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Processing and Characterization of Aluminium Based Activated Carbon Composite Made By Enhanced Stir Die Casting Method

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ABSTRACT

Nowadays the usage of aluminium composites in automobile industries and aerospace industries has been increased because of good corrosion resistant, low density and excellent mechanical properties. This paper presents the experimental determination of composition presents, percentage of weight loss and the tensile property of the different combination of activated carbon based aluminium composites. The production of aluminium composites with different combination of activated carbon were 1%, 4%, 6%, 8% and 10% respectively. The composition of the samples is determined by X Ray Fluorescent Spectrograph (XRF) analysis, percentage of weight loss is determined by Thermo Gravimetric (TG) analysis and Tensile strength analysis is determined in Universal Testing Machine (UTM). The composites are fabricated in the stir casting furnace.

KEY WORDS: Activated Carbon, x ray Fluorescent Spectrograph, Thermo Gravimetric Analysis.

1. INTRODUCTION

In the recent periods of utilization of aluminium composites in aerospace industries are increased due to the lighter weight. Increasing demands of lighter weight materials for improving the efficiency of vehicles is the main reason for current research and development in aluminium composites.Some metals having the reduced specific gravity their mechanical properties like strength and modulus are high which provides the required strength with less weight, thereby reducing fuel burn and operating cost. One of the main tasks to be done in this work was to find out which material is apt for composite preparation. Since it is a metal matrix composite, we had many options to fill up the slots of matrix and reinforcement material. Again, the next task to be followed was composite preparation. In order to prepare the same, the kind of reinforcement and type of method that we intend to use were to be decided beforehand. Focussing onto the materials which contributed most to the aircraft industry and to the developments in metal matrix composites lead us to take up aluminium as our matrix material. Lot of researches are still going on with aluminium. Besides, the contributions of aluminium to our industry in the yesteryears also made a key point in selecting the same. To select reinforcement was a totally different task. For the same, we needed to know how to mix both materials and what kind reinforcement should be used. We decided to melt aluminium and mix reinforcement to it. Aluminium was taken in solid form .We took reinforcement in particulate form to suit the composite preparation technique. Reinforcement was nothing but activated carbon. Carbon, occupies a significant place in the world of composites. Activated carbon, produced by slight modification to carbon in which carbon will be in active form was taken. The activated carbon have some excellent properties like which exists in active form, highly porous, higher absorption rates, binds materials by vanderwaals force or London dispersion force, Higher adsorption rates, more reactive than carbon, Prevents corrosion and have an application in gas purification, gold purification, metal extraction, water purification, medicine, air filter etc.

This content talk about the previous studies and research has been carried out on activated carbons and aluminium composites for improving the mechanical properties. Bakshi (2010) was carried out and literature review of metal matrix composite based carbon nanotube. From the review they identified the processing techniques, strengthening mechanisms and the mechanical properties of different composites. Kuen (2012) has been investigated the synthesis, characterization, and hydrogenation behavior of Pd, Ti or Fe doped CAs, NaAlH4, and MgH2 Nano composites. Krolow (2013) was reviewed the different carbon Nano composites synthesis process and their characteristics analysis techniques. Unnikrishnan (2012) was made a research work in processing of aluminium based silver coated carbon nano tube composites by powder metallurgy process. Akilesh was investigated the carbon activated aluminium composite material in EDM machining. The casted work piece gave high strength to weight ratio than the aluminium alloy Al 7075 (T6) with 9% of activated carbon. These studies clearly identify the effect of the carbon contents in aluminium composites and applications on largely applied in many applications due to light weight.In this current work activated carbon based aluminium composite has been carried out and determining the composition and mechanical properties.

2. PRODUCTION METHODOLOGY

For production of the composites reinforcement particles used in aluminium composite is an activated carbon particle with the dimension of mesh 300. The mesh size was determined by a particle size analyser. The aluminium ingot is initially cut in to the required size and then it is placed in the crucible of stir casting furnace as shown in the Fig.1. The 300 mesh activated carbon particle is initially preheated before reinforced in the molten metal. The degassing tablet hexacloroethane is added in the molten metal for degassing the molten metal. In this molten metal the preheated activated carbon is added and stirred it with an rpm of 150 for 15 minutes and then it was poured in to the mould. Then cooling the casting by atmospheric air and separated from the mould. Totally five samples of composites were made with different compositions of carbon in it. The purpose of this attempt was to study which composition will have the best set of properties. The compositions of activated carbon were 1%, 4%, 6%, 8% and 10% respectively.

Fig.1.Furnace used for casting

Fig. 2 Addition of activated carbon particles in to the molten metal

Fig.3 Pouring of molten metal in to the mould

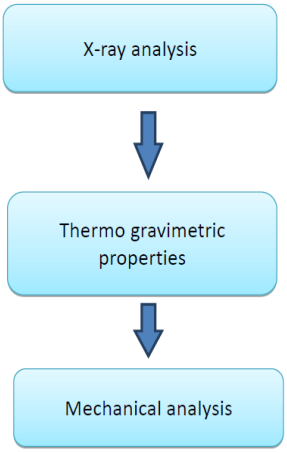

Fig.4.Sequence of Analysis

- By taking X-ray fluorescent spectrograph, to know how much carbon is present in each sample.
- Mechanical analysis was done to know the ultimate strength of the samples.
- Thermo gravimetric analysis was done to know the change in thermal properties of the samples with respect to change in temperature.

3. RESULTS AND DISCUSSION

3.1. X ray fluorescent Spectrograph: The composition presents in the fabricated samples were determined by using the analytical method of X-ray fluorescent spectrograph. It's a type of non-destructive technique to identify the composition. The presence of the composition is measured by the determination emitted radiation energies from the sample. Also the amount of composition present in the sample is determined by the corresponding intensities of the energies. The percentage of composition of elements present in the fabricated sample is tabulated as below.

Table.1.Percentage of composition

Samples	Sample Code	Composition %	
		Aluminium, Al	Carbon, C
A	Al-C 1%	98.4%	0.98%
B	Al-C 4%	94.9%	4.01%
C	Al-C 6%	92.7%	5.87%
D	Al-C 8%	90.78%	8.18%
E	Al-C 10%	89.1%	10.01%

According to the X-ray Fluorescent (XRF) Analysis the composites are having the composition of activated carbon as 0.98%, 4.01%, 5.87%, 8.18% and 10.01%.The compositions of aluminium for the different samples are 98.4%, 94.9%, 92.7%, 90.78% and 89.1%.

3.2. Thermo Gravimetric Analysis: The change in chemical and mechanical properties has been determined by increasing temperature of the material with heating at constant rate, or constant mass loss or time with constant temperature. The details such as decomposition, dehydration, oxidation or reduction, vaporization, 2nd order phase transition, desorption, sublimation and absorption could be provide by the thermo gravimetric analysis. The graph plotted for Differential Thermal Analysis (DTA) and Thermo Gravimetric Analysis (TGA) with respect to change in temperature is shown in the Figs. 5 to 9.

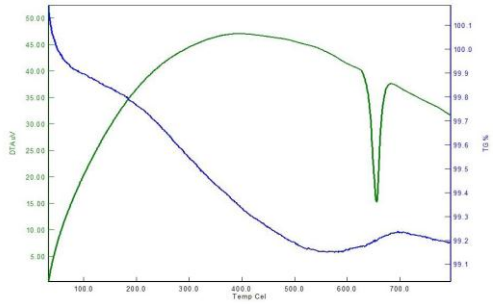

Fig.5.Thermogravimetric analysis curve for sample A (0.98% Carbon)

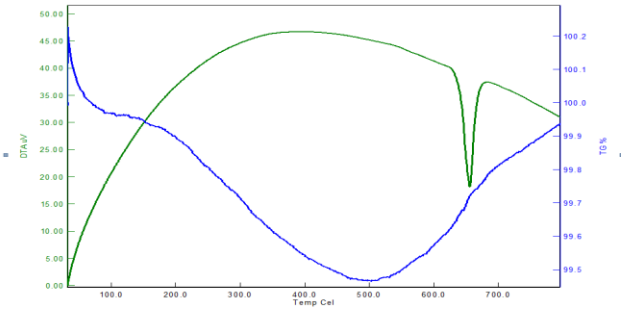

Fig.6.Thermogravimetric analysis curve for sample B (4.01% Carbon)

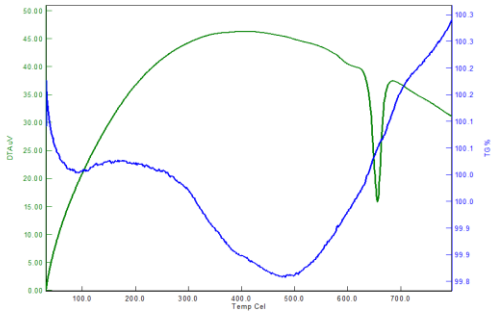

Fig.7.Thermogravimetric analysis curve for sample C (5.87% Carbon)

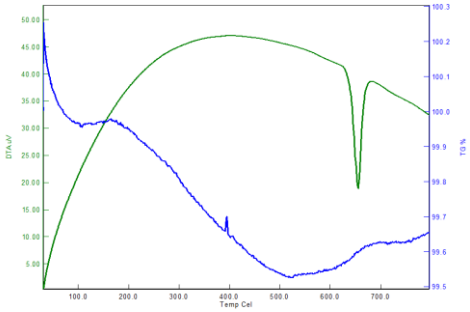

Fig.8.Thermogravimetric analysis curve for sample D (8.18% Carbon)

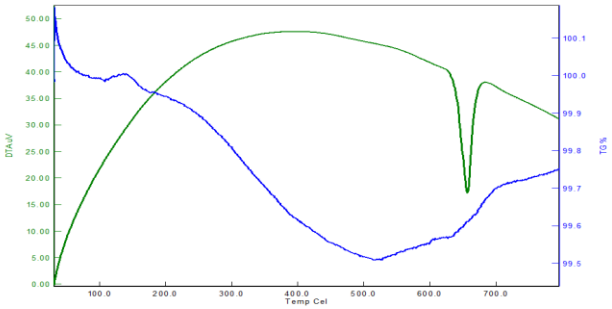

Fig.9.Thermogravimetric analysis curve for sample E (10.01% Carbon)

Table.2. Percentage of weight loss of the composites

Samples	Carbon (%)	% of Weight loss
A	0.98	0.99
B	4.01	0.5
C	5.87	0.15
D	8.18	0.46
E	10.01	0.4

Thermo gravimetric analysis has been conducted for all the five compositions. The result shows that the weight loss due to temperature variation is found to be 0.15% for composition with 5.87% carbon and this composition experiences minimum weight loss in comparison with other tested composition.

3.3. Tensile Property: For find out the maximum load withstand by the fabricated samples during tensile test has been carried out in universal testing machine. The specimens are machined as per the ASTM standard. The results obtained in tensile test is tabulated in the below Table 3.

Table.3.Tensile Properties

% of Carbon in Aluminium Composite	Original Length cm	Breaking Load KN	Change in Length cm	Elongation Cm
0.98%	10.1	15.4	11.4	1.3
4.01 %	10.1	17.5	11.5	1.4
5.87%	9.6	13.8	10.5	0.9
8 .18%	9.5	16.5	11	1.5
10 .01%	9.7	17	11.5	1.8

According to the ultimate strength analysis, the composite with 4.01% carbon withstands the maximum load of 17.5 KN. From this analysis it is obtained that the composite with 4.01% carbon composition shows the maximum strength among the other tested compositions.

4. CONCLUSION

Five different aluminium and activated carbon composite were synthesized with varying compositions of activated carbon content. The specimens have been subjected to XRF-x ray fluorescent Spectrograph for determining the actual composition of the composite. Thermo gravimetric and ultimate strength analysis were conducted to analyse the mechanical properties and to check the behaviour of the composite with variation in temperature. From the Thermo gravimetric analysis the composition with 5.87% carbon shows the minimum weight loss of 0.15% and from the ultimate strength analysis the composition with 4.01% carbon withstands the maximum load of 17.5KN.The best composition for the composite lies in between 4.01% and 5.87% carbon content. Optimization can be done between 4.01%and 5.87% to get the exact composition of high strength Aluminium- Activated Carbon composite.

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