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Fabrication of Aluminum/Magnesium Composite Material and Optimization their Mechanical Properties

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Abstract: ***Composite material is an mixture of different metal. different type of metals like Mg, Zn used in the process of manufacturing of aluminum composite in this research paper we take an sample of aluminum composite material containing Cu-Zn-Mg composite materials generally produces by selecting the matrix and reinforcement. Aluminum composite material has high melting point .in this paper we wake our test sample of aluminum magnesium composite material by stir casting. The purpose of our work is to find out the mechanical properties of Aluminum composite material & find the working capacity with compare to pure Aluminum metal. .pure metals have some limitations like low melting points, low porosity, low elasiticty etc. in technology Sector we used composite material to make an much effective prototype or mechanical structure having very good mechanical properties. Properties of composite materials is completely depends on the method used to produce it.***

Keywords: Stir Casting, Aluminum Cast Composites, Effect of Composition on Mechanical Properties of Cast Composites, "Al2O3" Particulates

1. Introduction

In modern technology we need some metal who have light weight high strength having good mechanical properties. Composite material is lighter and stronger with compare to pure metal. it also having very good mechanical properties with compare to other. Composite material is based on the metal matrix or reinforcement. Aluminum composite material is widely used today in transportation, defence area, mechanical structure and power equipment also. this need is fulfill by aluminum metal matrix based composite material. Composite material is an mixture of metal having lot of mechanical properties, such as high tensile strength, high melting temperature, much light in waight.in this experiment we produce Aluminum/Magnesium composite material by using one of the most effective and low coast having method that is called stir casting. in current sociality we can use more type of composite material to making different types of designs, bigger mechanical structure and many other equipment. Composite material is more strong & having several types of positive effective particiles. aluinum composite widely used is world by since 1920s .after finding the composite materials there is every sector used it

1.1 Manufacturing of Aluminum Composite Material Using Stir Casting Process

Aluminum composite material is manufacturing based on some factors like chemical composition, heat treatment, metal matrix, reinforcement metal and cost of process .so we should know some practical or theoretical values or process also. Aluminum metal matrix composite is made up by two metal i.e. matrix or reinforcement. Aluminum composite metal can be found in laminate or fiber. We use powder metallurgy process also to complete this process to convert powder into the solid metal. The powder metallurgy processes have some limitation also like cost or small size of particle component. The stir cast aluminum alloy matrix and process parameters was taken by Pai, et. al.[18]. They conclude from literature that stir casting process is an simple procedure and low cost process. Balasivanandha [16] describe that the stirring speed and stirring time on distribution of ceramics particles in cast metal matrix composites using SiCp reinforced in A348 aluminum matrix. It is known that 600 rpm stirring speed and 10 minutes stirring time are the best processing points give an good effect on properties of cast aluminum composites. Zhou and Xu [10]. had optimize two step mixing method and preheat treatment for obtaining better mechanical properties. Gupta and Surappa [9]. had used SiC reinforced in 6061 aluminum matrix and reported the mechanical properties are increased upto 15% SiCp. Gupta also told that processing - microstructure- mechanical properties of aluminum base metal matrix composite materials synthesized using casting route in this process. Das [6] describe an information about SiCp in his paper that the Reinforment in aluminum metal matrix composite. As he had observed that wear mechanical properties and microstructure, using casting route and reported similar effect of "Al2O3" particles on properties of composites materials. so, the present work was planned to investigate the effect of Cu-Zn-Mg in aluminum matrix reinforced with "Al2O3" particles for economical development of aluminum casting composite materials.

2. Experimental Work

For making this composite material we take pure aluminum ingot, copper, magnesium and aluminum oxide. The aluminum ingot was melted in a graphite crucible and mixed with required quantity of Cu-Zn-Mg metals at the needed temperature.

Table 1: Selected Compositions of Master Alloys in Grams for Manufacturing of Composite Materials

Alloy No.	Cu (gm)	Mg (gm)	Zn (gm)	Al (gm
1	0.00	22	50	728
2	10	40	30	460
3	40	50	30	250

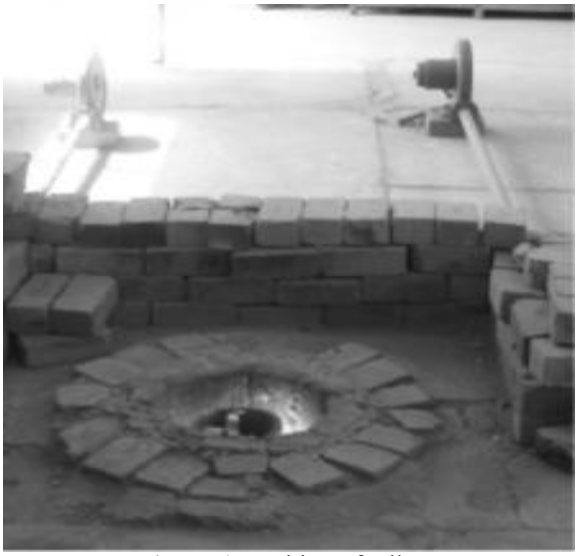

Figure 1: Melting of Alloys

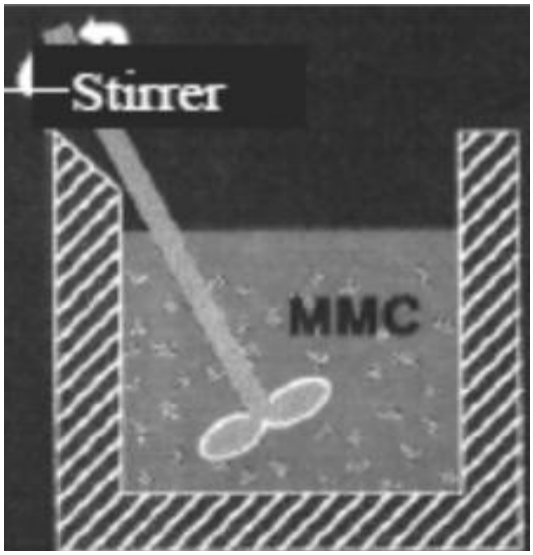

Figure 2: Stir Casting Process

The manufactured alloys were purged with N2 gas for few Seconds. The ceramics particles were mixed together in an mixer by stirring for some time and then cast in a steel mold consist 25 mm dia and 130mm length (Fig. 4). The temperature used to this casting method is used at 750oC.The cast sample of the composite was machined to given an surface finish, because the testing is done on the flat or finish surfaces.3samples were solution heat treated at 580oC for 1 hour and age hardened at 120oC for 24 hours in a muffle furnace. Tensile strength, elongation was determined using universal tensile testing machine at shreeram laboratory Ghaziabad The details of the tensile test parameters for this test sample are given in Table 2.Chemical analysis of the material to do reinforcement and samples were conducted using SEM and Spectrometer analysis method as shown at Table 3.The Optical Metallurgical Microscope of the component of alloys was also used to investigate aluminum matrix and ceramic particles at 100X and 200X magnification. Fig. 14(d) clearly shows uniformly distribution of ceramic particles. The mechanical properties like tensile strength, hardness, impact load are also done who's are show in Fig.

3. Results and Discussion

In this project work we focused to produce an composite material with high strength, low cost, lighter weight, with maximum places of use .in this work we take 3 sample of aluminum alloy most having magnesium at the ratio of 3.9%, 7.77%, 13.55%. This alloy is produced by conventional casting foundry method Figs. 1-3. Composite were reinforced with different %ages of "Al2O3" particles. the alloys properties and composition are analysis by simple melting at foundry and with by stir casting method. The result is given below in the table 1

3.1 Hardness Test

Hardness test is an method to find the accurate value of metal deformation. The value of hardness is given by apply 250N on sample piece..

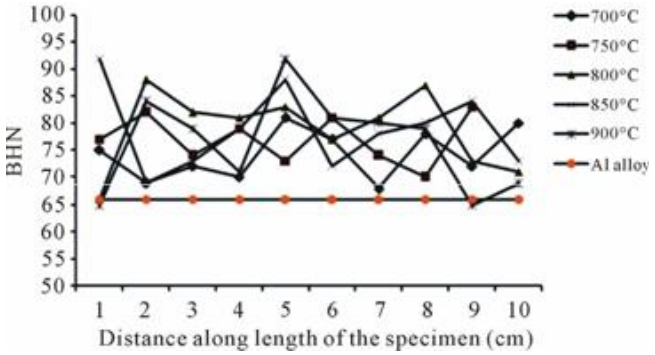

Figure 3: Effect processing temperatures on Hardness of Al/Mg

Hardness of an composite material is much more with compare to pure matal.when we done the process of adding two metal or adding reinforcement than due to the matrix adding process ,hardness of our metal is increased due to diffenerent properties of different metals. in the hardness test of our sample we can apply load at different temperature on the metal. We can make 3 sample of aluminum magnesium material so in the sample having maximum amount of magnesium having maximum strength

The mechanical properties like tensile strength, wear, hardness, elongation is done to find the composite material whos is molded or casted by using "A12O3" metal matrix in composite By using simply molded furnace stir casting. in the literature review we focused to do an work on the metal matrix using "A12O3" to make this aluminum magnesium composite metal & study of its mechanical properties to use this metal in different places. the, most of the previous work was done in this regard is discussed as under Venkatraman and Suundararajan [24], conducted research on 7075 aluminum alloy and AMMCs reinforced with SiCp using powder metallurgy method to achieve an good properties to the composite. They observed that precipitation hardening of

AMMCs gave positive response in improving in mechanical properties of the aluminum alloys. However, they did not investigated the effect of "Al2O3"particles in 7075 aluminum alloy using simple conventional stir casting method so we do this work to investigate the effect of reinforcement of A12O3 in the manufacturing of aluminum alloy by stir casting from powder metallurgy.

Table 2: Parameters of Tensile Testing Machine

Order Number	1 2.5 Cast Sample
Test Standard	ASTM
Material	Aluminum Cast Composite Material
Extensometer	Not determined
Load Cell	Maximum 250 KN
Pre-Load	2 N/mm²
Pre-Load	50 mm/min
Test speed	Speed 10 mm/min

Table 3: Theoretical Composition & Actual Average Composition in Weight Percent as Determined by X-Ray and Spectrometer Test Results

Alloy No.	Theoretical Composition	Actual Composition	Theoretical Composition	Actual Composition	Theoretical Composition	Actual Composition
1	0.05	0.063	2.55	2.22	3.11	3.09
2	2.01	2.46	2.70	2.25	5.90	5.50
3	7.55	7.44	1.12	1.48	6.87	6.50

Alloy of aluminum metal matrix composite having Cu-Zn-Mg were developed by Rupa Dasgupa and Humarira Meena [15]. They produced this aluminum alloy matrix from elemental metals reinforced with SiCp. They also used stir casting method to develop the alloy metal matrix composite. The mechanical properties of 7075 aluminum alloy matrix were compared with parent metal after casting with stir casting in conventional molten furnace process and heat treatment of the same matrix the research report concluded the improvements in mechanical properties and improvement of strength of and sliding wear resistance of cast aluminum alloy. The similar effects of porosity in stir casting were also found by numbers of investigators [1-12, 14-29] so they analysis the property of metal better

3.2 Tensile Test

When we make an composite material by adding reinforcement then in the phase of reinforcement adding tensile strength of the material is increased with the increase of volume fraction of the composite reinforcement.

Comparing mechanical properties alloys contains less Percentage of "Al2O3" as compared with alloy which contain the higher percentage "Al2O3" which shows some higher Strength and ductility in metal is founded when we change the %age to up and down.. The similar effect of the processing parameters and causes of porosity in stir cast & heat treated sample of aluminum composites were found by number of other investigators [6,7,14].Considering the experimental results of alloy 3 which show highest tensile strength 237 MPa was due to proper wetting and uniform distribution of ceramics particles in aluminum matrix composite. Similar effect of distribution of material reinforced with "Al2O3" particles.

The stir casting aluminum composite material usually contained porosity and the degree of porosity depend on the processing parameters such as pouring temperature ,types of matrix and volume fraction of reinforcements and the size of particles of reinforment in the process to complete the reinforcing.[6,7,14].After getting these data readings it is observed from the experimental work that Mg content up to 3.9% increases the wetting ability of the ceramics particles as compared to alloys which contains less amount of Mg it compare to this or no Mg.

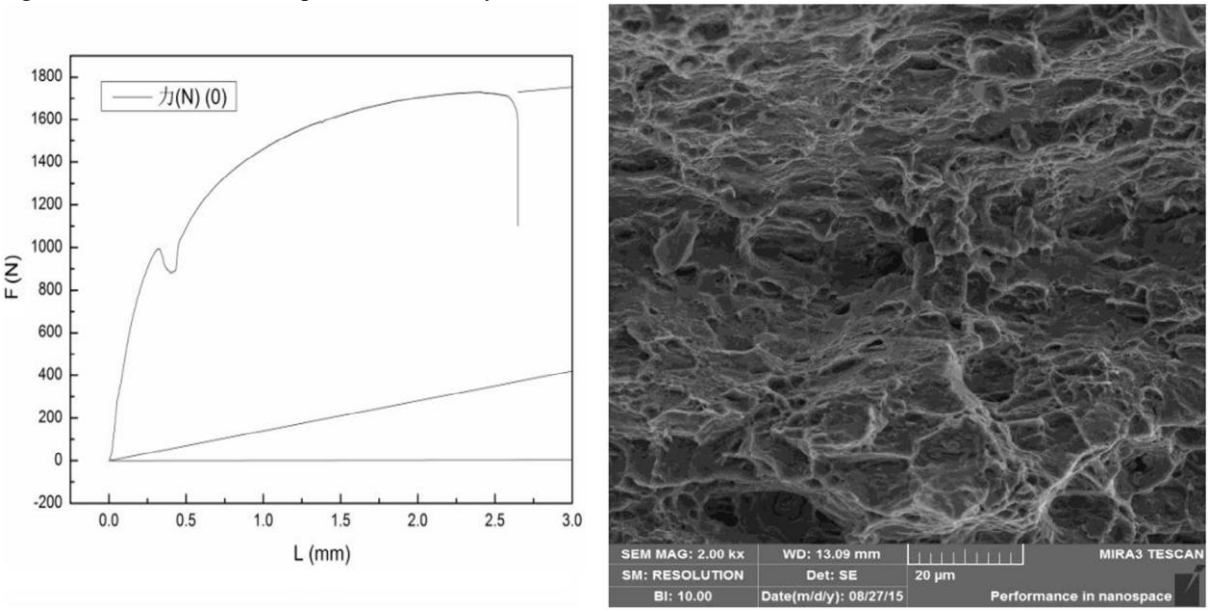

Figure 4: The Tensile Test Results of Al/Mg Composite Plate Fracture and the Fracture Images

The similar effect of Mg in this alloy has been found by other investigators [3,5,11,12,15,17,22].It is also given that the tensile strength of the composite material is increases as the percentage of "Al2O3" particle increase in as cast aluminum alloys up to 3.9% "Al2O3" particles in as cast conditions. This increase is due to the presence of "Al2O3" and silicon metal Particles which act to refine the grain size of aluminum casting composites by nucleating fine grains size during the solidification process after the heat treatment in as cast conditions. The decrease in tensile strength and ductility with increase the volume fraction of "Al2O3" particles up to 15% in as cast condition have been observed in aluminum alloy metal matrix.

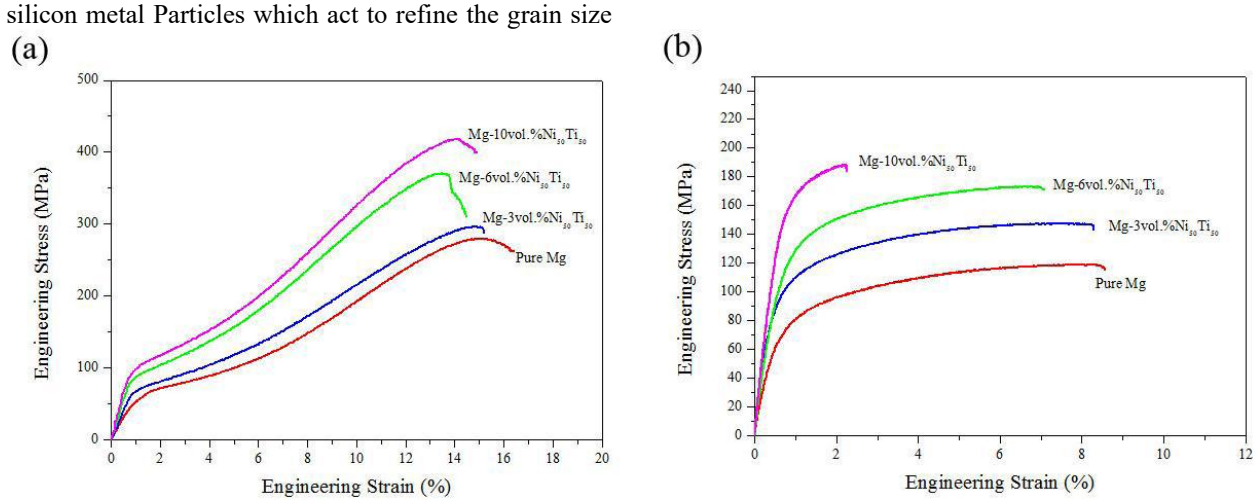

Figure 5: Stress Straine Curve of Al/Mg composite Developed (A) Compressive Loading (B) Tensile Loading

This is due to increase in porosity in stir casting method of aluminum matrix [6,7,14] .The experimental results of this project especially in alloy 1, 2 and 3 showing good aging response on mechanical properties of aluminum alloy matrix cast composite. The effect of Cu-Zn-Mg metals who are present in aluminum matrix using SiCp were investigated by number of investigators [10-11,15,21-22]. In this work when we compare mechanical properties of present work with the previous work conducted by other researchers using stir casting method (Table 4), giving superior responses to strength increases up to 300 MPa and ductility up to 17 % with addition of 10% "Al2O3" particles Reinforced in aluminum matrix and when we added some amount of Magnesium

3.3. Impact Test

By impact testing we can find that how much energy is observed by the sample piece in the fracturing with high velocity. We can use this method also for determining the toughness or notch sensitivity of the metal

In this experiment we use our aluminum magnesium composite material sample on which we apply different impact values to optimize the energy by metal in the fracture. the impact test of an sample is measure the value of energy in the fracture by applying the load.

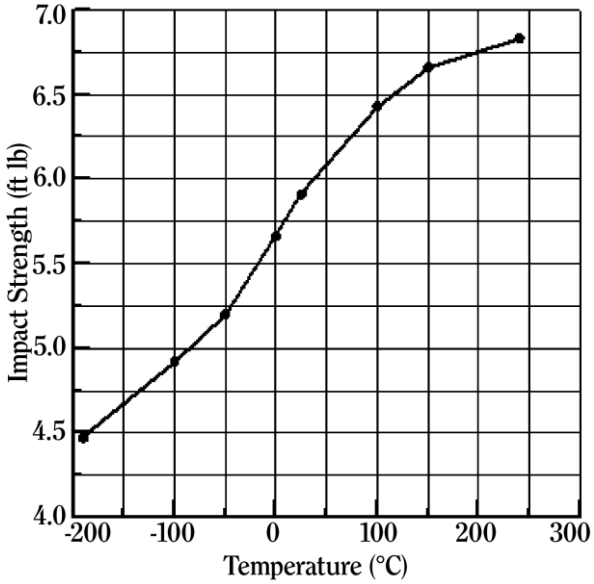

Figure 6: Impact Strength of Metal

Table 4: Load Testing

Sr no.	Sample	Impact Value Joules	Hardness Test
1	Aluminum alloy	68	28 BHN
2	Aluminum alloy 2	70	31 BHN
3	Aluminum alloy 3	70	33 BHN

Results of Testing

1) Hardness testing show that when we make an composite material with adding two metals by reinforcement or metal matrix than the hardness and ductility will be increase.
2) Tensile strength is increased.
3) Stiffness is also improved of Al/Mg based composite materials
4) By the impact load testing we can easily analysis that how much load metal can wear at the given temperature. Toughness of the sample is also increased with compare to the pure aluminum.

4. Conclusions

1) Aluminum composite material having good mechanical properties while we increasing the %age of magnesium.
2) Results show that "Al2O3" particles up to 10% Increase the tensile strength 237 MPa and elongation 17% in aluminum alloy matrix containing Cu-Zn -Mg in aluminum.
3) The results state that Cu contents in small quantity in the metal matrix composite i.e. less than 2.7% Cu increases the strength and ductility along with Mg and Zn contents in aluminum matrix as in case of alloy 1
4) In this composite materials Mg has pronounced effect on aluminum cast composites up to 3.5% Mg contents which increases wet ability, reduces porosity and develops very good bonding with "Al2O3" particles, and aluminum matrix 1 and 3 yields superior properties
5) When we take an sample with an amount of 2-3% Mg in combination with 4.5% Zn in aluminum matrix reinforced with 10% of "Al2O3" alloy number 1 and 3 particles yields best Combination of strength and ductility in case of a heat treated conditions.
6) In this composite material development in last we found that the overall mechanical properties of the composite material found to be good.

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