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Design and Analysis of Composite of Aluminium-7075 and Si-C Metal MatrixComposite with Egg Shell

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Abstract: ***Metal Matrix Composite possess increasingly improved properties including high enduringness, hardness, density and sensible wear resistance compared to alloys or the other metals. during this paper the composite material is developed by reinforcing of silicon carbide (Si-C) powder and egg shell in metal alloy Al7075. The composites square measure fabricated by Stir Casting Machine. TheMMC's specimens square measure ready by varyingthe proportion of weight fraction of the particles in three compositions. During this work Al-7075 Si-C MMCs square measured by admixture molten metallic element with silicon carbide by the help of mechanical stirring, called stir casting methodology.Conjointly during this work, the stir casting methodparameters square measure optimized at intervals thevary to get sensible mechanical characteristics anduniform admixture of reinforcement, that could be amajor concern in stir casting. The mechanical properties square measure enduringness, Impact check, Hardness is planned to analyze. The investigation is performed to check if the new MMCare able to replace plane wings.***

I. INTRODUCTION

Metal Matrix Composites square measure being more and more utilized in region and automobile industries because of their increased properties like elastic modulus, hardness, durability at space and elevated temperatures, wear resistance combined with vital weight savings over unreinforced alloys. The unremarkably used metal like matrices Al, Mg, Ti, metal and their alloys. These alloys square measure most popular matrix materials for the production of MMCs. The reinforcements getting used square measure fibers, whiskers and particulates. The benefits of particulate- reinforced composites over others square measure their formability with value advantage. Further, they are inherent with heat and wear resistant properties. For MMCs set, Al2O3 and Gr square measure wide used particulate reinforcements. Compositionally, MMCs havea minimum of two parts of the matrix and therefore the reinforcement. The matrix is actually a metal, however rarely a pure one. Except such cases, it's usually associate in nursing alloy. The foremost common metal alloys in use square measure based on metal and Ti. each of them square measure denseness materials and square measure commercially on the market during a wide selection of alloy compositions. The reinforcements for MMCs are often generally divided into five major classes they are Continuous fibers, discontinuous fibers, whiskers, wiresand particulates.

Metal matrix composites (MMCs) thanks to their tailored mechanical, phySi-Cal and thermal properties as well as their low densities, improved thermal and electrical conductivities, strength to density quantitative relation, abrasion resistance etc., have verified to be associate rising category of materials for the aerospace, automotive, and wear applications. The difficult part of the MMCs is that the value of the composite that depends on the matrix materials. Thus there has been associate increasing demand for the low-priced reinforcements. The previous studies on the low-priced reinforcements were like clay, fly ash, red mud bolstered to Al-Si alloys. which gave the improved mechanical properties reducing the densities. The earlier studies verified that the Egg Shell is associate by product that's one amongst the world's worst environmental issues, especially in the countries wherever the egg product business is well developed. Attempts to use egg shell in several applications, it's been a possible filler in polymer composites. The egg shell contains a comparatively high strength than the mineral carbonate. The egg shell contains ninety fifth by weight of Calcium Carbonate and five-hitter by weight of materials like Al2O3, SiO2, S, Pand Cr2O3, MnO. The general egg shell structure is a protein lined mineral crystals, majorly of the calcium carbonate, these characteristics say that egg shell is a good material for the inexpensive, light weight, and low load bearing composite applications as of in the automotive industry, homes, offices and factories.

Aluminum- (Silicon Carbide) could be a metal ceramic material consisting of carbide particles distributed during a matrix of metal alloy. It combines the advantages of high thermal phySi-Cal phenomenon of metal and low CTE (coefficient of thermal expansion) ofceramic.

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II. SELECTION OF MATERIALS

A. Aluminum -7075

The matrix material to be used was chosen as Al7075 which is a precipitation hardened aluminum alloy, containing zinc, magnesium, copper, and chromium as its major alloying elements. It has good mechanical properties and it is strong with strength comparable to many steels, has good fatigue strength and less resistanceto corrosion and many others. 7075 aluminum is composed of 90.0% Al, 5.6% Zn, 2.5%Mg, 0.23%Cr, and 1.6% Cu. The copper content of 7075 aluminum increases its susceptibility to corrosion, but this sacrifice is necessary to make such a strong-yet-workable material. Type 7075 aluminum is often used in the aerospace industry, which has increased concern for fatigue failure.The fatigue strength is a measure of a material's ability to withstand this cyclical loading, and is useful for applications where a part created using this material is subject to repetitive loading cycles.



B. Aluminum 7075Silicon Carbide (Si-C)

Silicon carbide is formed in two ways, reaction bonding and sintering. Each forming method greatly affects the end microstructure. Reaction bonded Si-C is made by infiltrating compacts made of mixtures of Si-C and carbon with liquid silicon. The silicon reacts with the carbon forming more Si-C which bonds with the initial Si-C particles. Sintered Si-C is produced from pure Si-C powder with non-oxide sintering aids. Conventional ceramic forming processes are used and the material is sintered in an inert atmosphere at temperatures up to 2000ºC or higher. Both forms of silicon carbide (Si-C) are highly wear resistant with good mechanical properties, including high temperature strength and thermal shock resistance. Our engineers are always available to best advise you on the strengths and weaknesses of each ceramic for your particular needs. Typical silicon carbide characteristics include: Low density, high temperature strength (reaction bonded) Oxidation resistance (reaction bonded) Excellent thermal shock resistance, High hardness and wear resistance. Excellent chemical resistance, Low thermal expansion and high thermal conductivity. Typical silicon carbide applications include: Fixed and moving turbine components Seals, bearings etc. The silicon carbide grade used in the composition is400 grit.



Silicon carbide

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C. Egg Shell (Silicon Carbide)

Normally egg shells are considered to be waste products at restaurants, food industries, houses etc. This will create pollution to the environment but it has high compressive strength and good tensile strength. By using the eggshells pollution can be reduced. Eggshell is a cheapest material and this is a waste product for the regular use.. Generally, this composite has good application in automotives. Various parts of automotiverequire compressive, impact, tensile strengths based onthe requirement of the component these materials are mixed in different proportions. In order to provide more environmentally responsible products, manufacturers are exploring alternative approaches to reduce the amount of polymer used to produce various polymer- based products. Mechanical properties of biological materials are increasingly explored via testing.

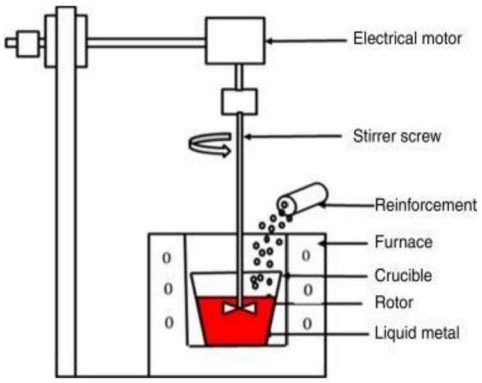


Egg shell

III. METHODOLOGY

The MMC is obtained by a process of stir casting, the stir casting is carried out in an electrical furnace. Processing technique is important factor. It must ensureuniform distribution of Si-C particle throughout the matrix material. Mechanical Stir casting is one of the processing techniques for preparation of Al- Si-C metal matrix Composites.

Stir casting is a type of casting process in which a mechanical stirrer is introduced to form vortex to mix reinforcement in the matrix material. It is a suitable process for production of metal matrix composites dueto its cost effectiveness, applicability to mass production, simplicity, almost net shaping and easier control of composite structure. Stir casting process involves stirring of melt composite, in which the melt metal is stirred continuously which expose the melt surface to the atmosphere which tend to continuous oxidation of aluminium melt. Stir casting setup consist of a furnace, reinforcement feeder and mechanical stirrer. The furnace is used to heating and melting of the materials. The mechanical stirrer is used to formthe vortex which leads the mixing of the reinforcement material which are introduced in the melt.

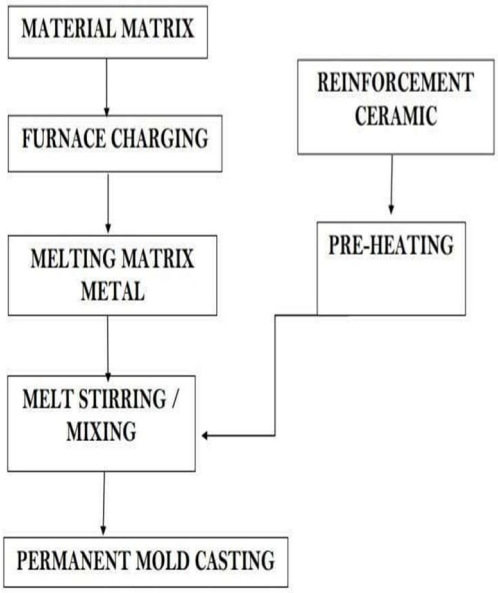


Stir casting

The impeller blade may be of, various geometry and various number of blades. Flat blade with three number is the preferred as it leads to axial flow pattern in the crucible with less power consumption. This stirrer is connected to the variable speed motors, the rotation speed of the stirrer is controlled by the regulator attached with the motor. Further, the feeder is attached with the furnace and used to feed the reinforcement powder in the melt. A permanent mold, sand mold or alost-wax mold can be used for pouring the mixed slurry.

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A. Process Flow Diagram



B. Melting The Material

The 1kg of metal is then put into the electrical furnace and the temperature is set to 900C. It took about4 hours to initially heat the furnace and then it took 1.5 hours change from solid phase to liquid phase. Thepowder of silicon carbide (Si-C) and egg shell is then added to the furnace.

The ratios are

- 10:2:1 (1kg of Al, 20gm of Si-C, 10gm ofeggshell)
- 10:4:2 (1kg of Al, 40gm of Si-C, 20gm ofeggshell)
- 10:6:3 (1kg of Al, 60gm of Si-C, 30gm ofeggshell)

The Si-C and egg shell powder is then preheated to 500 C in box furnace which can go up to a maximum temperature of 1200 C. The powder mixture is preheated to remove any moisture content present in the powder before adding it to the stir casting. All of theratios of the powder is preheated until the temperaturehits from 0-500c.

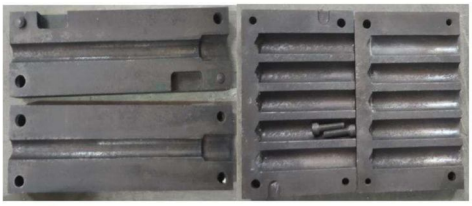


Box Furnace

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C. Casting the Material

The molten liquid is then poured into the molds. Two molds were used the dimension were 5cm diameterand 20cm in length. The second mold was of diameter 5cm and 10cm in length. The second diameter was a mold of 4 pieces. The molten liquid was then poured into the molds carefully and allowed to rest for 5mins. The is then opened and the metal is removed.



D. Cooling the Material

The metal is allowed to cool in the room temperature and the mold is released to separate the molten matrix. The metal after cooling is inspected for black spots which may have occurred due to the powdersburning which is possible if the temperature is not correctly. The metal is then visually checked for black spots.

IV. TESTING THE MATERIAL

The material was then subjected to three specific teststhey are.

1) Mechanical Testing
2) Impact Testing
3) Hardness Test

The mechanical testing is carried out in the testing centrethere are three mechanical test that are carried out they are

- Yeild Strength
- Ultimate Tensile Strength
- % Elongation

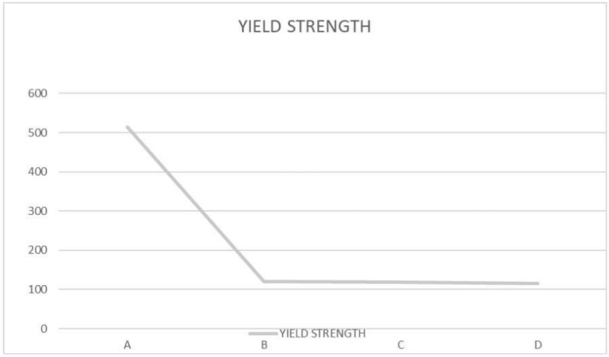
A. Yeild Strength

Yeild strength is the amount of stress at which plastic deformation becomes noticeable and significant. Theyield strength is a point at which plastic deformation occurs under stress.



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SPECIMEN	COMPOSITION	YIELD STRENGTH (N/mm^2 or MPA)
A	100% Al7075	514
B	Al7075+ 20% Sic + 10% Eggshell	120
C	Al7075+ 40% Sic + 20% Eggshell	119
D	Al7075+ 60% Sic + 30% Eggshell	116



The sample T1 was subjected to tensile test and the endresult of the material is shown in below image



B. Ultimate Tensile Stress

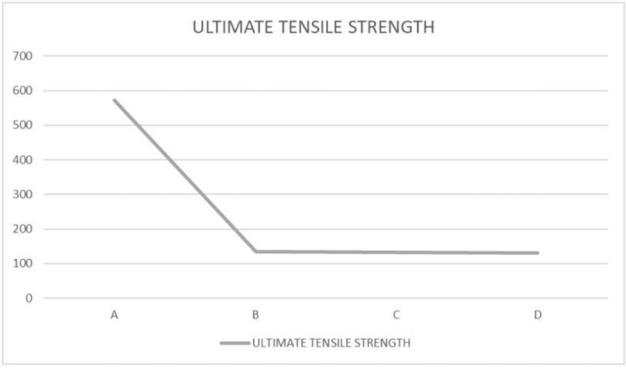
The ultimate tensile test is carried out by gripping the endsof a suitability standardized test piece in a tensile test machine and then applying a continually increasing uni-axial load until such time as failure occurs out by gripping the ends of suitably prepared standardized test piece in atensile test machine .

SPECIMEN	COMPOSITION	ULTIMATE TENSILE STRENGTH
A	100% Al7075	572
B	Al7075+ 20% Sic + 10% Eggshell	134
C	Al7075+ 40% Sic + 20% Eggshell	132
D	Al7075+ 60% Sic + 30% Eggshell	131

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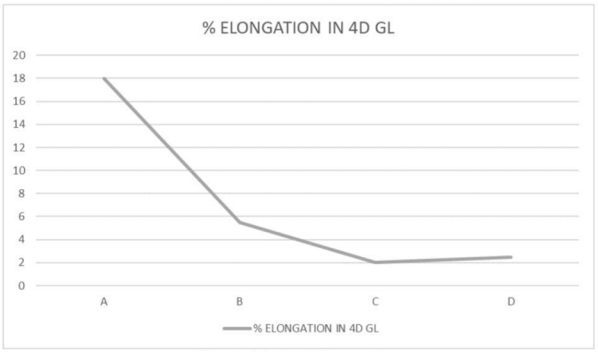
C. %Elongation

Percent elongation is typically carried out during a material tensile test. Rather than measuring the entire length of the specimen before and after the tensile test, agauge records the elongation over a set volume of material in the center of the test specimen. The fracture will occur in between the ends of the gauge. Elongation isa measure of how far a sample will stretch before it breaks. The result is normally expressed as a percentage,also known as percent elongation (% elongation). Aknown gauge length is critical to performing accurate elongation calculations.

SPECIMEN	COMPOSITION	% ELONGATION IN 4D GL
A	100% Al7075	18.00
B	Al7075+ 20% Sic + 10% Eggshell	5.50
C	Al7075+ 40% Sic + 20% Eggshell	2.00
D	Al7075+ 60% Sic + 30% Eggshell	2.50

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V. CONCLUSION

It is observed that the yield strength of the new MMC is 120Mpa and the pure aluminium7075 was 514Mpa. The UTM values of the new MMC is 134 and the pure aluminium value is 572Mpa.The new MMC hadabsorbed only 2 Joules of energy where as the pure Al075 absorbed 8 Joules of energy. The average hardness of thenew MMC is 89 whereas the pure Al7075 is 149The newMMC that was made by the addition of mixing of reinforcement material of Sic and eggshell with Al7075was performed. The material did not show any signs of increase in mechanical strength. The new MMC can be used in the manufacture of frames of aluminium bicycles and so on which does not require the tensile strength of the actual aluminium 7075. The experiment did not meet the standards of the pureAl7075. On even selecting the highest values in terms of mechanical properties the values were not able to satisfy the exsisting values.The test can be further carried out by reducing the quantity of reinforcement materials as it was observed that there is a decrease in mechanical properties with increase in quantity of reinforcement materials.

VI. ACKNOWLEDGEMENT

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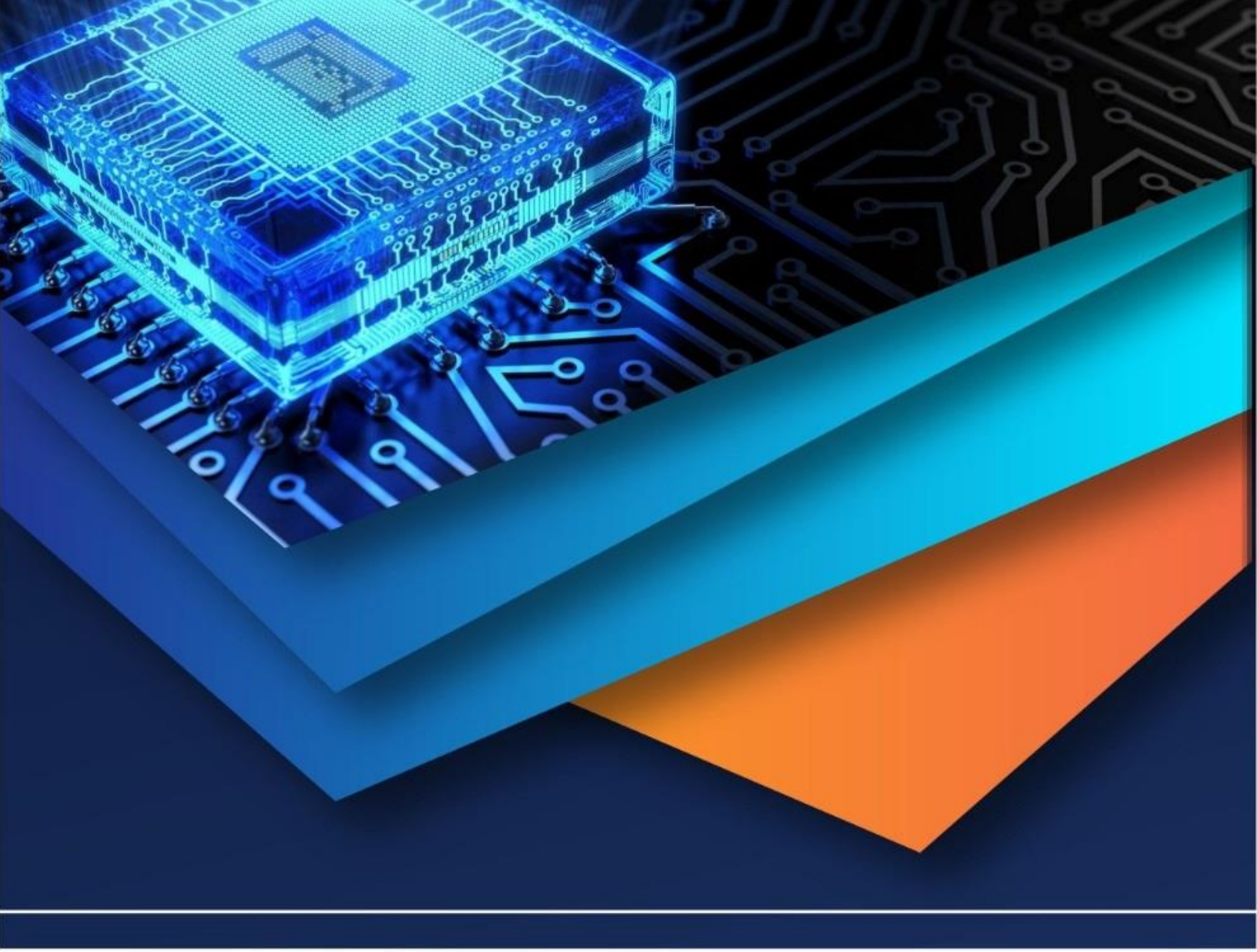
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