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Synthesis of Carbon Nanoparticles using *Borassus flabellifer*

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ABSTRACT

Carbon plays an important role in the development of nanoscience and nanotechnology because of its unique properties. Carbon is a cheap and abundant natural source, which is used for the synthesis of multi-walled carbon nanotubes. Bio-synthesis from the wastes of *Borassus flabellifer* as a carbon source has an advantage over other syntheses, owing to its simple, eco-friendly and low-cost nature. The prepared sample was characterized by X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDAX. The carbon nanoparticles have many applications such as cancer treatment, medical sensors and environmental pollutant detecting sensors.

Keywords: Carbon nanoparticle; *Borassus flabellifer*; Bio-synthesis; Medical sensors.

1. INTRODUCTION

Nanotechnology, as defined by size, is naturally very broad including fields of science as different as surface science, organic chemistry, molecular biology, semiconductor physics, microfabrication and molecular engineering (Albrecht *et al.* 2006). Until 1985, it was generally believed that solid elemental carbon occurs in two different crystalline phases: diamond and graphite. Nanostructured carbon materials have attracted tremendous attention due to their unique structures and superior properties (Taniguchi, 1974). Carbon nanoparticles (CNPs) are of great interest for both fundamental studies and practical applications. CNPs have been widely used in supercapacitors. They are used as high-performance electrode materials in batteries and they are excellent photoluminescent materials. The synthesis of carbon nanoparticles emerges as a safer and best alternative to conventional methods. The present work exhibits the synthesis of CNPs using *Borassus Flabellifer* by Bio-synthesis method. The carbon nanoparticles with *Borassus flabellifer* is being explored widely for use in cancer treatment (Gonzales and Noguezm, 2007).

2. MATERIALS AND METHODS

Borassus flabellifer was collected in and around Erode district, Tamil Nadu, India.

2.1 Preparation of Carbon Nanoparticles

First, the collected seeds were cleaned with water and then the seeds were dried for 15 minutes. Then castor oil was applied to the inner and outer surfaces of the seeds. Then the seeds were burnt using a candle with a steel plate placed over the seeds to collect the particles coming out of the flame.

Fig. 1: Palm seeds

The process is continued until the black fumes get completely stacked in the vicinity of the steel plate. The black masses so obtained were grained to powder using mortar. The dried powders were collected and characterized by X-Ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray Spectroscopy (EDAX).

Fig. 2: Carbon nanopowder

3. RESULT AND DISCUSSION

3.1 FT-IR Analysis

FTIR spectrum of synthesized CNPs from *Borassus flabellifer* by Bio-synthesis method is shown in Fig. 3. FTIR analysis was employed to identify the functional group present in the material. The peaks observed at 3455.62 cm^{-1} and 2926.14 cm^{-1} corresponded to the O-H stretching. The peak at 1735.04 cm^{-1} represented the C-H bending. The peak observed at 1635.71-1561.44 cm^{-1} corresponded to C=C stretching and the peak at 1041.61 cm^{-1} represented C-O stretching.

3.2 XRD Analysis

The crystallographic analysis was carried out by XRD. The XRD spectrum of prepared CNPs is shown in Fig. 4. The sharp peak revealed that the prepared carbon powder is crystalline in nature. The crystallite size of the prepared carbon nanoparticles was calculated using Debye-Scherrer formula,

$$D = (K\lambda/\beta\cos\theta) \quad \text{.....(1)}$$

where,

D = crystallite size in nm,

K= proportionality constant approximately equal to unity and

θ= angle of diffraction in degrees.

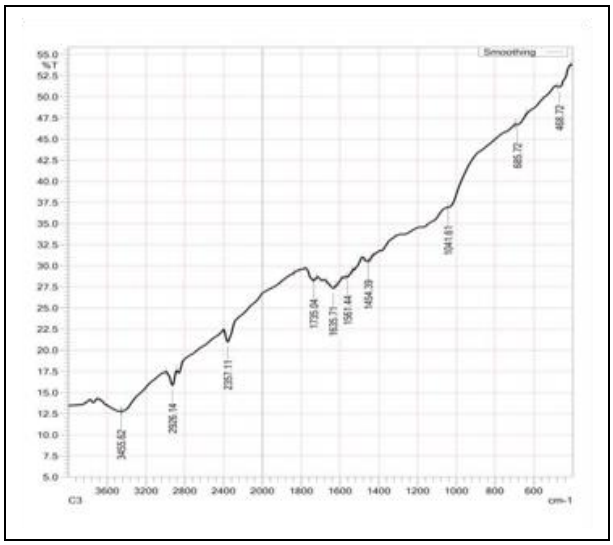

Fig. 3: FTIR spectrum of CNPs

Table 1. FTIR assignments of CNPs

S. No.	Wavelength in cm^{-1}	Assignments
1	3455.62	O-H stretching
2	2926.14	O-H stretching
3	1735.04	C-H bending
4	1635.71-1561.44	C=C stretching
5	1041.61	C-O stretching

Table 2. Structural analysis of the prepared CNPs

2θ (deg)	FWHM (deg)	D (A^0)	Crystallite size (nm)	Average crystallite size (d) (nm)	Micro-strain (x 10^{-3} m)	Dislocation Density (x 10^{15} m)
19.3000	13.1556	4.5952	0.6039		9.7640	0.00274
				1.2477		
16.7000	4.2000	5.3043	1.8916		7.2061	0.02794

3.2.1 Micro-strain

The micro-strain can be calculated from the following equation:

$$E_{Strain} = \beta/4tan\theta \quad .....(2)$$

where, β - full width half maximum of the peak in radians, θ - diffracted angle of X-ray pattern in degrees. The structural analysis of the prepared CNPs were listed in Table 2.

3.2.2 Dislocation Density

The dislocation density can be calculated using the formula,

$$\delta = 1/D^2 \quad .....(3)$$

where, D is the crystallite size of the sample in nm.

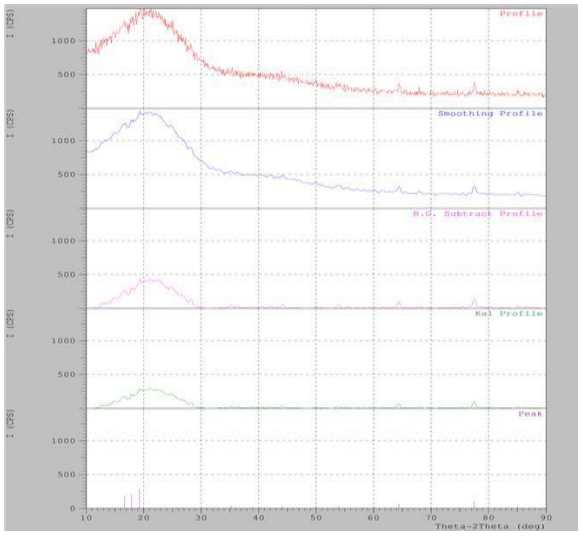

Fig. 4: XRD spectra of CNPs

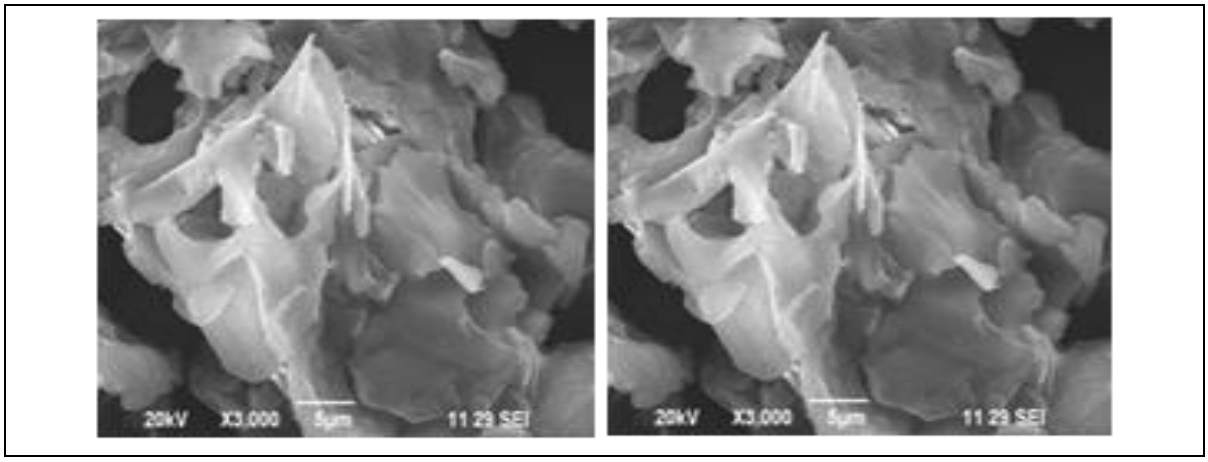

Fig. 5: SEM images of CNPs

3.3 Scanning Electron Microscopy

The SEM images of the prepared CNPs for different resolutions are shown in Fig. 5 revealed the morphology of the prepared sample of the synthesized CNPs. Well-dispersed jelly-like crystalline structure was observed.

3.4 Energy Dispersive X-Ray Spectroscopy

Fig. 6 exhibits the elemental composition of CNPs. The spectra reveal the presence of C and O. EDAX analysis revealed that the synthesized sample has pure CNPs.

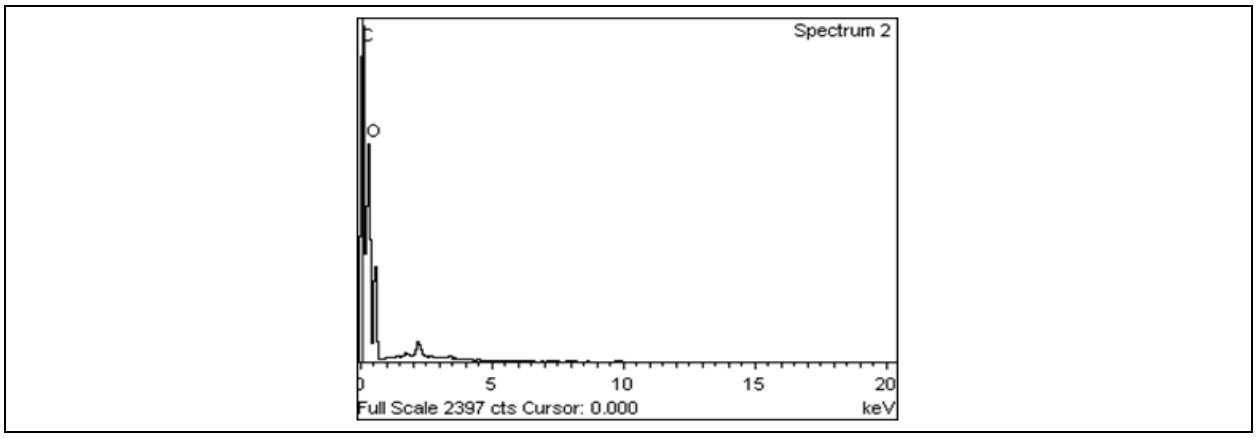

Fig 6: EDAX spectrum

4. CONCLUSION

Carbon nanoparticles were successfully prepared by Bio-synthesis method using *Borassus flabellifer* seeds and castor oil. The straight line and sharp peaks in the XRD spectrum have revealed that the synthesized carbon nanoparticles were crystalline in nature. The FTIR spectrum has confirmed the presence of C-O stretching and C=C stretching. The SEM image has revealed the morphology of prepared CNPs, depicting the jelly crystalline structure well-dispersed in an aqueous solution with a uniform size. The EDAX analysis has exhibited the elemental composition of CNPs, revealing the presence of C and O. The prepared CNPs can be used to develop high-capacity lithium-sulfur batteries.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

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