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Experimental Study of Metal Composites

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Abstract—*In this work, an effort has been made to prepare aluminium alloy metal matrix composite to study its machining and mechanical properties .Aluminium alloy material found to be best alternative with its unique treat of designing the material to give the required properties. Aluminium alloy metal matrix composite are gaining wide range acceptance for automobile and aero scope application because of their low density, higher strength , high stiffness and more corrosion and wear resistant .Preparation of aluminium alloy AA7075 metal matrix composite is made by reinforcing titanium di borate.TiB2. this composite is developed by adding TiB2 in aluminium alloy AA7075 by mass ratio 5%, 10%, 15% respectively. The composite are prepared by stir casting technique. In addition, there are many type of mechanical test are conducted such as hardness testing, tensile test and microstructure testing.*

Hardness test has be conducted by using the Rockwell hardness testing instrument. This test shows that the addition of reinforcement TiB2 increases its hardness value, but increases of reinforcement up to 15% revels reduction in hardness value. Tensile testing of the specimen shows a conclusion that the material tensile load wearing capacity is reduced with increase of the TiB2.Micro structure testing tells that the material, which reinforced into the metal matrix make stronger bonding and so for the melting point of the material are increases and also it makes more brittle then the basic aluminium.

1. INTRODUCTION

1.1 Introduction of composite material

Composite materials are combination of two or more materials (i.e., reinforcing elements, fillers and binders) differing inform or composition on a macro scale. A metal matrix composite is composite material with at least two constituent parts, one being a metal necessarily, the other material may be a different metal or another material, such as a ceramic or organic compound The various types are: (I) Metal matrix composites (MMCs) composed of a metallic matrix (aluminum ,magnesium, iron, cobalt, copper) and a dispersed ceramic (oxides, carbides) or metallic (lead, tungsten, molybdenum) phase.(ii) Ceramic Metal Composite (CMC) composed of ceramic matrix and embedded fibers and (iii) Polymer matrix Composites composed of a matrix from thermoses(Unsaturated Polyester (UP), Epoxy(EP)) or thermoplastic (Polycarbonate (PC),Polyvinylchloride, Nylon, Polystyrene) and embedded glass, carbon, steel or Kevlar fibbers (dispersed phase).

Typical engineered composite materials include:

Mortars, concrete

Reinforced plastics, such as fiber-reinforced polymer

Metal composites

Ceramic composites (composite ceramic and metal matrices)

Composite materials possess higher stiffness and specific strength compares to conventional metals and found more application in structural design application. Machining of composite materials requires better understanding of cutting processes regarding accuracy and efficiency. Machining composites particularly metal matrix composites (MMCs) exhibit poor machinability, results in faster tool wear, and process becomes uneconomical. Therefore process modeling (i.e., establishing the relationship between process parameters and desired response) and optimization of the process (i.e., to obtain optimum cutting parameters aiming an economy of the machining process) have become essential for any manufacturing processes.

1.2 AA7075

Aluminum alloy 7075 is an aluminum alloy, with zinc as the primary alloying element. It is strong, with strength comparable to many steels, and has good fatigue strength and average machinability. It has lower resistance to corrosion than many other Al alloys, but has significantly better corrosion resistance than the 2000 alloys. Its relatively high cost limits its use to applications where cheaper alloys are not suitable. Aluminum alloy 7075 is an Aluminum Alloy, with Zinc as the primary alloying element includes. Zinc 6%, Magnesium 2.3%, Copper 1.4 %. A Japanese company, Sumitomo Metal, developed the first 7075 in secret in 1943. 7075 was eventually used for airframe production in the Imperial Japanese Navy.

Density - 2.810 g/cm³

Tensile Strength - 280 M Pa

Melting Point – 477 - 635 °C

Elongation – 9 -10%

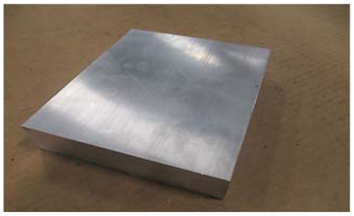


Fig. 1 aluminium alloy

1.3 TiB2

Titanium di boride (TiB_2) is an extremely hard ceramic, which has excellent heat conductivity, oxidation stability and resistance to mechanical erosion. TiB_2 is also a reasonable electrical conductor, so it can be used as a cathode material in aluminium smelting and can be shaped by electrical discharge machining. TiB_2 is the most stable of several titanium-boron compounds. The material does not occur in nature but may be synthesized by carbothermal reduction of TiO_2 and B_2O_3. TiB_2 is very similar to titanium carbide, an important base material for cermets, and many of its properties(e.g. hardness, thermal conductivity, electrical conductivity and oxidation resistance) are superior to those of TiC. TiB_2 does not occur naturally in the earth. Titanium diboride powder can be prepared by a variety of high-temperature methods, such as the direct reactions of titanium or its oxides/hydrides, with elemental boron over 1000 °C, carbothermal reduction by thermite reaction of titanium oxide and boron oxide, or hydrogen reduction of boron halides in the presence of the metal or its halides. An example of solid-state reaction is the borothermic reduction, which can be illustrated by the following reaction

$$2\ TiO_2 + B_4C + 3C \rightarrow 2\ TiB_2 + 4\ CO$$

- Density ($g.cm^{-3}$) - 4.52
- Melting Point (°C) - 2970
- Hardness (Knoop) - 1800
- Elastic modulus (GPa) - 510 -575

2. METHODOLOGY

In methodology the work initiate with melting the metal matrix in graphite crucible. We accomplice the reinforcement of material (TiB2) with metal matrix (AA7075) aluminum alloy using stir casting method we select the micro size of reinforcing material for reinforcement in metal matrix.

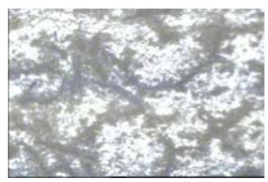
Firstly we melt metal matrix in graphite crucible with help of furnace . the metal matrix AA7075 alloy is melted in crucible till it gets converted into molten phase. Further we pour TiB2 taken is 5% 10% 15% to wt. Of metal matrix respectively. now stir casting is carried out by rotating HSS rod with help of motor by gradual change in speed afterward let it to solidify in crucible by spontaneous cooling . when it gets solidified we get a composite metal pieces. Further from these basic pieces, made specimen of different type. These different type undergone a hardness test, tensile test , micro-structure test.

3. RESULT AND ANALYSIS

3.1 Micro structure test

Composite material grain size are increased and the brittleness of composite metal is increased with respect to basic aluminum alloy.The microscopic images of specimen shows the grain structure clearly by magnify the object up to 100 times.

Fig.2-specimen 1(TiB2 5%, AA7075 95%) Fig.3-specimen 2(TiB2 10%,AA7075 90%)



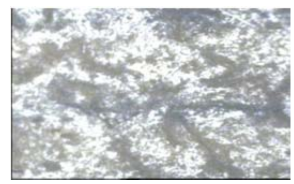


Fig. 4 and 5- microscopic images of specimen1 and specimen 2

3.2 Tensile test result

In this test phenomena the specified type of specimen are prepared which goes through several tensile forces and we find the brake point and pick point of the specimen of different composition.For the specimen first it is about 3579.6 N and for the second about 9636.4 N.

Fig.6-specimen 1st **Fig.7-specimen 2nd**

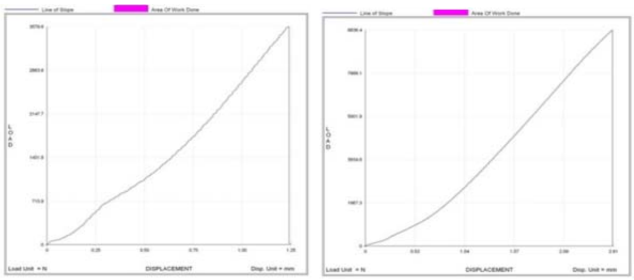


Fig.8 Graph between displacement and load of S1and load of S2

3.3 Hardness test

The material hardness is increasing with increase in the composition of TiB2.For the specimen first it is about 75.34 and for the second it is about 66.23.The number is a Rockwell hardness numbers.

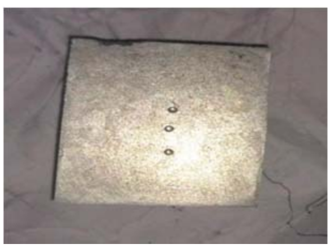


Fig.9 Specimen 1st

Fig.10 Specimen 2nd

4. CONCLUSION

Brittleness of composite metal increases with the % of TiB_2 increases. The Melting point of composite metal higher than base metal. Hardness of the composite metal increases. The tensile properties of composite metal are decreases. Elongation of the composite metal decreases.

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