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Synthesis of Carbon Fibers and Its Surface Area Mesurments

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ABSTRACT

Carbon fibre (CFs) are fibre about 5–10 Micrometres in diameter and composed mostly of carbon atoms. Carbon based materials such as graphenes, carbon black, carbon fibers (CFs), CNFs, carbon nanotubes (CNTs), carbon nanocoils, and carbon onions have attracted growing interest because of their low weight, small thickness, and high flexibility. Among various carbonaceous materials, CFs and their composites have been found to be fascinating candidates owing to their excellent mechanical and electrical properties, low cost, and wide availability as compared to CNTs and graphenes. Carbon fibres have several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high-temperature tolerance and low thermal expansion. In the present work, CFs is synthesized by using organic waste precursor obtained from plant fibre at 600^{o}C in inert atmosphere of Argon. The surface area analysis has done using Surface area analyzer instrument. Characterisation study of CFs was done with the help of SEM, FT-IR and XRD. The size observed in SEM for CFs is in the range of 1-2 µm.

Keywords: Carbon fibres, Plant Fibre precursor, Scanning Electron Microscope, FT-IR, XRD.

I. INTRODUCTION

The first known use of carbon fiber filaments is attributed to Thomas Edison in 1879 during his work on the incandescent light bulb through the baking of cotton threads or bamboo strips.

Over the past few years there have been very major improvements in the range of properties available in carbon fibres. Carbon fiber is increasingly being utilized as a reinforcing material due to its high strength and high modulus, which is imparted into the properties of the final composite. This is a result of advances in carbon-fibre technology.

Short discontinuous fibers are widely used to improve the tensile and bending performance of breakable materials, such as concrete and textile fibres.

Currently, PAN serves as the principal precursor (~96% of the carbon fiber market) material for carbon fiber production, although other precursors such as pitch and Rayon are also utilized.

Carbon fiber is a unique material to the extent that the material properties span a wide range of thermo-physical properties as well as series of outstanding properties of high strength, high modulus, high temperature resistance, corrosion resistance, fatigue resistance, creep resistance, light weight, and electric conduction that can be tailored to the desired application, allowing for a vast range of material properties.

Carbon fiber composites are currently utilized in the aerospace, athletics, automotive, construction, marine, and wind energy sectors, among others.

Carbon fibers in particular have garnered much attention. Compared to the unreinforced materials, material composites containing carbon fibers with lengths on the order of millimeters to one micro meter have shown superior tensile strength, flexural strength and flexural toughness.

As part of the continued push for improvements in specific strength and modulus, low-density electrical conductivity, and thermal conductivity, carbon fibers are being developed which possess a hollow structure. By increasing the final heat treatment temperature of carbon fibers, increases in tensile modulus, electrical

conductivity, and thermal conductivity can be achieved. This is due to the increasing structural order in the fiber as the carbonization temperature is increased.

Xie *et al*. also reported that the longer fibers in the non-conductive matrix were more effective to conduct electricity than shorter ones. Thus, the dosage of fibers could be minimized to achieve a certain conductivity value.

Chung compared the effectiveness of various electrically conductive components, including steel fibers, steel dust, carbon fibers, carbon nanofiber, coke powder and graphite, on the electrical conductivity of cement-based materials. It was found that steel fiber with 8 µm diameter was the most effective conductive filler for lowering the electrical resistivity.

In respect to carbon-based materials, carbon fiber with 15 µm diameter was more effective than carbon nanofiber, coke powder or graphite powder in improving the electrical conductivity. In the present work CFs is synthesized by using organic waste precursor obtained from plant fibre and its characterisation study was done with the help of SEM, FT-IR, XRD and surface area analysis.

II. METHODS AND MATERIAL

Synthesis of CFs by using organic waste precursor i.e Corn Hair was collected from market of kalyan. Then sample of Corn Hair 1st wash with distilled water to remove water soluble impurity like dust and other ingredient and pesticide. Then sample was dried in oven at 120^0C to remove the water and sample shocked in 10% KOH solution for 6 Hours. After 6 Hours sample was washed with distilled water till neutral pH and again dried in oven at 1200C to remove the water. Finally sample was calcinated / pyrolysis at 600^0C at inert atmosphere for 2h in CVD furnace.

Synthesized black particle i.e. CFs was collected and dipped into 1:1 HCl to remove the organic physical impurity and metal present in Corn hair after that sample was sonicated in 1:1 HCl solution for 30 minutes residue was filter through what man paper of No. 41 and dry in air. Dried sample wash with distilled water and again dried in Oven at 120^0C.

III. CHARACTERIZATIONS

1. FT-IR Analysis:

2 milligram of CFs was mixed with 200 mg of potassium bromide (KBr) (FTIR grade) and pressed into a pellet. The sample pellet was placed into the sample holder and FTIR spectra were recorded in FTIR spectroscopy. To validate again the nature of the synthesized CFs and their purity Fourier Transform Infrared spectroscopy (FTIR) (Jasco) studies were performed. Reports the typical FTIR spectrum of the pressed powder in the spectral range of 400-4000 cm^{-1} are shown in figure 1.

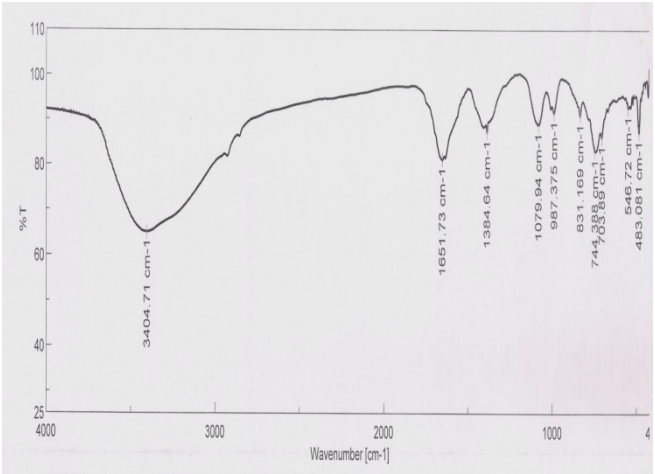

Figure 1. FT-IR Spectra of CFs

2. XRD Analysis:

X-ray diffraction (XRD) analysis (MiniFlex) with Cu-Ka radiation (k = 1.54178 Å) with 40 kV, 15 mA and Scan speed of Duration time 04.00 deg./minutes was used to examine the crystalline structure of the products. Fig.2 XRD patterns of prepared CFs powders.

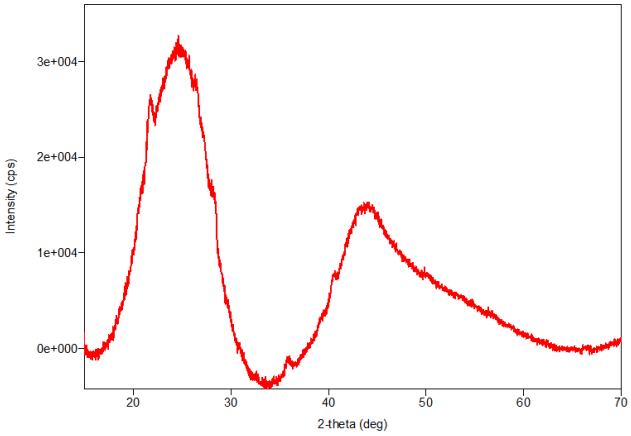

Figure 2. XRD Spectra of CFs

3. SEM Analysis :

Fig. 3 shows the SEM image of CFs. The SEM image was taken at X 25,000 magnification. These

pictures confirm the formation of CFs having diameter of 1-2 µm.

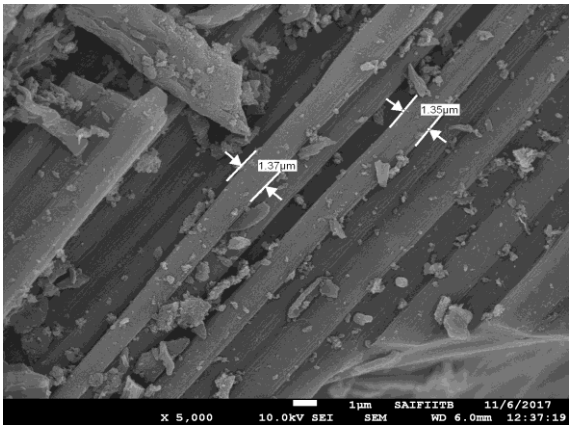

Figure 3. SEM image of CFs

4. Surface area analyser:

Sample exposed to Nitrogen gas at liquid Nitrogen temperature adsorbs Nitrogen and forms a single molecular layer of Nitrogen on the surface of the powder. Surface area can be calculated by measuring the volume of Nitrogen adsorbed using a modified single point BET equation based on theory by Brunauer, Emmet and Teller and using formula:

$$\text{Surface Area} = \frac{4.38\ x\ 273\ x\ 1-\frac{P}{P_0}}{273+Room\ Temp.}\ X\ \frac{Desorption\ Count}{Injection\ Count}\ X\ \frac{Injection\ Volume}{Sample\ Weight}$$

Sample is first regenerated to remove the adsorbed gases & moisture from the surface. Mixture of Helium gas (70%) and Nitrogen gas (30%) is passed over the sample in the tube. Sample is then dipped in liquid Nitrogen. Sample powder adsorbs Nitrogen on the surface at liquid Nitrogen temperature. After confirming that adsorption is over, sample tube is dipped in the water. This leads to desorption of adsorbed Nitrogen from sample, which is quantitatively determined using a Thermal Conductivity Detector coupled with an in-built Electronic Integrator and surface area was found to be 48.69 m^2gm^{-1}.

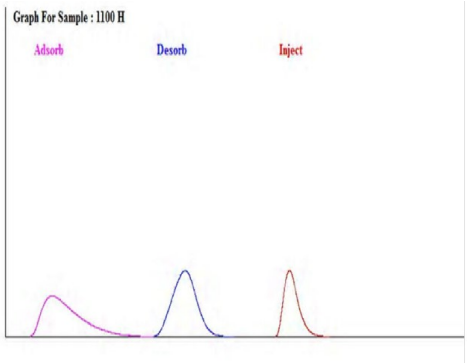

Figure 4. adsorption and desorption graph of CFs

IV. RESULTS AND DISCUSSION

Several approaches have been employed to obtain a uniform size synthesis of CFs Such as chemical and thermal methods. The development of easy, reliable and eco-friendly methods helps to increase interest in the synthesis. In this work CFs was synthesized using corn hair at 600°C in argon atmosphere. FT-IR analysis show that synthesized CFs have C-C and C=C strecghing witch was indicated by peak at 1651 and 1384 cm^{-1},703,831,987 cm^{-1} also indicate the C-C binding straching in finger print region and peak at 3404 cm^{-1} indicate that presesnce of amine ((NH_2) group on the smoth surface of CFs. In XRD Spectra peaks at 25.6° belong to carbon crystallographic structure of the carbon fibers.

SEM analysis show that The average diameters of the CFs were measured and found to be approximately in between 1-2 µm having smooth surface on fibre was observed.

V. CONCLUSION

In conclusion, Carbon fibers were prepared From organic waste precursor i.e. Corn hair by optimizing the temperature of pyrolysis to carbonisation of organic content at inert atmosphere to obtain uniform size of CFs. The average diameters of the CFs were measured and found to be approximately in between 1-2 µm.it also show that matrix residue of the surface of CFs was completely removed, and a smooth fiber surface was observed. Synthesed CFs has high-temperature tolerance and low thermal expansion because of that it can be used in athletics, automotive, construction industries.

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