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INVESTIGATION OF WEAR CHARACTERISTICS OF ALUMINUM REINFORCED QUARTZ IN COMPOSITES

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Abstract:

The Need for less weight, minimum cost and superior performance material necessitate to development of newer materials and hence an effort has been taken to develop aluminum matrix composites through stir casting method which is the simplest and economical way for producing aluminum matrix composite. The production of aluminum reinforced matrix composite was done by reinforcing with various weight percentage of quartz. The result indicated that addition of quartz in aluminum alloy improved the hardness and tensile strength. The wear test exposed that addition of quartz decreased the wear loss and increases the wear resistance. The SEM result on microstructure indicated that uniform reinforcement and good casting Test results shows the improved hardness and wear resistance of the composites.

Key Words: AMC, Hardness, Tensile Strength & Wear Resistance

Introduction:

The need for less weight, low cost and good quality performance materials leads to the improvement of new materials that meet these requirements. Newly developed materials are aluminum metal-matrix composites (AI-MMCs). Recent days, there are many products of composites were employed particularly for automotive and engineering applications. This is for the reason their high strength, high elastic modulus, and low co-efficient of thermal expansion, light weight, low thermal shock, good wear resistance and a lot of advantages.

Literature Survey:

Aluminum based MMCs create a separate category of advanced engineering materials over conventional Al alloys. With the growth of new forming methods and employ of low cost these composites is growing in a wide variety of industries. [1] Friend CM reported Al alloys found extensive application in transportation engineering because of its superior strength to weight ratio. Conversely, low wear resistance of Al alloys can be overcome by employ Al based MMCs developed for tribological applications. [2] David raja Selvam et al, reported that made-up the aluminium matrix composite with SiC and constant weight of fly ash by stir casting method. The tensile strength of the aluminium matrix improved by adding silicon carbide. [3] A. Rutecka et al, studied and examine the strain rate, fatigue properties, creep resistance and life time of Al/SiC MMC. By adding silicon carbide in aluminium the fatigue properties are improved. Magnitude of the mean strain decreased by adding silicon carbide. [4] C. Dhavamani et al, studied and examine the drilling of aluminium silicon carbide. By attractive minimizing surface roughness and increaseing metal removal rate. To represent the association between input and output variable a multiple regression model is used and genetic algorithm is used to optimize the process. Based on speed, feed and dia of cut finishing of drilling of the composite will be good. [5] T. S. Mahesbabu et al, studied and examine the turning operation in Al356 aluminium MMC adding silicon carbide and boron carbide as reinforcement. Based on the feed rate only the surface roughness will get increased or decreased. [6] J. Jebeebmoses et al, studied and describe about the production of aluminium with reinforcement of silicon carbide. By adding up silicon carbide particles the hardness and tensile strength improved. [7] Hamid Reza Ezatpour et al, reported the effect of nano alumina when added to Al606 alloy and extrusion properties on mechanical and micro properties. In this the milled nano- Al_2O_3/Al composite powder was inject into melt by argon gas. So that the strength and ductility gets increased. [8] K. Kalaiselvan et al, studied and work on manufacture of composites reinforced with boron carbide by stir casting method. The microstructure and mechanical properties has been analyzed. The wear resistance also gets increased by using boron carbide as reinforcement. [9, 10] Bharath. V et al, deliberate and made-up the aluminium alloy Al6061 composite reinforced with ceramic Al_2O_3 using liquid metallurgy route method. The reinforcements were pre heated before mix in the aluminium alloy. Hence the present Investigation was taken up to understand the change in wear of the quartz reinforced aluminium composites.

Material and Method:

Quartz is the second most rich mineral found at Earth's surface and its sole properties create it one of the most valuable natural substances. LM9 provoides excellent resistance to corrosion under both ordinary and marine circumstances.LM9 can be anodized by any of the common processes, the ensuing protective film ranging in colour from grey to dark brown, depending on the method employed (table 1). Stir casting process has been engaged for producing particle reinforced metal matrix composites for decades. In a stir casting process, the reinforcing phases are dispersed into molten matrix by mechanical stirring. In producing metal matrix composites through the stir casting method, there are quite a lot of factors that need significant attention, together with the difficulty of achieving a uniform distribution of the reinforcement material, wettability between the two main substances, porosity in the cast metal matrix composites, and chemical reactions between the reinforcement material and the matrix alloy (table 2).

Table 1: Chemical composition of Aluminium LM9

Material	% of Composition
Copper	0.04

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Magnesium	0.51
Silicon	11.37
Iron	0.48
Manganese	0.42
Nickel	0.002
Zinc	0.02.
Lead	0.009
Tin	0.002.
Titanium	0.01
Aluminum	Remaining

Table 2: Process parameters of Stir Casting

Parameters	Units	Value
Spindle speed	RPM	400
Stirring time	Min	5
Temperature of melt	°C	920
Preheated temperature of quartz particles	°C	300
Preheated temperature of mould	°C	250
Power feed rate	g/s	0.8-1.2

Design of Experiments:

Taguchi methods are developed by Genichi Taguchi to get better the quality of manufactured goods, and more recently also applied to engineering. Professional statisticians have welcomed the goals and improvements by Taguchi methods, particularly by Taguchi's development of designs. The Taguchi method involves reducing the variation in a process through robust design of experiments. The in general purpose of the method is to create high quality product at low cost to the producer. The new design proposed by Taguchi involve using orthogonal arrays to classify the parameters affecting the process and the levels at which they should be vary.

Methodology:

A group of aluminum alloy was melted at 920°C via an muffle furnace. previous to stiring the Quartz be supposed to be pre-heated at a temperature of 300°C.When the melting temperature reaches the aluminium alloy will melt and then stirring process should be completed by using the mechanical stirrer. The melt was agitated with the aid of a mechanical stirrer to structure a fine vortex. The mixtures of preheated Sio2 particles were added at a regular feed rate into the vortex. The process parameters engaged are given in Table. After stirring the molten mixture, it was poured into the preheated permanent mould. The MMCs having different weight percentages (5, 10 and 12%) of quartz were made-up by the same procedure.

Results and Discussion:

Wear of components is a serious factor and it influences the service life period. Wear is defined as the progressive loss of material from the surface of a solid body due to mechanical action i.e., get in touch with or relative motion against a solid or liquid contact body. Advanced engineering materials, composites are employed where high wear resistance is required. The abrasive wear resistance of the metal matrix composites increases with increase in the volume fraction addition of particles, under both high and low stress abrasive wear environment.

Hardness and Tensile and Wear with Volume Fraction % of Quartz:

Due to reinforcement of quartz in aluminum LM9 the hardness of the composites improved. During machining the result shows that continuous and discontinuous chips are formed at irregular interval at 5% of volume and discontinuous chip formed at 12% of volume. It indicated an increase in hardness and tensile strength of the composite (Table 3)

Table 3: Increasing of Hardness

S.No	Amount of quartz added in LM9 (%)	Rockwell hardness in MPa	Tensile strength in MPa
1	0	48.04	168.75
2	5	51.33	179.49
3	10	52.53	183.6
4	12	53.70	189.54

Wear loss is minimum at 12 % composition of quartz compared 5% , 10% to other samples. Its shows in the Graph figure 1.

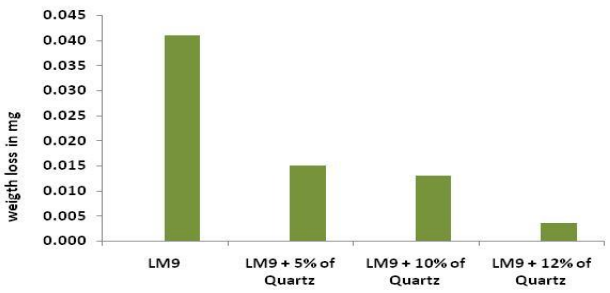

Figure 1: Wear loss of AMCs

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Microstructure and SEM Analysis:

The microstructural characterization of aluminum reinforced LM9 with different quartz was shown in below figures 2 to 4. Figure 2 shows the outcome of normal load on the wear rate. As the normal load increases the coefficient of friction also increase which leads to more wear rate. This is most common phenomenon in most of the material. Normal load has the highest effect on the sliding wear rate. Figure 3 gives the numerous scratches on the wear surfaces. This suggests that the primary wear mechanism is abrasive wear. The examine of wear surface of the alloy and composite of lower magnification reveals different pattern of grooves and ridges running parallel to one another in the sliding direction. In figure 4 there were a numerous scratches on the wear surfaces. This shows that the primary wear mechanism is abrasive wear. The examine of wear surface of the alloy and composite of lower magnification reveals distinct pattern of grooves and ridges running parallel to one another in the sliding direction. The result shows the surface was characterized by long and continuous grooves which have heavy scares. The presence of micro defect on the sliding surface is another important phenomena observed. The wear surface shows distinct parallel grooves throughout the worn surface

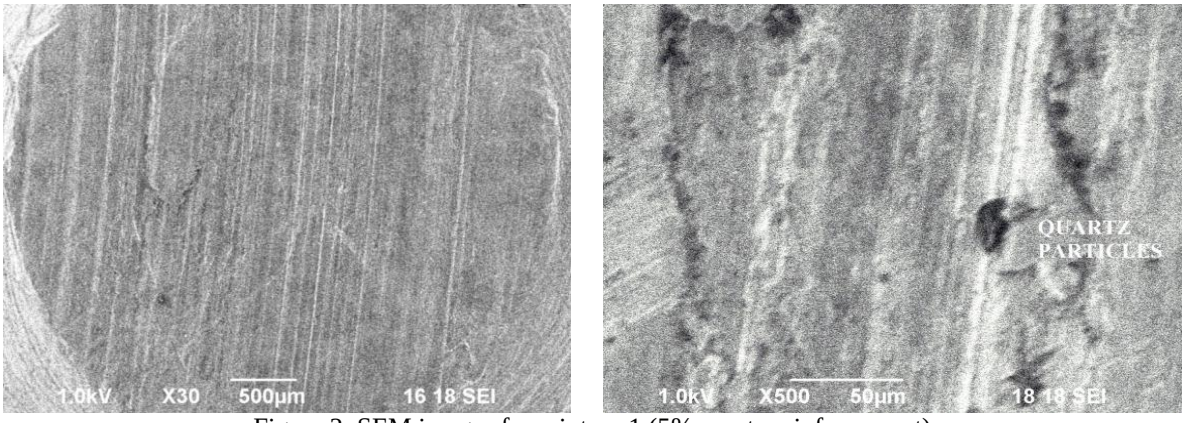

Figure 2: SEM images for mixture 1 (5% quartz reinforcement)

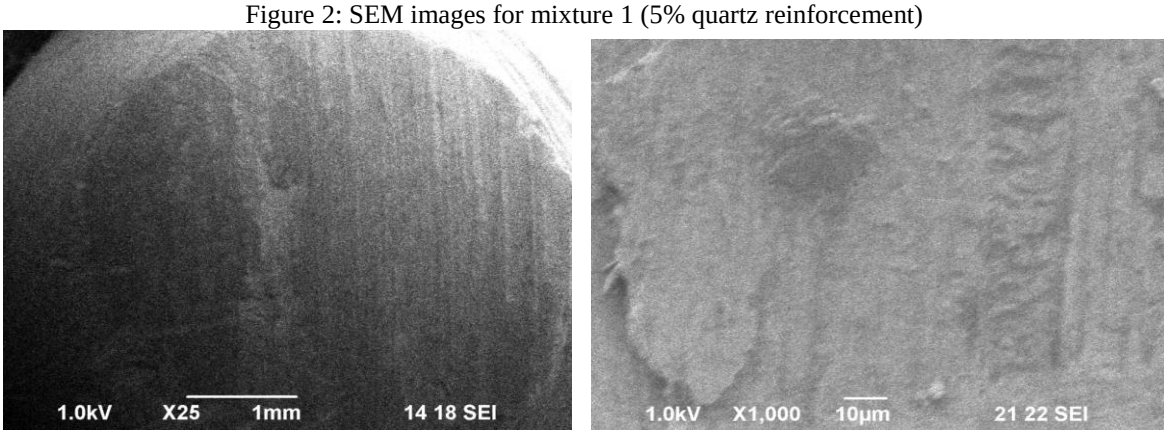

Figure 3: SEM image for mixture 2 (10% quartz reinforcement)

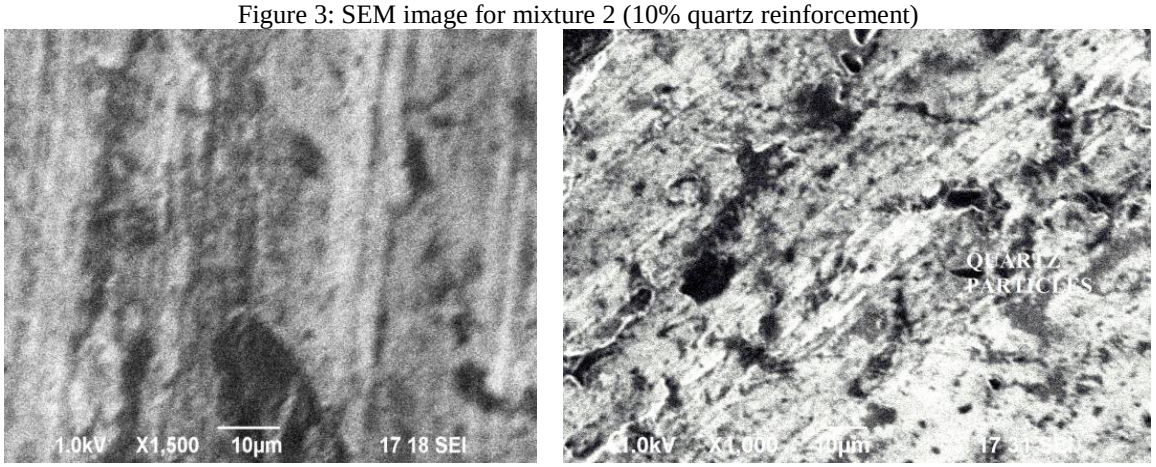

Figure 4: SEM images for mixture 3 (quartz 12% reinforcement)

Conclusion:

Stir casting method can be successfully employed to manufacture aluminum matrix composite reinforcing quartz with desire properties. Reinforcing quartz with aluminum alloy in the respective percentages (5 to 12%) has shown an appreciable increase in its mechanical properties and wear resistance. The hardness and tensile strength were increased with the addition of weight percentage of quartzs. The SEM result revealed the distribution of quartz in aluminum matrix as fairly homogeneous.

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