

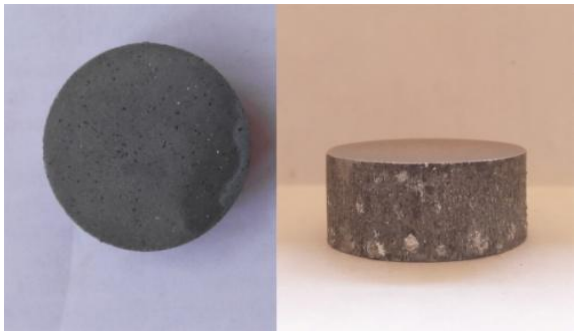

Figure 1 c) 2.5%SiC,7.5%TiC,2%Y2O3

Fig.1(a), 1(b),and 1(c) are the various prepared composite meterials.

4) Sintering Process

Sintering involves heating of the green compact at high temperatures in a controlled atmosphere [reducing atmosphere which protects oxidation of metal powders]. Sintering increases the bond between the particles and therefore strengthens the powder metal compact. Sintering temperature and time is usually 0.6 to 0.8 times the melting point of the powder.

In the case of mixed powders of different melting temperature, the sintering temperature will be above the melting point of one of the minor constituent and other powders remain in the solid state. The important factors governing sintering are temperature, time and atmosphere.

III. Result and Discussion

1) Hardness test

The average values plotted in graph HV versus of % of reinforcement. From fig 2 it has been clearly proved that addition of SiC & TiC with aluminium matrix increases the hardness value.

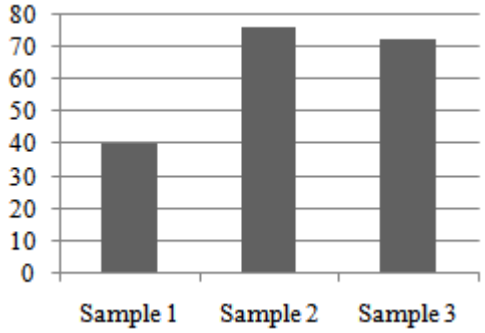

Figure 2 Vickers hardness of specimens

2) SEM Analysis

Electron microscopy of the composite surface was carried out to know the morphology of the composite. The below Figure 3 shows the surface of the composite samples which indicates that the mixture was uniform because there was no segregation of particles.

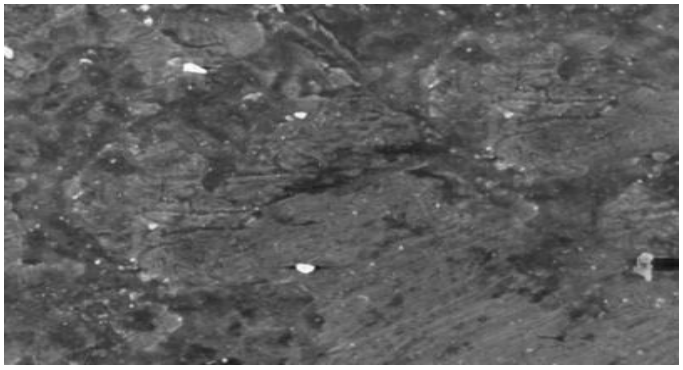

Figure 3 a) sem image of the composite (5%Sic,5%TiC,2%Y2O3)

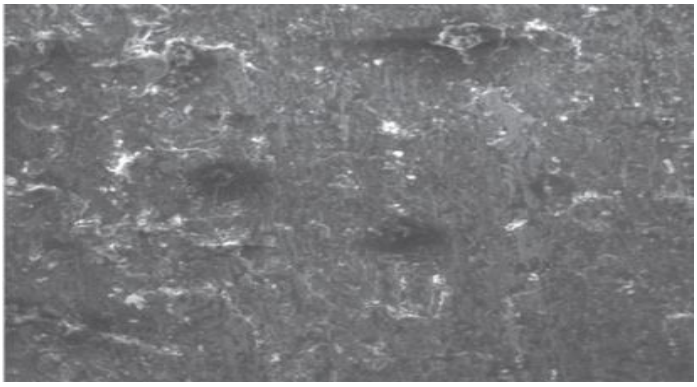

Figure 3 b) sem image of the composite (7.5%SiC,2.5%TiC,2%Y2O3)

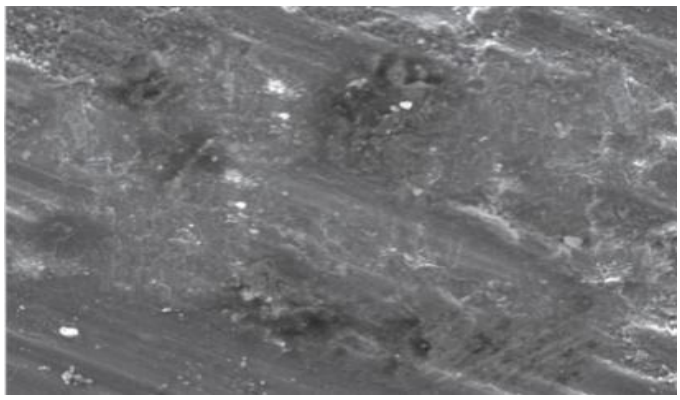

Figure 3 c) sem image of the composite (2.5%SiC,7.5%TiC,2%Y2O3)

From the above fig 3 (a), (b), and (c) it shows that the uniform distribution of particles in the matrix takes place.

IV. CONCLUSION

The microstructure and mechanical properties of Al7075 hybrid composites containing a varied weight ratio of SiC, TiC and Y2O3 were investigated. The results show that:

1. The Micro structural indicates shows the presence of SiC, TiC &Y2O3 and its distribution in the metal matrix. The increase in weight percentage of reinforcement leads to cluster formation.
2. Clustering and non-homogenous dispersion of SiC particles in Al matrix observed in the microstructures. Porosities found in the microstructures.
3. It has concluded from hardness measurement that, the addition of reinforcements has the effect on hardness value.

From the results above, SiC, TiC and Y2O3 reinforced AMCs showed better hardness, tensile strength and wear resistance than unreinforced Al.

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