EFFECT OF MECHANICAL AND PHYSICAL PROPERTIES OF ALUMINUM ALLOY LM12 WITH THE REINFORCEMENT OF SILICON CARBIDE

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ABSTRACT

Aluminum alloy LM12 metal matrix composites are broadly used in different industrial application, because it having greater mechanical and chemical properties. This paper contains around the change in mechanical properties of AL LM-12 when it is reinforced with SiC of production by using stir casting techniques. For this reason AL LM-12 and reinforcement of SiC with various wt% utilized. SiC is reinforced in 0, 5, 10, 15 and 20 wt%. Impact of SiC reinforcement on AL LM-12 and its properties are BHN and microstructure analysis of MMC's discussed in detail of this paper.

Key words: AL/SiC, AL LM-12 MMC's and BHN and microstructure analysis

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1. INTRODUCTION

Metal matrix composites are obtained by reinforcement of ceramic particles to a base metal to realize improvements in properties (1-5). The reinforcements forms can be found in fibers, whiskers and particulates(6-8). To achieve the required properties of MMC-reinforcement material, fabrication method, varying percent and %wt can be followed to make it suitable of industrial applications. Because of their superior strength, less weight ratio and hardness of metal matrix composites are replacing monolithic materials in aerospace as well as automobile industries. (9-13).

Present work describes the hardness and microstructural analysis of LM12 Aluminum alloy with reinforcement of silicon carbide with various %wt of SiC.

Table: 1 composition of the LM12 alloy

Element	Wt.%	Element	Wt%
Copper	09-11	Zinc	0.8 max
Magnesium	0.2-0.4	Lead	0.1 max
Silicon	2.5 max	Tin	0.05 max
Iron	1.0 max	Titanium	0.2 max
Manganese	0.6 max	aluminum	Balance
Nickel	0.5 max		

2. EXPERIMENTAL SET UP

As we know wear is process of removal of material eviction that usually occurs at outer surface of the material. In this experiment totally five specimens are prepared, having same length and diameter but different wt % of SiC (% wt 0, 5, 10, 15 &20) MMC's. Conducted the BHN and analysis of microstructure of MMC's

2.1. Development of MMC's by using stir casting process

The specimens are produced by using a stir casting process as shown in Fig.1

Figure 1 Stir casting process

3. RESULTS AND DISCUSSION

3.1. Brinells hardness test (BHN)

Hardness testing machine, Brinell's micrometer, specimen, ball indenter of 5mm.

Figure 2 Hardness testing machine

Table 2 Brinells hardness test

Specifications	Ranges
Maximum test height	225mm
Depth of thread	130mm
Max depth of screw below base	260mm
Max load	250 kgf
Net weight	65 kgf

$$B.H.N = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$$

Figure 3 Weight

3.2. Parameters

Table 3 Parameters

Ball material	Hardened steel	constant
Specimen material	AL alloy LM12/SiC	
Specimen dimension	12	ISO6506-1:1999(E)
Ball dia(mm)	5	constant
Load (kgf)	250	constant
Test time (Sec)	20	constant

3.3. Specimen Calculations

$$B.H.N = \frac{2P}{\pi D(D - \sqrt{D^2 - d^2})}$$

$$B.H.N = \frac{2(250)}{\pi 5(5 - \sqrt{5^2 - 2.5^2})}$$

$$B.H.N = 47.5 \text{ Kgf/mm}^2$$

Tabular Column**Table 4 Specimen**

Test Material	Diameter of indentation d(mm)	B.H.N
LM 12	2.5	47.5
LM 12 + 5% SiC	2.3	56.8
LM 12 + 10%SiC	2.2	62.4
LM 12 + 15%SiC	2.1	68.8
LM12 + 20% SiC	1.9	84.8

Conducted the BHN test under specifications which is shown in table 2 and 3 The MMC's of aluminum alloy LM12. The reinforcement of SiC at Different wt.% SiC varies in the ranges 0,5,10,15,20 wt.% Al alloy LM12 (MMC's) shown in fig:4. Improvement results shown in below graph fig:3.3.

3.4. Graphs BHN v/s Different MMC's Compositions **Figure 4 BHN**

Shown the above fig no:4 X-axis plotted against the MMC's, whereas Y-axis represents value BHN.

Table 4 depicts an increase in hardness of the composite with enhanced SiC content. Enhancement in hardness of about 19% for 5% SiC, 32% for 10% SiC, 45% for 15%SiC and 78% for 20%SiC over and above that in the base metal was realized. Enhanced hardness could be attributed to dispersion hardening due to reinforcements in the matrix. Dispersion hardening has been attributed to reduced mobility of dislocations pinned down by dispersoids in the matrix.

4. METALLOGRAPHY (MICROSTRUCTURE)

The microstructure analysis of MMC's of aluminum alloy LM12. With the reinforcement of SiC. Different wt.% varies at 0,5,10,15,20 wt.% of SiC and Optical Metallurgical Microscope obtained from NIKON Epiphot 200 machine as used. As shown in below picture.

4.1. Microstructure analysis of Aluminum alloy of LM12

Figure 5 Microstructure analysis of LM12

4.2 Microstructure analysis of Aluminum alloy of LM12+5%SiC

Figure 5 Microstructure analysis of LM12+5%SiC

4.3. Microstructure analysis of Aluminum alloy of LM12+10%SiC

Figure 6 Microstructure analysis of LM12+10%SiC

4.4. Microstructure analysis of Aluminum alloy of LM12+15%SiC

Figure 7 Microstructure analysis of LM12+15%SiC

4.5. Microstructure analysis of Aluminum alloy of LM12+20%SiC

Figure 8 Microstructure analysis of LM12+20%SiC

Fig.5-8 displays the electron micrograph of the base metal LM12 and its composite at 0, 5, 10, 15 and 20 % SiC. Base alloy LM12 (Fig.5) reveals Al matrix (light gray) with islands of silicon (dark gray). Composite of LM12 with 5% SiC (Fig.6) 10% SiC (Fig.6) depict a similar base metal microstructure interspersed with fine particles (light grey) of SiC. Composite with 15% reinforcement (Fig.7) reveals denser and also be with very fine particles (light grey) of SiC. Composite with 20% reinforcement (Fig.8) reveals high denser.

5. CONCLUSIONS

Composite of aluminum alloy LM12 and silicon carbide was successfully fabricated by a stir casting route and tested. Microstructure of the composite revealed a fairly uniform distribution of silicon carbide in LM12 matrix.

Silicon carbide reinforcement enhanced the hardness of the composite. With increasing reinforcement content an increase in hardness was observed. Increase in hardness (BHN) could be attributed to dispersion hardening resulting from the reinforcement particle aggregate.

Following increase in hardness (BHN) an improvement in strength and reduction in percent elongation and reduction of area were noticed.

The microstructural investigation reveal the uniform distribution of SiC particles in to Al matrix. It is very difficult to obtain the exact percentage of SiC, but it has been successfully achieved by adopting suitable process parameters. By this process achieve the homogeneous and uniform distribution of reinforcement. The addition of silicon carbide particles to the matrix alloy improves the mechanical properties such as hardness and improves the material strength of molecules of the matrix alloy.

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