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Synthesis and Characterization of Carbon Nanofibres from Luffa Fibres (*Luffa cylindrica*)

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Short Communication

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ABSTRACT

Nowadays, with increase in the awareness towards green chemistry, leads to the synthesis of nanomaterials using a simple green cheap and eco-friendly technique. Natural or nature-based sources act as a versatile basis for the synthesis of nanomaterials. In this paper carbon nanofibres have been synthesized from *Luffa cylindrica*. The obtained materials were characterized with optical microscopy studies, Transmission Electron Microscopy (TEM), Higher Resolution Transmission Electron Microscopy (HR-TEM), Selected Area Electron Diffraction (SAED). The compound also shows prolonged antimicrobial efficacy and is found to be effective against microbes isolated from epidermal region of the skin.

DESCRIPTION

Atoms are the building blocks of manufactured products and the properties of these synthesized products mainly depend on their size and arrangement of atoms at a very minute scale. Nanotechnology is an emerging field that includes almost all disciplines of science and engineering playing a crucial role in many key technological advances of this modern millennium [1].

It refers broadly to a field of applied science and technology whose unifying theme is the control of arrangement of particles of matter on the nanometre scale regime and the fabrication of devices within that size range [2]. Nanomaterials became important for their unique material properties and applications, which largely depend on the size, distribution and morphology. They possess completely different properties than their bulk counterpart.

This change in properties is due to large surface area relative to volume ratio in nano scale [3-6]. Nanomaterials have many applications starting from pharmaceuticals to electronic gadget making. Generally various chemical and physical methods have been employed for the synthesis of nanoparticles. Nanomaterials are generally found in many shapes like nanowhiskers, nanoflakes, nanotubes, nanofibers etc.

This present work, documents the study of carbon nanofibers obtained from *Luffa cylindrica*, by calcination in a muffle furnace maintaining the temperature at 600˚C for about 2 hours, where pyrolysis takes place in a limited supply of air.

The raw materials used for the synthesis are the dried luffa fibres, collected from luffa trees in cachar district. The synthetic strategy adopted for the synthesis of carbon nanofibers from dried *Luffa cylindrica* are as follows.

Synthesis of the material

Approx. 2.2252 g of dry *Luffa cylindrica* were calcined in muffle furnace at 600˚C for two hours. The carbon and other volatile oxidizable material volatilizes under this condition. The black ash left after was taken out and analysed as obtained. The yield was recorded to be 0.4422 g (19.87%).

Characterisation of the materials

The obtained materials were characterized with optical microscopy studies, Transmission Electron Microscopy (TEM), Higher Resolution Transmission Electron Microscopy (HR-TEM), Selected Area Electron Diffraction (SAED).

Measurements

Optical microscopy was carried out using olympus optical microscope at central instrumentation laboratory, S. S. college, hailakandi. Transmission electron micrographs were obtained on a JEOL, JEM-2100, 200 kV, Transmission Electron Microscope (TEM) at saif, nehu, shillong. The antimicrobial analysis was carried out by disc diffusion method using agar nutrient media at Institutional Bio-tech. hub, g.c. college, silchar.

The synthesized materials were black and found to be stable in air for months. The yields of the synthesized carbon nanomaterials were recorded to be 19.87%.

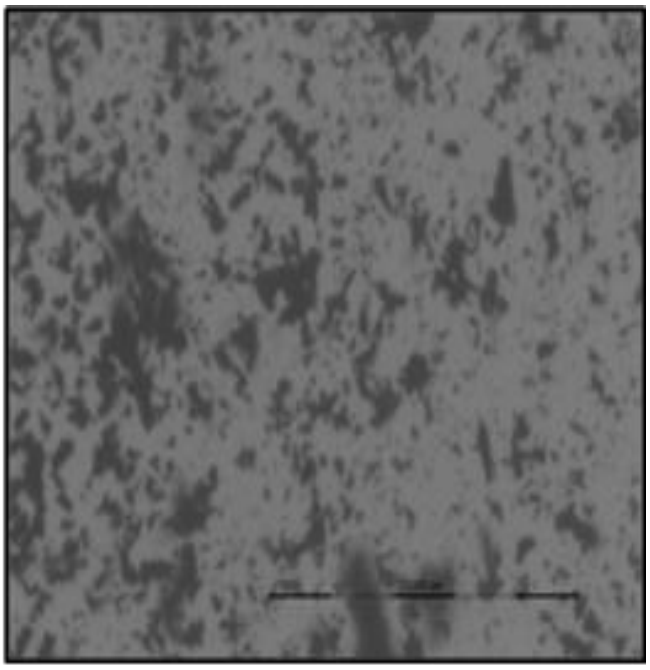
Morphology studies

The morphology of the synthesized materials was investigated through optical microscopy and transmission electron microscopy.

Optical microscopy

The optical microscopic images of synthesized nanomaterials exhibited the presence of fibres as shown in Figure 1.

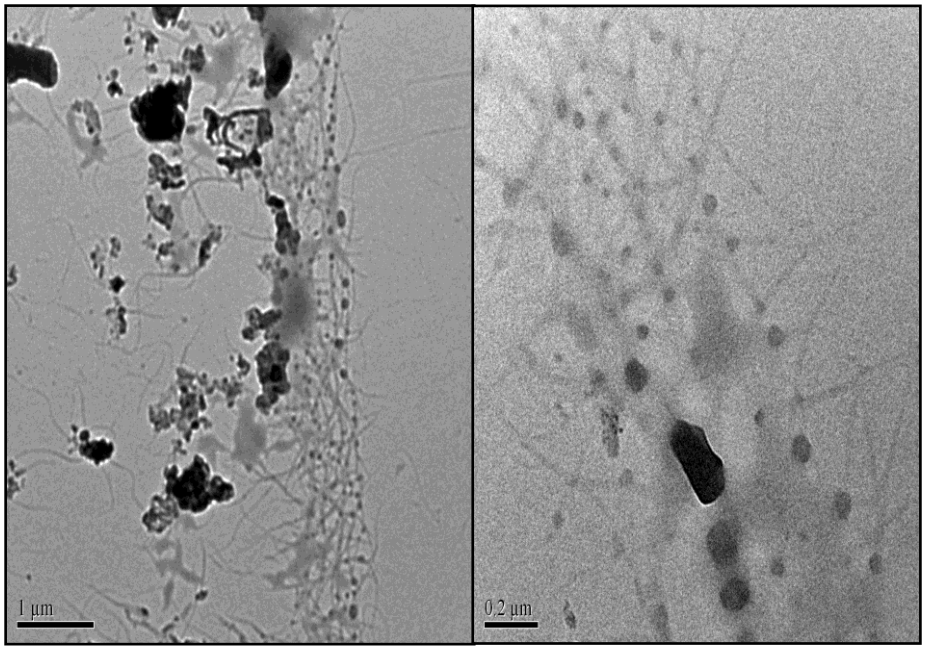
Figure 1. Optical microscope image of luffa fibre.



Transmission electron microscopy

The TEM images characterized the materials as nanofibres. The diameter of the fibre was found to be 50 nm and the length was found to be more than 5 µm as shown in Figure 2.

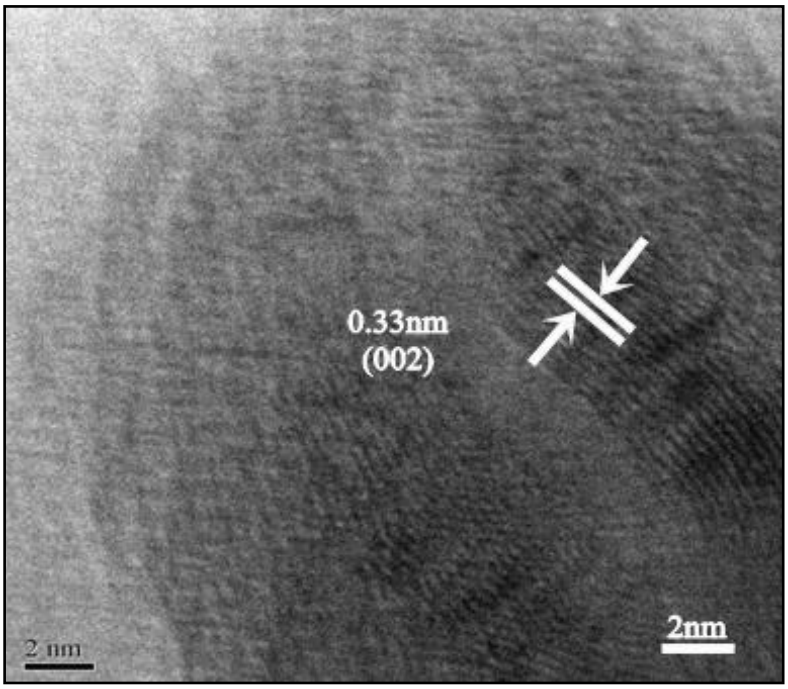
Figure 2. Transmission electron microscopy images of luffa fibre.



From HRTEM

The interlayer spacing is calculated to be 0.33 nm which is characteristic of (002) plane of graphitic carbon as shown in Figure 3.

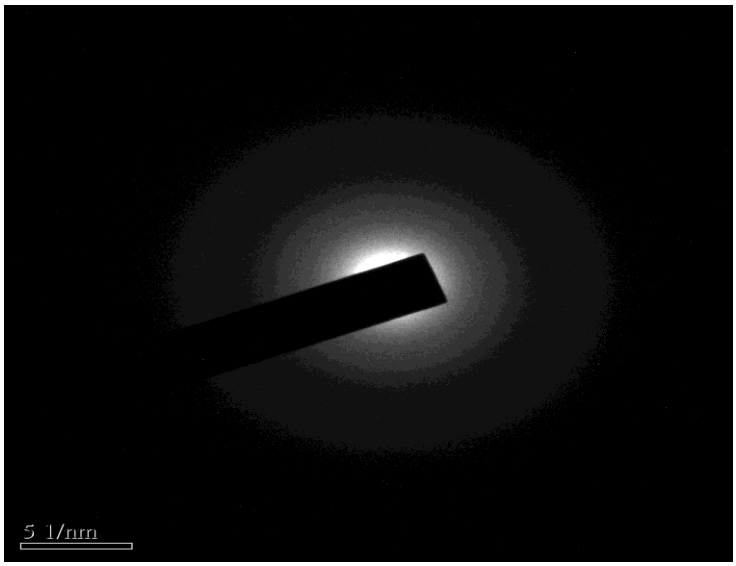
Figure 3. High resolution-TEM image of Luffa fibre.



The SAED pattern

Showed concentric rings that confirms graphitic carbon as well as the polycrystalline nature of the material as shown in Figure 4.

Figure 4. Selected area electron diffraction (SAED) image of luffa fibre.

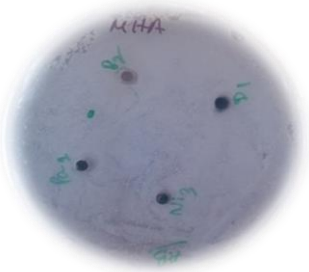


Antimicrobial activity

To evaluate the effectiveness of synthesized nanoparticles/nanofibres on bacteria isolated from neck. The microbes were first streaked on nutrient agar media and were further sub-cultured to recover in pure form as shown in Figure 5. Pure cultures (in broth) were spread plated on mueller hinton agar. Most of the isolates were

gram negative which may belong to *Staphylococcus sp.*, *Streptococcus sp.*, *E. coli* etc. Here zone of inhibition is found to be 10 mm.

Figure 5. Petri plate showing the inhibition zone of the material marked as P_2.



CONCLUSION

Thus carbon nanofibres have been conveniently synthesized using simple and low cost technique from nature based abundant source which gives a scope to researcher for synthesizing materials in nano dimension from other natural based sources. The synthesized material was in nano range, which is revealed from its morphological studies. The TEM images revealed the presence of carbon nanofibres of diameter of 50 nm and the length is found to be more than 5 μm. From high resolution TEM, the interlayer spacing is calculated to be 0.33 nm. The SAED pattern showed concentric rings that confirms graphitic carbon as well as the polycrystalline nature of the material. The materials also exhibit good antimicrobial activity and the zone of inhibition is found to be 10 mm. The method can be scaled up for obtaining the material at industrial scale. The materials could be potential candidate for clinical trial for their anti-microbial activities.

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