OPEN ACCESS

International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-3, September 2019

ALFA: Fly Ash - Aluminium Metal Matrix Composites for Light Weight Material

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Abstract: In the present work, properties such as wear rate, hardness, impact energy and microstructure of the Aluminum-fly ash composite synthesized by stir casting were investigated by varying the fly ash in the range of 5 and 15 by weight %. The phase identification and structural characterization was carried out on ALFA composites using SEM and EDAX tests and it was found that there was a uniform distribution of fly ash particles in the aluminum matrix phase. The hardness and the wear resistance increased and the impact energy decreased as the fly ash content in the ALFA composite was increased and it can be used as a light weight material for many engineering and non-engineering applications.

Keywords : MMC; Stir Casting; Wear; Electro Static Precipitator (ESP);SEM

I. INTRODUCTION

The main aim of this investigation is to analyze the effective utilization of fly ash in manufacturing metal matrix composites suitable for various industrial, engineering and non-engineering applications. These properties have led to the greater use of ALFA composites in manufacturing of crank shaft, gear, brake drum, jet fighter, electronic heat sink, etc.Lignite fly ash significantly increases the wear resistance and hardness of the matrix material. Because of these advantages, the present investigation makes an attempt in synthesizing Al – fly ash composites and analyzing its enhanced properties. Fly ash is an inevitable by-product of Lignite coal burning due to its high ash content. Large amount of ash is produced by all thermal power plants in India and the quantity reaches approximately 15 to 20 million tonnes / year.

Manuscript published on 30 September 2019
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II. MATERIALS AND METHODs

Fly ash used in this work was collected from the ESP of Mettur Thermal Power Plant station in Tamil Nadu. The chemical composition of fly ash mainly depends on the chemical composition of coal. However, the coal burning methods can change the fly ash content as shown in table 1.

Table 1. Substance structure of Fly ash (Wt %)

SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O	Loss on Ignition
59.04	30.02	8.75	2.46	1.0	1.01	0.99	1.89	2.23

Synthesis of ALFA composites

Synthesis of ALFA composites was carried out by stir casting technique. Circular rods (diameter – 25 mm, length – 100 mm) of pure aluminum were placed in the crucible and melted in an electric arc furnace. Then skimming was done mainly to remove oxides and other impurities.

Resistance test

Average of five readings was taken for each hardness value. The detention time for the hardness measurement was 20 seconds. The specimens with a diameter of 50 mm and a thickness of 10 mm were sectioned from the cylindrical cast bar and surface finished.

Impact test

The Izod impact testing machine with a test capacity of 160 joules was used to carry out the impact test with a notch depth of 2 mm and a notch angle of 45˚ were used in this work.

Microstructure Examination

Tests for metallographic perceptions were separated from the as cast non strengthened aluminum and fortified ALFA composite. Scratching of cleaned tests was additionally done utilizing Kellers reagent. Fig.1 shows Microstructure of ALFA.

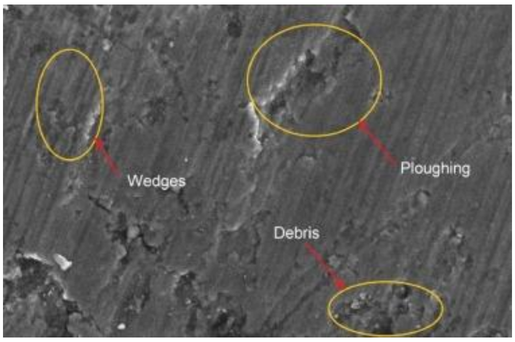

Fig.1 Microstructure of ALFA

III. RESULTS AND DISCUSSION

Mechanical properties of ALFA composites

Fig.2 shows the increasing trend in hardness of the pure Al and ALFA composites in as cast condition. It should be mentioned that all the samples shows enhanced hardness compared to that of pure Al. These elements can be attributed to the formation of complex phases which are hard and have a positive effect on their mechanical properties. These results are in good agreement with the results.

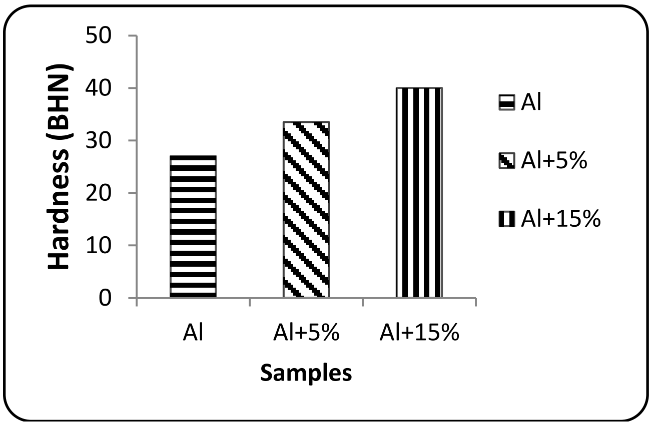

Fig.2 Hardness of Aluminum and various Composites

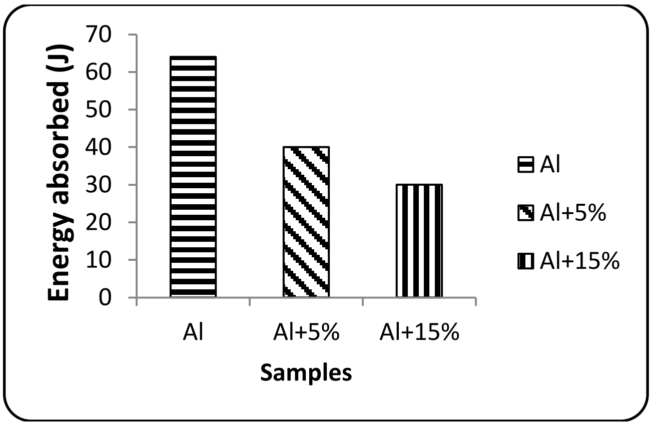

Fig.3 Impact energy absorbed by various composites

Fig 3 The impact energy decreased as the percentage of fly ash augmented in the matrix composite. The brittle nature of the reinforcing agent led to the reduction in the impact energy of the composite. Fig shows the variation of impact energy with fly ash addition. It has been observed that 5% fly ash reinforced composite has higher impact energy than the other reinforced composite samples.

IV. CONCLUSION

The conclusions drawn from the experimental work is summarized as follows:

A series of ALFA composites with 5 and 15% fly ash content were produced using stir casting method successfully. Pronounced increase in hardness value was observed by reinforcing the Al metal matrix with 5 and 15% fly ash content. The impact energy of nonreinforced metal is 64 J whereas it is found that the impact energy decreased as the fly ash content increased in ALFA composites.A predominant change in the wear resistance is observed in the sliding wear test. As pure aluminum is soft, its wear resistance is found to be a very low. From SEM analysis, it is concluded that wastage of fly ash in thermal power plants can be turned into an industrial wealth by the production of light weight composite materials such as ALFA which can be a suitable raw material for automobile, aircraft and many other non-engineering applications.

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Retrieval Number: C6884098319/2019©BEIESP
DOI:10.35940/ijrte.C6884.098319
Journal Website: www.ijrte.org

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