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Al Metal Matrix Hybrid Composite Reinforced by Cu and Al_2O_3: Stir Casting and Testings

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ABSTRACT

The purpose of this work is to improve the strength of aluminum metal by reinforcing copper (Cu) and aluminum (Al2O3) by a stirring method. To improve mechanical properties like hardness, strength, we make composites with different compositions of copper and aluminum oxide by weight (% by weight). Various tests have also been carried out to verify the granulation. The aluminum hybrid composite is applicable for aerospace, defense along with automotive industryby reason of features such as high strength, strength / weight ratio and abrasion resistance. This is a very good way to get the aluminum foil in to improve aircraft. Three set of composites with different compositions of reinforced materials has been developed. Different tests have been performed to know the results.

Keywords:-MMC, Stir Casting,SEM Testing and Brinell Hardness Testing

INTRODUCTION

In earlier days, metals were used for various purposes. But, now the metals are mixed with different materials and other metals to improve the base metal's physical and chemical properties. The composites have a wide potential area for different types of applications[1]. One factor hindering the widespread use of MMCs was their relatively high cost. This is mainly due to the expensive processing currently used to produce high quality composites. Matrix composites are made to reduce costs, reduced weight and high performance, which are readily available on the market for our use. Current work has been done on stirring aluminum as the base metal with the reinforcement of Al2O3 (3.4.5 wt%) and copper (2.3.4 wt%).Aluminum is the most abundant metal in the earth crust and the third nearly everyone plentiful element, following oxygen and silicon[2]. It creates up on 8% of the Earth's solid exterior. Due to the easy availability, the high weakness / weight ratio, the simple machinability, durable, tough and malleable, aluminum is the most extensively used non-ferrous metal. Aluminum alloys be alloys in which aluminum (Al) is the principal metal[3]. The typical alloying elements are copper, magnesium, manganese, silicon and zinc. Like all composite materials, aluminum matrix composites be not a solitary material, except a relatives of materials whose stiffness, density and thermal and electrical properties be adjusted. The matrix retains the reinforcement to form the desired shape, while the reinforcement improves the overall mechanical properties of the matrix[4-5]. When properly calculated, the new combined material exhibits healthier strength than any individual material[6].This paper is aiming to design and develop an aluminium based MMC to suit for the requirements of aircraft materials. Subsequently the testing methodologies being required

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to experimentally confirm the improvement in the properties of the aluminium MMC is carried out[7-9].

EXPERIMENTAL WORK

We have made the Composite of Aluminium reinforced by Al_2O_3 and Copper (Cu) with three different compositions. The simple and the majority commercially used method is recognized as stirring molding technique[10]. It concerns the reinforcement of copper and aluminum particles into liquid aluminum molten metal and the solidification of the mixtures. Reinforcements Copper and aluminum oxide are preheated designed for half an hour at a temperature of 1084 ° C and 500 ° C respectively. The reinforcement metal (Al2O3 and copper) is reinforced in the base metal matrix when the aluminum was heated to the molten state at 660oC and reinforcement(Al2O3 and copper) were amplified in fully molten state, stirring was gradually started from 250 to 300 rpm over 5 minutes using a speed controller. The heating temperature is set at 630 ° C, which is lower than the melt temperature of matrix. A uniform semisolid stage of the melt matrix was achieve by stirring at 630 ° C. torrential preheated reinforcement into the semi-solid stage of the matrix improves the wet capability of the reinforcement, reduce the settling of particles on the bottom of the crucible. To maintain fluidity, a small amount of Mg (4 µm) was added by wrapping the Mg in the aluminum foil. The flow speed of the calculated gains is 20 grams a minute. The scattering point is taken for 5 minutes.

Table 1: compositions of samples

Sample No.	Aluminium (gm)	Copper (%)	Alumina (%)	Mg (gm)
1	500	2	3	4
2	500	3	4	4
3	500	4	5	4

Stir casting machine was carefully operated so that we could get the best result out of it. And the samples could be made with the right amount of reinforcements and the reinforced metals get uniformly distributed in the casting samples.

Figure 1: samples after casting

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Figure 2: Weight balance machine

Figure 3: Stir casting machine

Figure 4: melting the base metal (Al) in the furnace

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Figure 5: Preheating of mould

A. Hardness Test

Hardness is a evaluate of how opposed to solid is to a variety of types of lasting shape change when a compressive force is applied.a number of materials, like metal, are harder than others. Macroscopic hardness is normally characterized by strong intermolecular bonds, but the performance of pressurized solids is complex[11-12]; therefore there are different hardness measurements: scratch hard, indentation hard and rebound hardness[13].The Brinell hardness test is performed on the Brinell hardness test machine, applying a load of 100 Kgf for 30 seconds to different samples using a 4mm diameter ball indentor.The hardness depends on the toughness, plasticity, strength, toughness, viscosity elasticity and viscosity. Brinell hardness capacity was performed on base metal and composite samples using a standard Brinell hardness testing machine.Brinell-hardheidsmetingenwerden uitgevoerd om de invloed van fijn stof (koper en aluminiumoxide) op de aluminiummetaalmatrix te onderzoeken wanneer de gewichtsfractie in verschillende monsters op de matrixhardheid wordt gevarieerd.

Figure 6: Hardness testing samples

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Table 2: Brinell Hardness Test of different samples

Samples	First Test (in Kgf)	Second Test (in Kgf)	Third Test (in Kgf)	Average (in Kgf)
Sample 1	61	63	62	62
Sample 2	62	64	62	62.66
Sample 3	65	67	69	67

Figure 7:Brinell hardness testing machine

B. SEM Test

The full form of SEM is Scanning Electron Microscope test. The morphology, density, kind of reinforces particles and their sharing have a major influence on the properties of particulate matter-composites. SEM microscope is a kind of microscope that produces images of a sample by scan it with a paying attention beam of electrons. The electron interacts with atoms in the sample and produces various detectable signals that have information about the surface geography and compositions of the sample. The optical micrograph is shown in Fig which shows the still spread of the reinforcement in the matrix. The SEM images of the ready samples were taken and exposed in Fig. In the SEM test, view all three samples with a scanning electron microscope mounted in the SEM machine and by observing the different type of microstructure of the grain size of the samples, we see that all samples have different microstructure.In sample first the amount of reinforcement is less so image shows less reinforcement over the surface of sample first while in second and third sample the amount of

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reinforcement is respectively more so image of sample second and third shows more reinforcement over the surface of sample second and third respectively. The surface morphology and chemical composition were examined using a scanning electron microscope. It can be represented by the figure. We have obtained the powder form of the sample by filing it and then test it on the SEM machine.

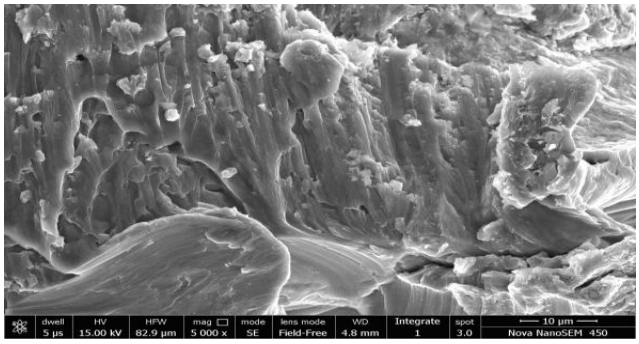

Figure 8:Aluminium including copper (2 wt.%) and alumina (3 wt.%)

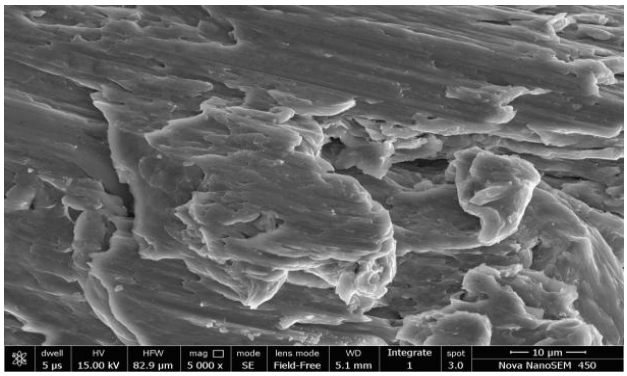

Figure 9:Aluminium with copper (3 wt.%) and alumina (4 wt.%)

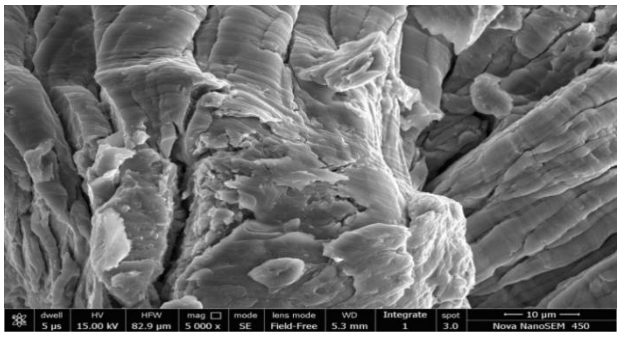

Figure 10: Aluminum including copper (4 wt.%) And aluminum oxide (5 wt.%)

RESULTS

The hardness test shows that it is in Al MMC increases with the increase of copper plus aluminum oxide as reinforcements. Table 3 shows the average number of Brinell hardness.

Table 3: Brinell Hardness No. of different samples

Samples	First Test	Second Test	Third Test	Average
Sample 1	37.19	41.96	47.65	42.26
Sample 2	54.52	54.52	41.96	50.33

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Sample 3	54.52	47.65	54.52	52.33

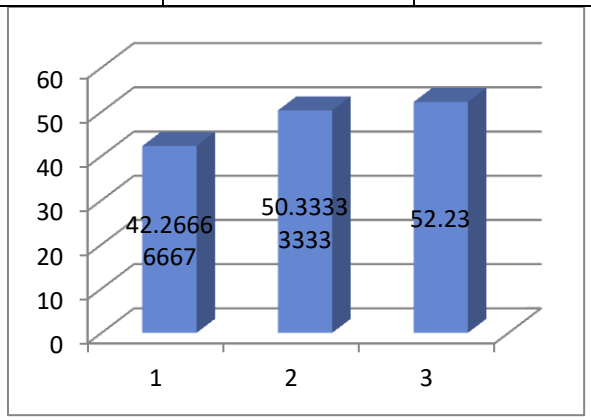

Figure 11: Graph of Brinell hardness number

The above graph shows the average Brinell hardness number. It clearly shows that the hardness is increasing as the reinforcements (copper and alumina) is increased in the Al MMC sample.

The surface morphology and chemical composition were examined using a scanning electron microscope. The results are shown in the figure.

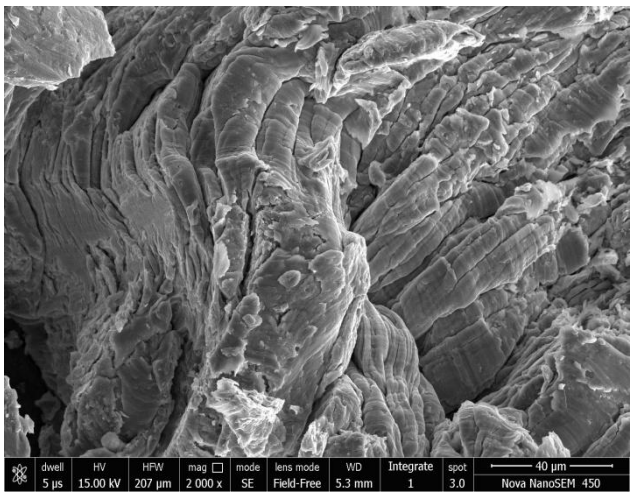

Figure 12: SEM Testing

CONCLUSION

The results confirmed that stirred cast Al-based hybrid MMCs with (copper and alumina) reinforced formulation clearly give the best results in SEM and hardness tests**.** The hardness testing is confirm that the hardness increases as the reinforcement (copper and alumina) is increased by wt.% in different samples.For SEM, small quantity of the sample is converted into powder form. After that the powder particles is put in SEM machine and then image is taken at different mega-pixels and output is seen on the screen. The surface morphology and chemical composition is check in SEM machine. It is shown in fig. 8,9,10 and 12.

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