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PREPARATION AND CHARACTERIZATION OF ALUMINIUM METAL MATRIX COMPOSITE BY USING STIR CASTING TECHNIQUE

Rajasekar Thiyagarajan[1,*], Vignesh Ganesan[2], Milon Selvam Dennison[3], Nelson A.J.R[4]

[1]PG Scholar, Department of Mechanical Engineering, Karpagam Academy of Higher Education, Coimbatore-641021, INDIA
[2-4]Assisstant Professor, Department of Mechanical Engineering, Karpagam Academy of Higher Education, Coimbatore-641021, INDIA

Abstract: The present examination has been centered on the use of welding slag of electrode E6013 in a valuable way by scattering it into aluminium alloy Al6061 to produce a composite by stir casting technique. The mechanical property studied is the hardness of the produced composites. The experimental results showed significant changes in each composition. The hardness tend to increase when compared to the unreinforced Al6061.

Keywords: Aluminium alloy Al6061, welding electrode E6013, reinforcement, composite

1. Introduction

Metal matrix composites (MMC) are extensively used in numerous manufacturing sectors such as automotive, aerospace, electronics, marine and medical industries due to their enviable properties like high strength, low weight, high module, low ductility, high wear resistance, high thermal conductivity and low thermal expansion [1]. Metal matrix composites (MMC) have been getting universal concentration on account of their greater strength and stiffness in addition to high creep resistance and high wear resistance compared to their corresponding wrought alloys and are extensively used in manufacturing sectors [2]. Aluminium, magnesium alloys and titanium are frequently used as metal matrix and aluminium oxide (Al_2O_3), silicon carbide (SiC) and boron carbide (B_4C) are commonly used as fortification through the production of MMCs. In modern years, aluminium metal matrix composites have been used in variety of general and special applications owing to their superior specific strength, high temperature capability, specific stiffness, lower coefficient of thermal expansion, better wear resistance, enhanced dimensional stability and amenability to conventional metal forming techniques. The properties of aluminium composites essentially depend on the method adopted to process them. Normally, aluminium composites are processed through stir-casting owing to their simplicity and cost effectiveness [3-4]. Machinability of aluminium MMCs has received significant attention because of high tool wear connected with machining [5-13]. Many researchers and practitioners worked in the field of producing Aluminium Matrix Composites (AMC) due to its vital need to the manufacturing sectors, few are listed below;

Anilkumar et al. [14] have detailed that the mechanical properties of fly-ash debris fortified aluminium combination (Al 6061) composites tests handled by stir-casting route. Three arrangements of composites with fly-ash debris molecule sizes of 4-25, 45-50 and 75-100 µm have been utilized. It has been discovered that the rigidity, compressive quality and hardness of the aluminium combination (Al 6061) composites diminished with the expansion in molecule size of strengthened fly-ash. Increment in the weight portions of the fly-ash remains particles expanded a definitive rigidity, compressive quality, hardness and lessened the malleability of the composite.

Kumar et al. [15] prepared aluminium based (Al 6061) composites through silicon carbide and in addition fly-ash as fortifications by changing mass division of Al 6061 and fly-ash debris (9, 12, and 15%) and keeping up 9% silicon carbide consistently. They acquired superb enhancements in mechanical properties, for example, hardness, compression and tensile through ascent in wt % of fortification.

Behera et al. [16] manufactured LM6 aluminium alloy-oriented composites toughened with diverse weight portions of particulate silicon carbide using stir-cast method and observed the outcome of toughened percentages on forge ability. They reported the growth in weight portions of particulate reinforcement in the matrix metal to have enhanced the mechanical property such as hardness. It also caused poor forge ability.

Mahdavi and Akhlaghi [17] prepared Al6061/SiC/Gr hybrid composite having 20% volume of particulate silicon carbide and in addition 13% volume of uncoated particulate graphite utilizing in-situ process. It has been noticed that the amplified silicon carbibe particulate size and also graphite substance yielded in upgraded compressibility of powder blends and also declined hardness of the hybrid composites.

Jayashree et al. [18] looked into the impact of silicon carbide on mechanical and wear behavior of stir-cast aluminium MMCs. They detailed that mechanical and tribological properties of the composites enhanced with silicon carbide particles and prescribed the composites for a few applications like aviation, vehicle, space, submerged and transportation.

Admile et al. [19] have endeavored to give a broad writing survey on the general execution of fly-ash debris strengthened composites manufactured by stir-casting. They have checked on writing in every class as indicated by the key factors and gave a reasonable diagram of the use of fly-ash as a fortifying specialist in various aluminium combination lattices alongside its unmistakable execution.

From the literature survey, it becomes clear that the preparations of Al6061 based composites were prepared by many researchers but still, there remain some research gaps. So in this research work Al6061 is reinforced with welding slag of various compositions and its mechanical property hardness was investigated.

2. Materials and methods

Aluminium alloy 6061 is widely used in manufacturing industries due to its superior advantages such as strength, good toughness, good surface finish, excellent corrosion resistance to atmospheric conditions, good corrosion resistance to sea water, can be anodized, good weld ability and bras ability, good workability, widely availability. The chemical composition of Al6061 is given in Table 1 and the physical property is given in Table 2.

Table 1: Typical composition of aluminium alloy 6061

Component	Composition (wt.%)
Magnesium	0.8-1.2
Silicon	0.4 – 0.8
Iron	Max. 0.7
Copper	0.15-0.40
Zinc	Max. 0.25
Titanium	Max. 0.15
Manganese	Max. 0.15
Chromium	0.04-0.35
Aluminium	Rest

Table 2: Physical Properties

Property	Value
Density	2.7 g/cm^3
Melting point	580^{0}C
Modulus of elasticity	70-80GPa
Poisons ratio	0.33

3. Processing of Composites:

Welding slag powder of electrode E6013 is reinforced with Al6061, are processed by stir casting method. Liquid metallurgy route was used to produce the hybrid composite specimens. The matrix alloy Al6061 was first superheated above its melting temperature and the required quantities of E6013 is weighed accurately and fed into the furnace. Stirring was for carried at 650rpm about 50 seconds until the interface between the particle and the matrix promoted wetting and the particles were uniformly dispersed. The melt was solidified in a cast iron permanent mould to obtain flat plate samples. Thus three different compositions were cast as mentioned above by stir casting method. The stir casting setup used for the study and control panel for controlling the stirrer speed and the temperature is depicted in Figure 1.

Figure 1: Aluminium stir casting setup

4. Results and Discussion

The cast composites samples were machined to specified dimensions as per test standards and the hardness test was done.

4.1. Brinell Hardness Test

Brinell hardness test was employed on the cast samples following the test standard ASTM E10-14. Four samples were tested for each composition and mean value was taken as the brinell hardness text result. The results for hardness test are as follows;

Table 3: Brinell hardness number of the AMC

Sl. No.	Sample	Brinell Hardness (500kg load, 10mm ball)
1	Al 6061	95
2	Al 6061 +5% of Welding Slag	95.5
3	Al 6061 +7% of Welding Slag	96.2
4	Al 6061 +9% of Welding Slag	96.9

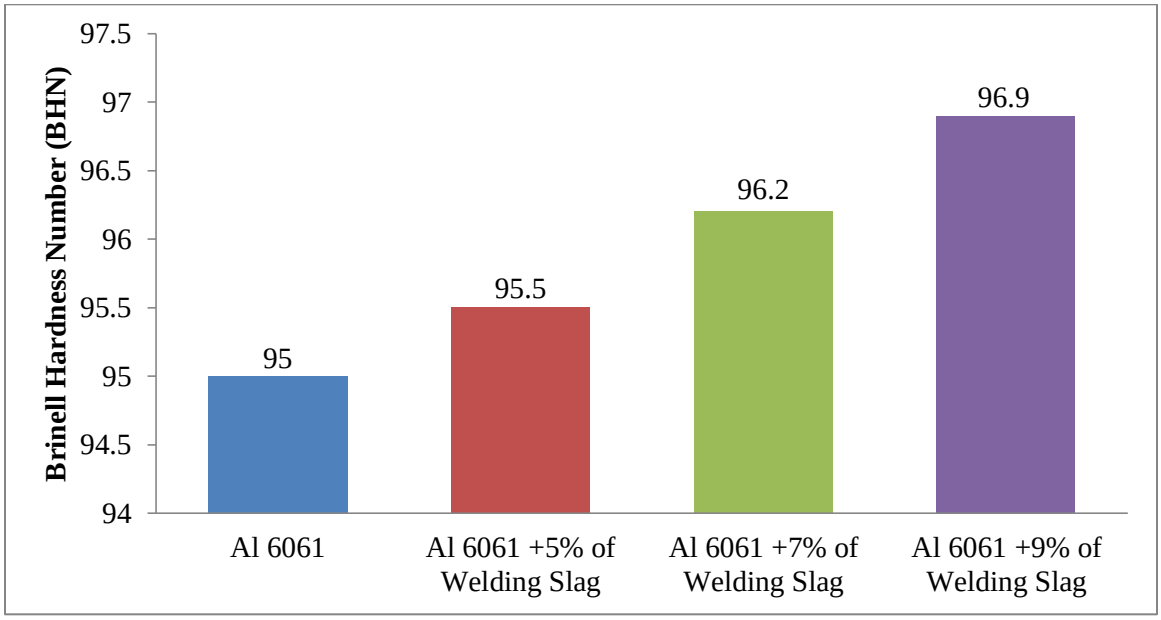

Figure 2: Variation of hardness results

5. Conclusion

This research work is concluded with the following key points:

i. The stir casting method used to prepare the composites could produce a uniform distribution of the reinforcement.
ii. The hardness increased with the increase in the weight fraction of reinforcement.
iii. Thus the fabricated reinforcement could be used in manufacturing sectors were more strength is required.

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