SYNTHESIS AND CHARACTERIZATION OF CNTS BY NATURAL PRODUCT

B.TIWARI1, I.P.TRIPATHI2, SANJAY SAXENA3 HARIBHUSHAN, A.P.DWIVEDI4, RANJANA DUBEY5

1 Director, D.S Institute of Technology and Management Ghaziabad, 2 Dept of Chemistry, MGGV Chitrakoot, 3 Dept of Chemistry, Maya Institute of Technology & Management, Dehradun, 4 Dept. of Physics, Jind, 5Dept of Chemistry MGGV Chitrakoot, Srm university, Ghaziabad, India

Received: 26 Feb 2011, Revised and Accepted: 29 March 2011

ABSTRACT

Nanotechnology is one of the most emerging technology these days. Metal carbon nano tubes are having vast applications in every sphere of life very frequently. Due to vast applications of CNTs it is necessary to develop new methods to prepare CNTs. One of the new methods to prepare CNTs is chemical method. In this methods Complexes of transition metal Ni(II) with amino acids present in egg albumin have been synthesized. The complex so formed is analyzed by spectroscopic methods like IR, NMR Spectroscopy. The amino acid metal Complex is decomposed at higher temperature using muffle furnace to obtain metal carbon nano tubes. These metal carbon nano tubes are characterized using scanning probe instruments like DLS and STM.

Keywords: Carbon nano tubes, Natural product, Ni(ii),Albumin, Amino acid, Amino acid-Metal complex, IR,NMR,DLS,STM

INTRODUCTION

Carbon nano tubes (CNTs) are allotropes of carbon with a nanostructure. The length-to-diameter ratio of CNTs is up to 28,000,000:1, which is significantly larger than any other material. As a matter of fact CNTs are molecular-scale tubes of graphitic carbon with outstanding properties. They are among the stiffest and strongest fibers known, and have remarkable electronic properties with many other unique characteristics.

The carbon nano tube structure has already made its appearance because it represents an entirely new form of matter. Single -Walled nano tubes can be either semiconductor or metallic. Nano tubes are also very stiff and very stable. They are built with their length exceeding thickness thousand of times.

Clusters of C-atoms in cylindrical forms (carbon nano tubes) have novel properties that make them useful in many applications in nanotechnology, electronics, optics and other fields of materials science, as well as potential uses in architectural fields.

Due to vast applications of CNTs, it is required to develop new methods and techniques to prepare carbon nano tubes and characterize them. It is also required to inculcate some desired properties in them, so that they can be used in various applications.1, 3, 5

MATERIALS AND METHODS

Two normal metal salt solution of Ni2+ was prepared by using AR grade chemicals. It is allowed to react with amino acids present in egg albumin to form a complex of amino acids with nickel ion. The metal-albumin complex, so formed was decomposed at higher temperature as reported in the literature.

Preparation of amino acid –metal complex

As we know that proteins are macromolecules comprising of amino acids as monomer. Amino acids are compounds containing –NH2 and COOH. With the help of these groups amino acids form complexes with metals and different chains of amino acids are combined together. These compounds on decomposition give carbon -metal nano tubes.

When aqueous solution of Nickel Salt is allowed to react with amino acids present in egg albumin the lone pair present on nitrogen of –NH2 and oxygen of COO– of COOH group present in amino Acid form complex with Ni (ii). In this way nickel (ii) forms cross link between two amino acid chains.

The structure of albumin is very complex and it is very difficult to produce exact structure of amino acid-metal complex. Egg albumins contain a number of different chemical compounds, which form complex with metal to form complex. These metals –amino acid complexes are heated in muffle furnace till decomposition.

Theses complexes on decomposition give carbon nano tubes.3, 4, 5

The complex of Amino Acid and metal is expected to contain following groups:

(i) NH2 group
(ii) COOH group
(iii)CH2 group
(iv) Amide group etc.

The compound when analyzed using IR(Infra red) and NMR(Nuclear Magnetic resonance) gave following results. From the results of NMR and IR it is clear that the compound contain all the above said groups.

Characterization

Spectral studies- Though it is very difficult to analyze the complexes of albumin and metal but certain important features can be identified which give valuable information about the structure.

IR spectra-IR Spectra of Nickel Amino Acid Complex is shown is fig1. The information, which we get by the IR spectra, is shown in Table 1: Typical infrared absorption bands for nickel amino acid complex

<table>
<thead>
<tr>
<th>Functional group</th>
<th>Prominent absorption band (cm⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-H (alkanes)</td>
<td>1376</td>
</tr>
<tr>
<td>Alcohol hydrogen bonded</td>
<td>3369</td>
</tr>
<tr>
<td>C-H</td>
<td>2925.78</td>
</tr>
<tr>
<td>Carboxylic acid (hydrogen bonded)</td>
<td>2854</td>
</tr>
<tr>
<td>Carboxylic acid</td>
<td>1744</td>
</tr>
<tr>
<td>Amide</td>
<td>1630</td>
</tr>
<tr>
<td>C-O carboxylic acid</td>
<td>1092 &amp; 1167</td>
</tr>
</tbody>
</table>

Table 2: Characteristics proton chemical shift

<table>
<thead>
<tr>
<th>Types of proton</th>
<th>Chemical shift δ (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(CH)2-CH</td>
<td>1.45</td>
</tr>
<tr>
<td>CH2—</td>
<td>4.4</td>
</tr>
<tr>
<td>—CH—</td>
<td>5.5</td>
</tr>
<tr>
<td>—CH—COOH</td>
<td>6 – 7.8</td>
</tr>
</tbody>
</table>

*Amide group is due to the peptide linkage (—C—NH) between different amino acid chains

NMR spectra: NMR Spectra of Nickel Amino Acid Complex is shown in fig 2. The information, which we get by the NMR spectra, is summed up in the table.
The chemical compounds formed are decomposed at different temperatures (800°C, 1000°C, 1200°C) in a muffle furnace. At 1200°C only soot is formed. The samples decomposed at 800°C and 1000°C are characterized by scanning probe instruments.

RESULTS AND DISCUSSION

Characterization by scanning probe instruments

Characterization by DLS: Samples were sent for DLS (Differential Liquid Scanning) analysis and following results are found which gave valuable information about the formation of CNTs. The results are:

Results of sample 800c_S3: In this sample the chemical compound is prepared by taking ethyl alcohol as solvent and is decomposed at 800°C. The results are shown in the fig.3 and are summed up in table 3.

Results of sample 1000c_S3: In this sample the chemical compound is prepared by taking ethyl alcohol as solvent and is decomposed at 1000°C.

The results are shown in the fig.4 and are summed up in table below (fig. 1, fig. 2 and table 3)

Interpretation

Nano material have diverged tunable physical properties as a function of there size and shape due to strong quantum confinement effect and large surface/ volume ratio.

The average intensity reports were reported 44.43% where as average CNTs possess a size distribution report of about 90.15 nm as diameter. Where as some peaks show 83.46 nanometer, 43.02 nanometer etc.

Metal CNTs has diameter of about 30 to 70 nm and length up to 50 micrometer. The CNTs are nearly mono dispersed and average width is 17.40 nm. Many research paper shows the absorption peaks of metal CNTs are from 70 to 130 nm as diameter. It shows one of the most challenging application in electronics, where both the metallic and semi conducting properties of the single wall nano tubes are exploited.
Results

Fig. 3: DLS Results of sample decomposed at 800°C

Fig. 4: DLS Results of sample decomposed at 1000°C.
Characterization by STM:- To confirm the formation of CNTs the compounds were analyzed by using STM(Scanning Tunneling Microscope). STM pictures are shown above.

CONCLUSION

Nickel-carbon nano tubes can be formed by the reaction of aqueous solution of nickel salt with amino acids present in egg albumin and decomposing the compound formed.

The results also reveal that the decomposition at 800°c is incomplete and the formation of nano particles is less in the range of 10 to 100 nm. At 1000°c vast increase in the formation of nano particles in the above said range is observed.

REFERENCES

6. Nanotechnology "A gentle introduction to next big idea" By Mark Ratnra &Denial Ratnra.