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Enhancement of Mechanical properties of Pure Aluminium Reinforced with SiC Nano particle

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Abstract: *Aluminium are widely used in aerospace,automobile industries due to their low density and good mechanical properties, good corrosion resistance and wear, low coefficient of thermal expansion as compared to conventional metals. The good mechanical properties of these materials and relatively low manufacturing cost make them a very attractive for different applications both from scientific and technology points of view. The aim of designing metal matrix composite materials is to combine the desired properties of metals and Ceramics.*

Present work is concentrated on the study the behaviour of Aluminium reinforced with silicon carbide (SiC) composite manufactured by the stir casting technique. Different percentage of reinforcement is used. Tensile test, Hardness Test, Impact test performed on the samples obtained by the stir casting process.

Keywords: *Aluminium ,Composite,SiC Nano Particle*

I. Introduction

Scientists are continuously trying to improve various properties of engineering materials. This led to new category of materials called composite materials; they are composed of a combination of distinctly different two or more micro or macro constituents that differ in the form of composition and it is insoluble in each other.

Composite materials have a continuous, phase called the matrix; and a dispersed,non-continuous, phase called the reinforcement. The reinforcing phase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally continuous. In a composite, each material retains its original properties but when composited it yields superior properties which cannot be obtained separately. Such types of material are developed to satisfy proper mechanical properties which cannot be derived from conventional materials. And also composites meet the requirements of specific design and function, along with the desired properties.

According to matrix constituent, composites are classified into organic-matrix composites, metal matrix composites (MMCs) and ceramic-matrix composites.Among these composites, MMCs provide significantly enhanced properties such as higher strength, specific modulus, damping capacity, stiffness, good wear resistance and weight savings. The major disadvantage of MMC usually lies in the relatively high cost of fabrication and of the reinforcement materials.

II. Literature Survey

S.Venkat Prasad et.al [2017] He studied that, The applications of aluminium and its alloys can be found in almost every engineering field such as aerospace, marine, automotive, structural and various other fields. Due to its versatile properties it is preferred for fabricating different types of metal matrix composites. Metal matrix composites exhibit better and improved strength, toughness, formability, corrosion resistance, machinability, stiffness,wear, creep, fatigue and numerous other mechanical properties as compared to metals. With the invention and development of these aluminium metal matrix composites various drawbacks faced by the engineering society have been overcome and best possible solutions are provided. This review paper mainly focuses on the mechanical behavior of various types of aluminium metal matrix composite developed using different fabrication techniques. Main emphasis is on the study of wear behavior of AMMCs with various input conditions, prepared using stir casting process as it is one of the predominantly used fabrication technique.

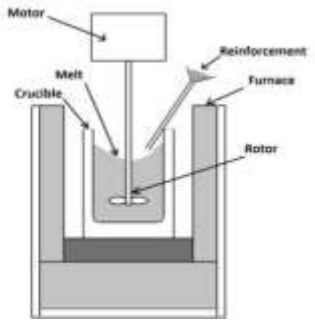
Rasoul Azari Khosroshahi et.al [2017] He studied that, Stir casting is an economical process for the of aluminium matrix composites. There are many parameters in this process, which affect the final microstructure and mechanical properties of the composites. In this study, micron-sized SiC particles were used as reinforcement to fabricate Al-3 wt% SiC composites at two casting temperatures (680 and 850 C) and stirring periods (2 and 6 min). Factors of reaction at matrix/ceramic interface, porosity, ceramic incorporation, and agglomeration of the particles were evaluated by scanning electron microscope (SEM) and high-resolution transition electron microscope (HRTEM) studies. From microstructural characterizations, it is concluded that the shorter stirring period is required for ceramic incorporation to achieve metal/ceramic bonding at the

interface. The higher stirring temperature (850 C) also leads to improved ceramic incorporation. In some cases, shrinkage porosity and intensive formation of Al4C3 at the metal/ceramic interface are also observed. Finally, the mechanical properties of the composites were evaluated, and their relation with the corresponding microstructure and processing parameters of the composites was discussed.

III. Experimental Work

Stir Casting Process

Stir Casting is a liquid state method of composite materials fabrication, in which a dispersed phase ceramic particles, short fibres) is mixed with a molten matrix metal by means of mechanical stirring. This is the most prominently used technique (it is also referred to as the vortex technique) is attractive because of simplicity, low cost, flexibility, most sized economical for large components to be prepared as well as production of near net shaped components. This process involves the introduction of pre-treated ceramic particles into the vertex of molten alloy created by the rotating impeller.



Stir Casting Process

Stir Casting is characterized by the content of dispersed phase is limited (usually not more than 30 % Vol) and distribution of dispersed phase throughout the matrix which is not perfectly homogeneous. There are local clouds (clusters) of the dispersed particles (fibres) and there may be gravity segregation of the dispersed phase due to a difference in the densities of the dispersed and matrixphase. The technology is relatively simple and low cost. Distribution of dispersed phase may be improved if the matrix is in semi-solid condition.The method using stirring metal composite materials in semi-solid state are called as rheocasting. High viscosity of the semi-solid matrix material enables better mixing of the dispersed phase. The figure given above shows the stir casting setup.

Pit Furnace

Specimen Preparation

Aluminium was melted in a crucible by heating it in a pit furnace at 800°C for three hours. The furnace temperature was first raised above the liquidus temperature of Aluminium near about 750oC to melt the Al completely and was then cooled down just below the liquidus to keep the slurry in Semi solid state .stirring was carried out with the help of radial drilling machine for about 15 minutes at stirring rate of 300 RPM. At this stage, the SiC particles were added manually to the vortex. In the final mixing processes the furnace temperature was controlled within 700 ± 10°C. After stirring process the mixture was pour in the mould to get desired shape of specimen.The presence of reinforcement throughout the specimen was inspected by cutting the casting at different locations and under microscopic examination. Same process was used for specimens with different compositions of SiC. Compositions of samples are shown in Table.

Sr.NO	Specimen	Aluminium (gm)	Silicon Carbide (gm)	Silicon Carbide (%)
1	NP0	170	0	0
2	NP5	161.5	8.5	5
3	NP10	153	17	10
4	NP15	144.5	25.5	15

Tensile Test

This is one of the most widely used mechanical test to evaluate certain properties of the metal. It has a great importance in many engineering application like machine design, manufacturing etc. The tensile test is generally performed in Universal Testing Machine (UTM). This test provide data on the strength and ductility of metals under uniaxial tensile forces. The tensile strength of a metal is essentially its ability to withstand tensile load without failure. In tensile test, a metallic sample is subjected for a gradually increasing stress or load which is uniaxial but in opposite direction. The sample get first elastically deformed and then plastically deformed, finally fractures in two pieces. Tensile testing of Aluminium- Silicon carbide metal matrix composite (MMC) will be conducted by making the five samples according to ASTME8-08 as shown in fig. The tensile test can be carried out on standard sample or nonstandard metallic samples. Generally the specimen has a circular cross-section or it may have rectangular or square cross-section as well, which is prepared from a plate or sheet metal. Testing was performed on computerized universal tensile testing machine and all samples with different reinforcement percentage to check them under tensile loading. UTM and loading of sample over machine is shown in Figure. The samples after test were break as shown on Figure.

Computerized UTM machine

Tensile Testing Specimen as per ASTM E8M-08

Specimen before Testing

Sample break after tensile test

Compression Test

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size as oppose to tensile strength, which withstand loads tending to elongate." Compression loads are opposite to tensile loads i.e. the direction of loading. In the case of tensile test we use load but in opposite directions while in case of compression test we use the loads uniaxially but in same direction. The same universal testing machine is used for this test. Generally this test carried out for brittle metals and non-metals which are very good in compression. This test is mainly used for the materials such as cast irons, concrete, blocks, bricks, ceramic products.

Sample put on UTM machine

Impact Test

The impact toughness of a material can be determined with a Charpy or Izod test.Many engineering metals have to withstand impact forces or suddenly applied loads during a service. Impact properties are not directly used in fracture mechanics calculations, but the economical impact tests continue to be used as a quality control method to notch sensitivity and for comparing the relative toughness of engineering materials. For both tests, the specimen is broken by a single overload event due to the impact of the pendulum.

Impact Testing Machine

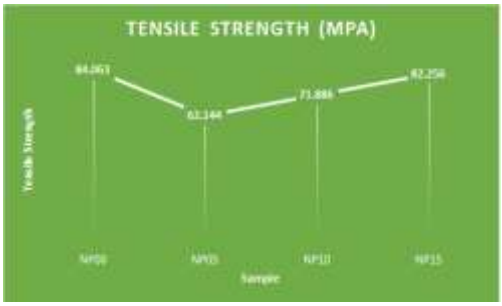
IV. Results and Discussion

Tensile Test Result

Tensile tests were used to assess the mechanical behaviour of the composites and matrix alloy. The composite and matrix alloy rods were machined to tensile specimens with a diameter of 6mm and gauge length of 30 mm. Ultimate tensile strength (UTS), often shortened to tensile strength (TS) or ultimate strength, is the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross-section starts to significantly contract.

Table 01 Tensile Strength of all Samples

Sr. No	Sample	Tensile strength(MPa)
1	Np 0	84.063
2	Np 5	62.144
3	Np 10	71.886
5	Np 15	82.256



Comparison of Tensile strength

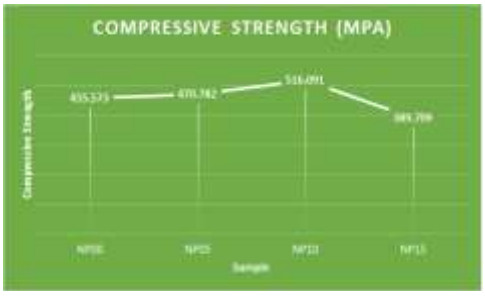
As shown in above Figure the tensile strength of Np05 goes on decreasing which is due to not proper mixing of SiC in the aluminium matrix which is due to proper mixing of SiC with aluminium and may be due to manufacturing defects. Strength of Np15 is 82.256 which is due to proper mixing of SiC with aluminium and may be due to manufacturing defects.

Compressive Strength Test

Compression test are used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by measuring fundamental parameters that determine the specimen behavior under a compressive load these include the elastic limit, which for „Hookeans" materials is approximately equal to the proportional limit, and also known as yield point or yield strength, young"s modulus and compressive strength.

Table 02 Compressive strength of all Samples

Sr. No	Sample	Compressive strength (Mpa)
1	Np 0	455.573
2	Np 5	470.782
3	Np 10	516.091
4	Np 15	501.272



Comparison of compressive strength

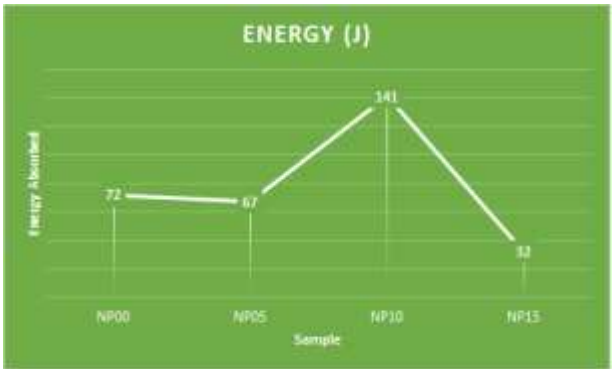
From the Figure it is asses that as the percentage of SiC increases the compressive strength also increase and it is slightly less for Np15 Sample.

Impact Test

The impact toughness of a material can be determined with a Charpy or Izod test.Impact properties are not directly used in fracture mechanics calculations, but the economical impact tests continue to be used as a quality control method to notch sensitivity and for comparing the relative toughness of engineering materials. For both tests, the specimen is broken by a single overload event due to the impact of the pendulum. As top pointer is used to record how far the pendulum swings back up after fracturing the specimen. The impact toughness of a metal is determined by measuring the energy absorbed in the fracture of the specimen.

Table 03 Energy absorbed by all Samples

Sr. No	Sample	Energy (Joule)
1	Np 0	72
2	Np 5	67
3	Np 8	141
4	Np 12	32



Comparison of Energy absorbed

From Figure it is observed that the energy absorbed goes on increasing from Np05 to Np10 and it lower for the Np15. From the impact graph of samples we can come to a point that toughness increases with reinforcement. Surprisingly percentage of reinforcement is not making remarkable influence on toughness.

V. Conclusion

The conclusions drawn from the present investigation are as follows:

The results confirmed that stir die cast aluminium with SiC reinforced nanocomposites is clearly superior to base aluminium in the comparison of tensile strength, Impact strength as well as compressive strength.Aluminium matrix composites have been successfully fabricated by stir casting technique with fairly uniform distribution of SiC nano particles.

It appears from this study that UTS and Yield strength trend starts increases with increase in weight percentage of SiC in the matrix. It has been observed that as percentage of SiC increases compressive strength also increases.

Impact strength is increase by adding SiC.

References

[1]. M.Dinesh, Dr.R.Ravindran(2016)" Aluminium AA 7075 properties enhanced by Zirconium and Chromium nano particle" *International Journal of ChemTech Research Vol.9,* No.01 pp 296-301 ISSN: 0974-4290

[2]. Rishav Kumar, RamachandraNaik AL, Sameer Ahamed, Nitish Kumar Chaubey, Prof.Girish K.(2016)," Microstructure And Wear Properties Of Irconium Nano Metal Matrix Composites" ISSN: 2277-9655

[3]. M. Ramachandra, G. Dilip Maruthi, R. Rashmi(2016)," Evaluation of Corrosion Property of Aluminium-Zirconium Dioxide (AlZrO2) Nanocomposites" *International Journal of Materials and Metallurgical Engineering Vol:3,* No:10, 2016

[4]. L.E. Agureev, V.I. Kostikov, Zh.V. Eremeeva, A.A. Barmin, S.V. Savushkina, B.S. Ivanov(2016)," Aluminum Composites With Small Nanoparticles Additions: Corrosion Resistance" *Mechanics, Materials Science & Engineering,* January 2016 – ISSN 2412-5954

[5]. Chennakesava R Alavala(2016)" Micromechanics of Thermoelastic Behavior of AA6070 Alloy/Zirconium Oxide Nanoparticle Metal Matrix Composites" I*nternational Journal of Engineering Research & Science (IJOER) ISSN: 2395-6992 Vol-2,* Issue-2, February- 2016

[6]. Mohamed Gobara(2015),"Effects of TiO2/SiO2 reinforced nanoparticles on the mechanical properties of green hybrid coating" *International Letters of Chemistry, Physics and Astronomy, ISSN: 2299-3843, Vol. 47,* pp 56-66doi:10.18052/www.scipress.com/ILCPA.47.56

[7]. Aakash Kumar, Prabhutosh Kumar(2015),"A review onmechanical properties triblogical behaviour the microstructural characterization of aluminium matrix composites" *International Journal of Scientific & Engineering Research, Volume 6, Issue 6,* June-2015, ISSN 2229-5518

[8]. Girisha K.B, Dr.H.C.Chittappa(2014)," Preparation, Characterization and Mechanical Properties of Al356.1 Aluminium Alloy Matrix Composites Reinforced With MgO Nanoparticles" *International Journal of Innovative Research in Science,Engineering and Technology Vol. 2,* Issue 10, October 2013

[9]. Joseph Goldenstein(2001),"Scanning electron microscopy and X microanalysis" ,Plennum Publisher 2001

[10]. S. Balasivinandha Prabhu(2006),"Influence of Stir Speed and Stir Time on distribution of particles in cast metal matrix composite",*Journal of material processing Technology 171*(2006) 268-273