International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 6, Issue 5 (May 2017), PP.48-54

Synthesis And Characterization of Aluminum –Silicon-Fly Ash Composite By Stir Casting Method

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Abstract :- In this work aluminium 7075 as matrix and silicon carbide and fly ash as reinforcements has been used. The %wt of reinforcement are varied to study the difference in aluminium property. Following are the samples are aluminium 7075 as 100%, aluminium 7075 90% + 10% SiC, and aluminium 7075 90% + 10% fly ash. The materials are obtained by stir casting technique. During casting 300 grams of aluminium has been taken as sample 1. 270grams of aluminium has been taken with 30grams of SiC as sample 2. The third sample is the mixture of 270grams of aluminium with 30grams of fly ash. Then the materials are made in the form of cylindrical rod of 30mm diameter and max length of 70mm. The composites are analysed for the mechanical study and the results are obtained based on hardness and the work has been extended to study the micro structure of the specimen by SEM analysis and Chemical Conformation.

Keywords:- Al 7075 Alloy steel, SiC, Fly ash, Stir casting, Micro hardness testing, SEM analysis, Chemical conformation.

I. INTRODUCTION

The increasing need of materials is growing very rapidly in the industrial technology. The combination of good strength, hardness, stiffness, roughness and density is limited in convectional materials. Composites are used to overcome these shortcomings. The combination of two or more constituents at microscopic scale to form new material with different properties is composites. Achieving homogenous distribution of reinforcement is the major challenge faced during the Metal matrix composites (MMCs) process. The homogenous distribution has strong impact on quality and properties. Aluminium is the most promising material used in various fields and technologies. Due to the low weight and high strength it is used in variety of applications. Stir casting technology have attracted the attention and growing at very rapid rate as casting method in Metal matrix composites.

II. LITERATURE REVIEW

1. **Mohammad Hayajneh et al. [1]** studied the wear loss quantities of some aluminium-copper-silicon carbide composite materials. He observed that addition of silicon carbide will improve the wear resistance. Artificial neural network is a new type of information processing system. he potential of using neural network in prediction of wear loss quantities of some aluminium-copper-silicon carbide composite materials has been studied. The use of artificial neural network represents the new methodology in many different application of composite including prediction of tribological properties.
2. **Manoj Singla et al.[2]** studied about aluminium silicon carbide composite containing four different weight percentage is 5%, 10%, 20%, and 25% of silicon carbide which is fabricated by liquid metallurgy method. Dry sliding wear test was carried out on pin-on-disc apparatus at normal Loads of 5, 7, 9 and 11 kgf and at a constant sliding velocity of 1 m/s. It was also observed that wear rate varies linearly with normal load but lower in composites as compared to that in base material.
3. **Kenneth G. Budinski et al. [3]** studied about aluminium and its alloys in Engineering Materials. It has a face centred cubic structure as do as other metallic metals as copper, silver, Nickel, gold. The mechanical properties are one-third the weight of Steel, gold thermal and electrical conductivity, most alloys weldable, will not rust, can be die cast, non magnetic, non-toxic, good formability. Aluminium can be protected with the conventional plating and organic finishes that can be applied to those metals: Paints, Vitreous, enamels, organized etc

4. **Vishal Sharma et al. [4]** investigated the effect of Al-4.5 wt% CU/ Zircon sand/ silicon carbide hybrid composites by Stir casting route by controlling various casting parameters. The aluminium silicon carbide samples were observed under optical and scanning electron microscope. Micro structural observation of aluminium silicon carbide cast hybrid composites shows uniform distribution of reinforcement particle and the matrix. Micro hardness tester is employed to evaluate the interfacial bonding between the particles and the matrix by intending the micro hardness intender on the particle with the varying load (100 gram,200 gram, and 300 gram)and time (10 seconds ,15 seconds ,20 seconds and 25 seconds).It has been concluded that by the variation in the hardness at constant load varying or at constant time varying load, the bond strength can be compared.
5. **Shahin Soltani [5]** studied that Stir casting is an economical process for the fabrication of aluminum 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).
6. **Raghavendra N[1] and V S Ramamurthy[2] [6]** studied that Hybrid Metal Matrix Composite have been developed using stir casting process for improving the Wear Behavior at lower cost. The silicon carbide (SiC) as one of the reinforcement used with 3% weight fraction and Alumina (Al2O3) as the major reinforcement in 3%,6%,9% &12% weight fraction. Al- 7075 has been considered as the matrix material .The low cost stir casting process has been used for the development of the composite system. The Silicon carbide has been selected as the next ceramic which is a carbide type of ceramic. The SiC has good lubricating effect along with it reduces the noise and vibration during the relative motion
7. **Subramono et al [7]** studied that the wear resistance of aluminum/fly ash composite is reduced due to de-bonding and fracture of the fly ash particles. It shows that the density and strength of the composites slightly decreased with increasing content of fly ash particles. Whereas the hardness was slightly increased for the composites with fly ash up to 10%wt. It indicated that hardness, tensile strength, compression strength, resistance to dry wear, corrosion and impact increase with increasing fly ash content.
8. **D. Mohana Rao, Bapi Raju Bandam M.E [8]** studied that Among various discontinuous dispersoids used, fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. Hence, composites with fly ash as reinforcement are likely to overcome the cost barrier for wide spread applications in automotive and small engine applications. Cast aluminum matrix particle reinforced composites have higher specific strength, specific modulus and good wear resistance as compared to unreinforced alloys.
9. **Kesavulu A[1] , F.AnandRaju[2] , Dr. M.L.S.Deva Kumar[3] [9]** studied that Fly ash particles are used in metal matrix composites, are low costand low density are available in large quantities of waste by product in power plants. The adding of fly ash with aluminium reinforcement by using stir casting process it can reduces the cost and density of aluminium material. Metal composite processes are improved mechanical properties like strength, hardness, low density and good wear resistance compared to other metals. In this study,aluminium clad and fly ash chemical analysis is studied before and after mixing and forming as particulate metal matrix composite and comparing the mechanical, physical properties of the MMC at varying % of fly ash addition. By adding of commercially aluminium with fly ashis decreases the need of intensive energy-aluminium, by resulting in energy savings [3]. By mixing the aluminium fly ash composites by using stir casting process method,in stir casting process is mixing conventionally in directly furnace it will reduce the time for mixing the aluminium and fly ash.
10. **N.Banthia[a], J.Sheng[b] [10]** studied about the fracture, toughness of micro-fibre reinforced cement composites and said that all the elements present in the surface and mechanical properities on the surface of elements it can be either enlarged to the comfortability.

III. EXPERIMENTAL PROCEDURE

Experimental details and specification:

Casting	:	Stir casting electric furnace
Work material	:	Specimen 1-Base material: Aluminium7075
		Specimen 2- Aluminium-Silicon carbide
		Specimen 3- Aluminium-Fly ash
Rotar speed	:	400rpm
Temperature	:	850degree Celsius

- Stir casting process for fabrication of the composites
- Performing facing and turning of the fabricated composites

- Performing chemical conformation test for the fabrication
- Conducting micro hardness test for fabricated composites
- Performing SEM analysis on the fabricated composites
- Result and Discussions

Work Material

Aluminium 7075

The AL7075 alloy work piece material is chosen because of its wide use in aero dynamics and aerospace for ring gears, pinions, helical gears, bearing races, Arbors, bushes, camshafts, kingpins, ratchets, gears, splinted shafts etc. The work piece material (cylindrical rod) with dimensions of 30mm x 50mm was taken and it was machined in CNC turning center.

Reinforcement Materials

Silicon carbide

Silicon carbide material is chosen as reinforcement material because it is widely used in applications requiring high endurance, such as car brakes, car clutches and ceramic plates in bulletproof vests. Electronic applications of silicon carbide such as light-emitting diodes (LEDs) and detectors.

Fly ash

Fly ash material is chosen as reinforcement material because it is widely used for its low weight and density and increase the strength of the materials in which it is added.

Vickers Micro Hardness Test:

The Vickers test can be used for all metals and has one of the widest scales among hardness tests. The unit of hardness given by the test is known as the Vickers Pyramid Number (HV) or Diamond Pyramid Hardness (DPH).

Scanning Electron Microscope

A scanning electron microscope (SEM) is a type of electron microscope that produces images of a sample by scanning it with a focused beam of electrons. The electrons interact with atoms in the sample, producing various signals that contain information about the sample's surface topography and composition.

Material Specification

The following materials specification has been tabulated below:

- Aluminium
- Aluminium and silicon carbide composite
- Aluminium and fly ash composite.

Table: Aluminium specification

S.NO	HEIGHT	DIAMETER
1.	70mm	30mm

Table: Aluminium and silicon carbide specification

S.NO	HEIGHT	DIAMETER
1.	70mm	30mm

Table: Aluminium and fly ash specification

S.NO	HEIGHT	DIAMETER
1.	70mm	30mm

IV. RESULTS AND DISCUSSIONS

Results For The Chemical Conformation

Sample 1

Table: Chemical composition of Aluminium 7075(100%wt. of Al)

Element	**Al**	**Cr**	**Cu**	**Fe**	**Mg**	**Mn**	**Si**	**Ti**	**Zn**
Percentage Wt.%	90.03	0.199	1.2	0.38	2.13	0.04	0.04	0.08	5.73

Sample 2

Table: Chemical composition of Aluminium + Silicon Carbide (Al 90%+ 10%wt. of SiC)

Element	**Al**	**Cr**	**Cu**	**Fe**	**Mg**	**Mn**	**Si**	**Ti**	**Zn**	**Ni**	**Pb**
Percentage wt.%	87.3	0.17	2.21	0.45	2.43	0.04	0.08	0.04	7.09	.007	0.06

Sample 3

Table: Chemical composition of Aluminium + Flyash(Al 90% + Fly ash10%)

Element	**Al**	**Cr**	**Cu**	**Fe**	**Mg**	**Mn**	**Si**	**Ti**	**Zn**	**Ni**	**Pb**
Percentage wt.%	88.61	0.18	1.7	0.43	1.86	0.04	0.58	0.10	6.39	.007	0.01

V. RESULT FOR MICRO HARDNESS :

Table

Name Of The Samples	Percentage	Hardness Values In Hv 300gms		
		Trail 1	Trail 2	Trail 3
Aluminium7075	Al 100%	85	80	84
Aluminium+Silicon Carbide	Al 90%+ 10%Wt. Of Sic	125	121	126
Aluminium+Flyash	Al 90% + 10% Wt. Of Fly Ash	108	113	112

Result Of Scanning Electron Microscope

The samples were viewed under the electron microscope

Sample 1

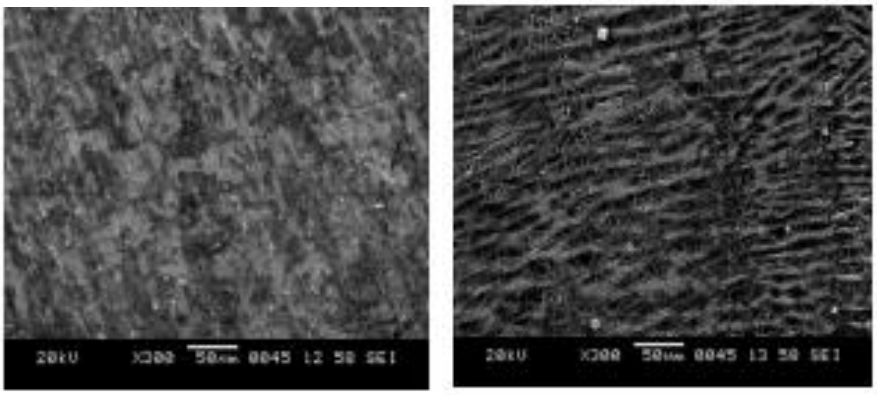

Fig aluminium 7075 magnification X200 and X300

Sample 2

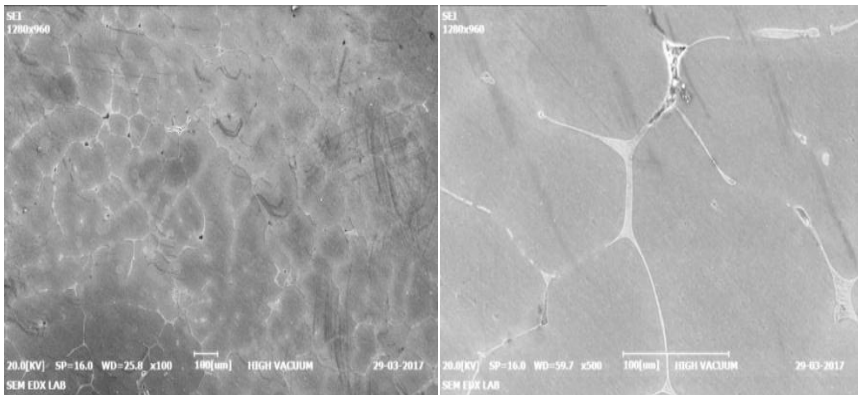

Fig Al 90%+ 10%wt. of SiC of magnification x100 and X500

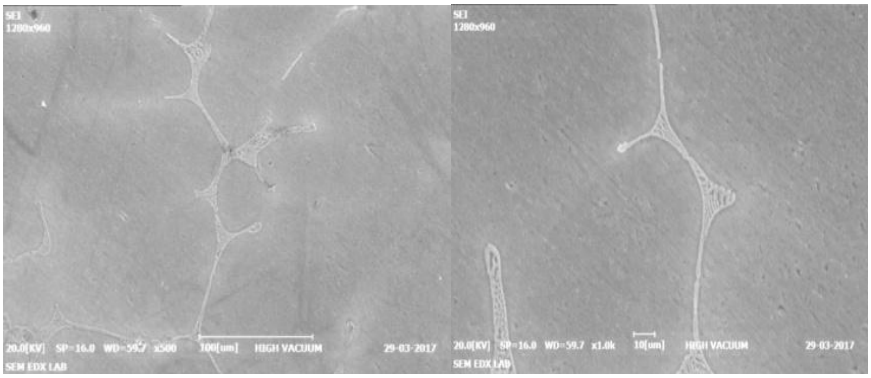

Fig Al 90%+ 10%wt. of SiC of magnification X500 and x1000

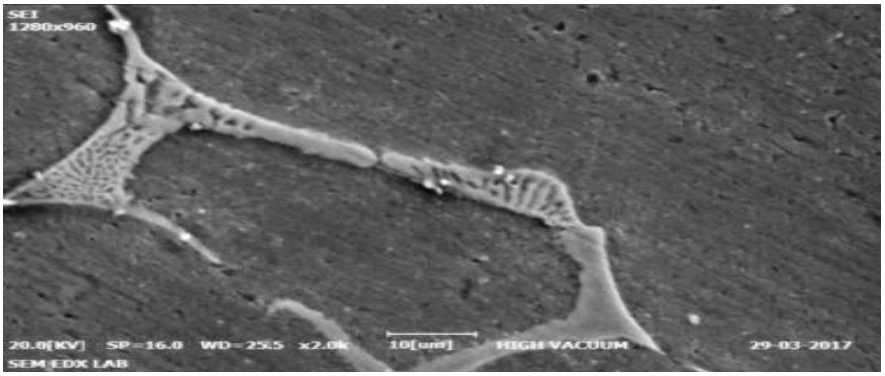

Fig Al 90%+ 10%wt. of SiC of magnification x2000

Sample 3

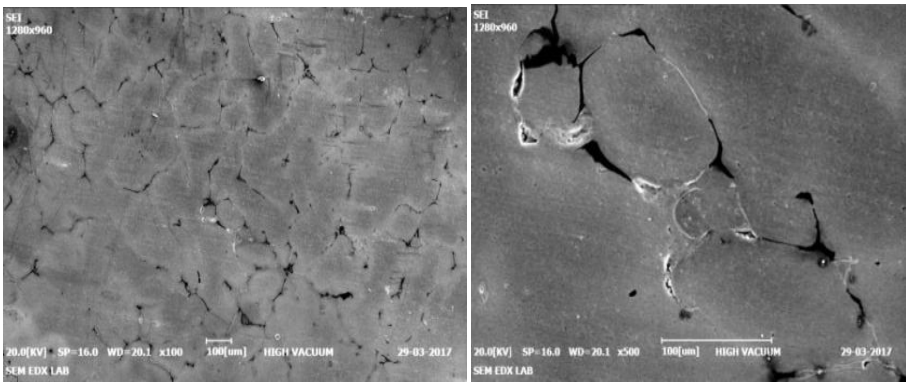

Fig Al 90% + 10% wt. of fly ash of magnification X100and X500

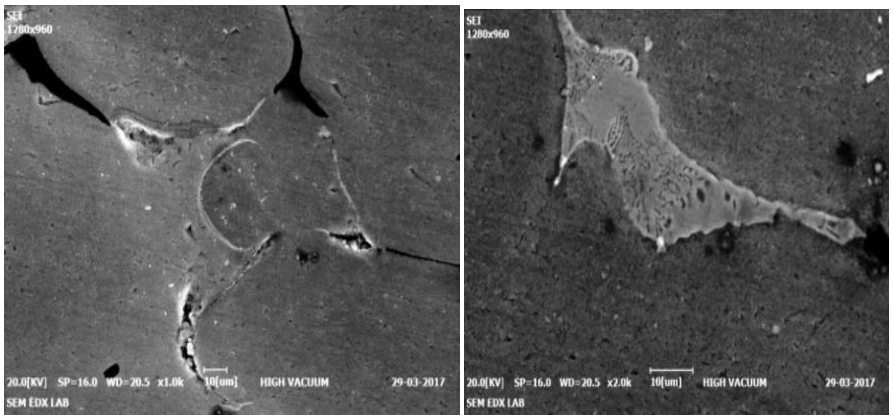

Fig Al 90% + 10% wt. of fly ash of magnification X1000 and X2000

V. CONCLUSION

1. Aluminium based hybrid metal Matrix composites have been successfully fabricated by Stir casting technique with fairly uniform distribution of silicon carbide and fly ash.
2. It is found that strength and hardness of the composite increases with increase in the composition of reinforcements.
3. The SEM test clearly reveals the dispersion of silicon carbide and fly ash.
4. THE MICRO Hardness Test Which Was Conducted in QV-1000DAT MICRO Hardness tester machine Was seems to be Increasing With increase in Composition.
5. The hardness of the composite with different composition increases with increase in percent of reinforcement. From this study hardness seems to be increased with increase in the percentage of reinforcements added.
6. During the comparative testing it is found that aluminium silicon carbide has achieved the higher hardness as compared to aluminium fly ash.

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