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‘’FABRICATION OF AL7075-SiC-GRAPHITE HYBRID COMPOSITE BY STIR CASTING’’

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Abstract— Aluminum metal matrix composites are having light weight, high strength, good corrosive resistance and toughness. it is used in several applications in aerospace and automotive industries. The hybrid metal matrix composites are consisting of at least 3 constituentsAL7075 is used where high strength is critical and good corrosive resistance. Very high strength the reinforcement particles are SiC and Graphite have good mechanical welding properties. In this work AL7075/SiC/Graphite hybrid composites were fabricated with different wt. %(0.5%,1%,1.5%,2%) of SiC and constant graphite with 1 wt.% by using stir casting process. We perform different tests (tensile, hardness, toughness, and microstructure)on this metal matrix composite. Impact strength charpy and Izod of the composite materials are increased with addition of 2 wt. % SiC, which is 42% and 66% respectively compare to base alloy. The tensile strength is increased up to 41% compare to base alloys The hardness strength are increased to composites of 1.5 wt.% Sic and 1 wt% graphite. The hardness is increased up to 11% compare to base alloy in the composite of 0.5% of SiC.

Keywords— **Al 7075, SiC, Graphite, Metal matrix**

I. INTRODUCTION

Aluminum-based discontinuously reinforced metal matrix composites (MMC) have received considerable attention because of their improved strength, high modulus and increased wear resistance over conventional aluminum alloys. The size of reinforcements in commercial MMC generally ranges from a few micrometers several hundred micrometers. Because of fabrication difficulties only recently reinforcements with nanometer size have been used. It was reported that the yield strength of pure aluminum was doubled by adding only 4vol. % Al7075 particles [1]

The tensile strength and Young’s modulus of 7075 Al were increased by 35.7% and41.3% respectively by adding only 1 wt. % SiC and Graphite in the matrix [2].

II EXPERIMENTATION

Stir Casting

Stir casting fabrication technique is used to produce A7075-SiC-graphite hybrid composite. In this process stirring will be done while mixing two different materials by maintaining one material at liquid phase. Mixed metal pour into die, and high pressure will be applied on material when it is in semisolid state. It is useful to increase density of the material. With increase in density all properties of the material will increase. Stir casting process is recently developed process to make composites in more effective manner. In this process we will get advantages of both stir casting the processes.

Materials selection

• A7075 selected as matrix material
• Micro silicon carbide (SiC), graphite particles selected as reinforcement material.

Elements	Chemical composition (wt%)
Zn	5.6
Mg	2.5
Cu	1.5
Mn	0.04
Fe	0.3
Si	0.08
Al	bal.

composition of A7075 alloy

Stir casting setup

The stir casting setup consists of stirrer, preheater. The cylindrical die is designed in order to minimize leakage, provide uniform pressure, and ensure smooth ejection of the cast. hydraulic cylinder is a close fit to the die cavity in order to minimize leakage. A thin film of mould release is applied to the inner walls of the die cavity. The mold release is applied to the die to prevent adhesion, sticking of the composite specimen to the inner die wall and to the cylinder.

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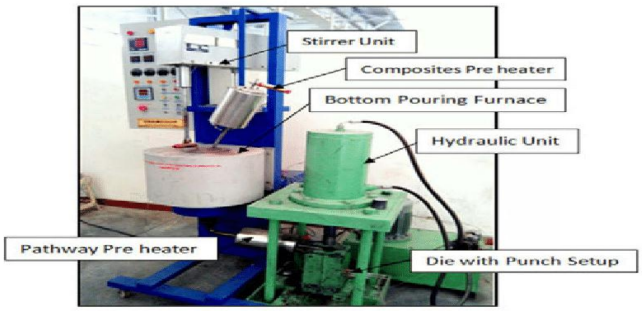


Casting parameters

- Stirrer Speed: 300 rpm
- Pre heating Temperature: 720 0C
- Melt Temperature: 800 ^{o}C
- Stirring Time: 5 min
- Hydraulic Press load: 20 Ton

Stir casting process

- Cut the purchased A7075 material below the crucible dimensions (40mm length and 20mm width)
- The calculated quantity of SiC, graphite, particles is placed in the preheated and pre-heated to 720°C to enhance wet ability.
- The aluminum A7075 alloy charge is melted and maintained at 800°C (typically between 150–250°C above its liquids temperature).
- The preheated SiC, graphite particles are added slowly into molten A7075while mixing with the help of stirrer (stirrer speed 300 rpm).
- After mixing of preheated ceramic particles into molten metal, pour the mixture into die.
- Eject the solidified cast from die after cooling in air.

Aluminum Alloy

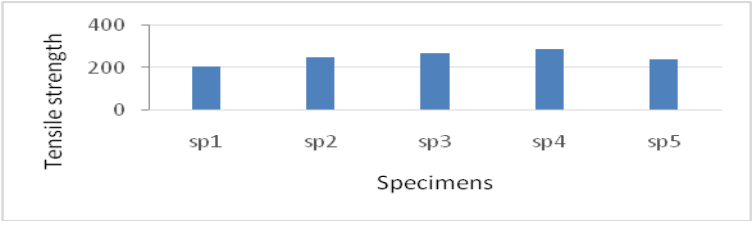
Samples	Composites
1	A7075+ 1 wt.% Graphite
2	A7075+1 wt.% Graphite+ 0.5 wt.% SiC
3	A7075+1 wt.% Graphite+ 1 wt.% SiC
4	A7075+1 wt.% Graphite+ 1.5 wt.% SiC
5	A7075+1 wt.% Graphite+ 2 wt.% SiC

III EXPERIMENT AND RESULT

Tensile test

ASTM E8 standard. The tensile strength values are mentioned in the table and stress-stain graphs are shown in fig Ultimate tensile strength of friction stir welded A7075 alloy and hybrid composites are plotted in graph. The highest tensile strength is observed in 1 wt. % Graphite and 0.5 wt. % of Sic reinforced composite which is 41% more than welted base A7075 alloy specimen, because of uniform distribution of the reinforcement particles and good bonding between matrix and reinforcement. In 1 and 1.5 wt. % SiC composites have more tensile strength compare to base alloy

Specimens	Tensile strength(mpa)
A7075+ 1 wt.% Graphite	205
A7075+1 wt.% Graphite+ 0.5 wt.% SiC	249
A7075+1 wt.% Graphite+ 1 wt.% Sic	272
A7075+1 wt.% Graphite+ 1.5 wt.% SiC	290
A7075+1 wt.% Graphite+ 2 wt.% SiC	240



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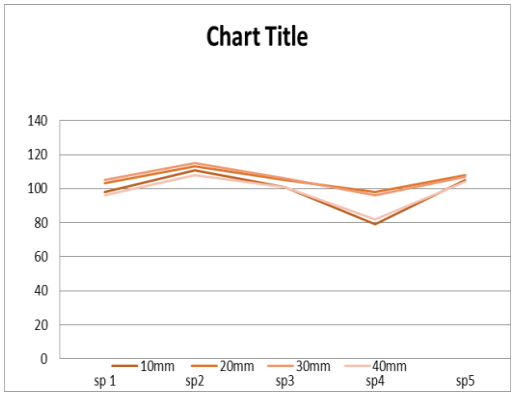
Hardness

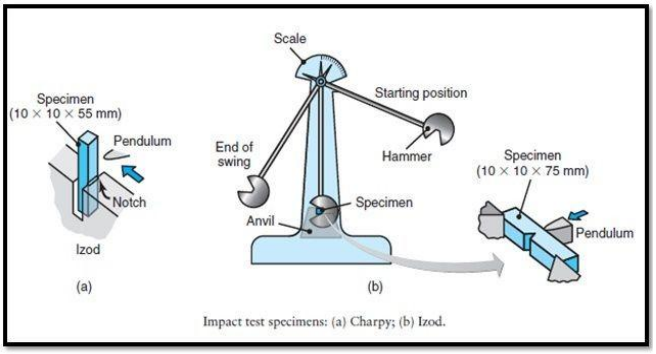
Hardness test is performed on A7075 alloy and A&075-SiC-graphite hybrid composite specimens according to ASTN E-10-08 and these results are the average number of three different places of impressions. These alloy and hardness values are at different distance 10 , 20 , 30, 40 mm on the specimens . The average hardness values of samples compared.

Specimens	Hardness
A7075+ 1 wt.% Graphite	100.5
A7075+1 wt.% Graphite+ 0.5 wt.% Sic	111.37
A7075+1 wt.% Graphite+ 1 wt.% Sic	103.25
A7075+1 wt.% Graphite+ 1.5 wt.% Sic	88.75
A7075+1 wt.% Graphite+ 2 wt.% Sic	106



Impact test

Impact test is used to find fracture toughness of a solid material toughness is the ability of a material to absorb the energy before fracture. Two methods are used to measure the toughness.



Impact test specimens: (a) Charpy; (b) Izod.

1. Charpy impact test
2. Izod impact test

Charpy impact test

Charpy impact test is performed as per ASTM E23 by using charpy impact tester. Specimens for the impact test are rectangular bars cut in dimensions of 10 mm width (b), 10 mm to thickness (d), and 55 mm length (L) Notches are cut in the samples at 30mm from any end. The test material is secured horizontally in place at both ends, and the striker hits the centre of the test material, behind a machined notch. The notch is positioned away from the striker, fastened in a pendulum.

When the swing pendulum strikes the composite specimen, the specimen absorbs energy until yielding. At this point, the specimen starts to undergo plastic deformation.

charpy test

Izod impact test

Izod impact test is performed as per ASTM E23 standard using an Izod impact tester. Specimens for the impact test are

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rectangular bars cut in dimensions of 10 mm width (b), and 10 mm thickness (d), and 75 mm length (L). Notches are cut in the samples at 25mm from any one end. The test material is fastened at a vertical position at the bottom, and the notch is facing the striker. Izod test setup; (a) Izod impact tester, (b) Positioning of Izod Specimen.
When the swing pendulum strikes the composite specimen, the specimen absorbs energy until yielding. At this point, the specimen starts to undergo plastic deformation. When the sample can no longer absorb more energy, fracture occurs
The sample is held in place at both ends in the test fixture. It is hit by the pendulum of the test equipment at the speed of 3.46 m/sec. Toughness and failure mode of each specimen are evaluated by visual examination of the fracture structure.

Izod test

Optical microstructure

Microstructure of A7075 alloy and A7075/Sic/graphite hybrid composites analyzed by using optical microscope.A7075 base alloy microstructure is shown in the grains are open and elongated due to no ceramic particles. it is observed that addition of ceramic particles graphite from 1wt% constant and 0.5wt%, 1wt%, 1.5wt%, 2wt%sic showing decrease in grain size, due to obstacle in dislocation movement and proper stirring speed.

Showing some agglomeration in composite, due to non-uniform distribution of particles. The fine grains help to improve the mechanical properties. According to Hall–Petch relationship, the grain size influences the mechanical properties of metallic materials.

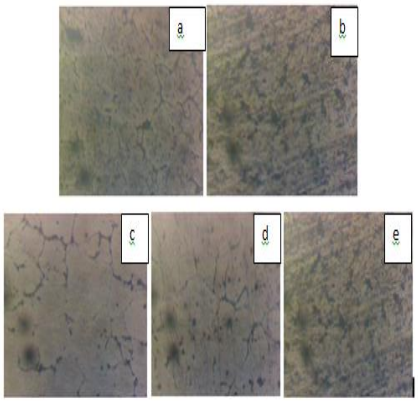

Fig Optical microstructure of (a) A7075+ 1 wt.% Graphite, (b)A7075+1 wt.% Graphite+ 0.5 wt.% Sic (c)A7075+1 wt.% Graphite+ 1 wt.% Sic (d) A7075+1 wt.% Graphite+ 1.5 wt.% Sic and (e)A7075+1 wt.% Graphite+ 2 wt.% Sic

IV.CONCLUSION

Composites were fabricated by traditional powder metallurgy and extrusion, microstructures, ageing behaviour and mechanical properties were studied in this work. The following conclusions can be made:

1. Different volume fractions of particulates could be introduced to 7075 aluminum matrix by traditional powder metallurgy technique.

2. The dispersion of the particulates in aluminum matrix was not homogeneous, most reinforcements dispersed along grain boundaries and clustering were formed and aggregation tends to increase with increasing particulates content.

3. Silicon carbide particulates did not change the aging kinetic and precipitates phases of 7075.

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