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Synthesis and characterization of CNTs using egg albumin & Metal (Cr^{+3})

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ABSTRACT

The growing need for analytical devices requiring smaller sample volumes, decreased power consumption and improved performance have been driving forces behind the rapid growth in nanomaterials research. Due to their dimensions, nano structured materials display unique properties not traditionally observed in bulk materials. Due to the vast application of CNTs, it is necessary to develop new methods for the synthesis of CNTs. In this method, complexes of transition metal Cr(III) with amino acid present in egg albumin have been synthesized. The complex so formed, is analyzed on the basis of spectroscopic method of UV, IR and NMR spectroscopy. The amino acid metal complex is decomposed at higher temperature in muffle furnace to obtain metal carbon nano tubes.

Introduction:

Carbon nano tubes (CNTs) [1] are allotropes of carbon with a cylindrical nanostructure. Nano tubes have been constructed with length-to-diameter ratio of up to 132,000,000:1 significantly larger than for any other material. These cylindrical carbon molecules have unusual properties, which are valuable for nanotechnology, electronics, optics and other fields of materials science and technology. In particular, owing to their extraordinary thermal conductivity and mechanical and electrical properties, carbon nanotubes find applications as additives to various structural materials. For instance, nanotubes form only a tiny portion of the material(s) in (primarily carbon fiber) baseball bats, golf clubs, or car parts.

The carbon nano tube structure has already made it appearances because it represents an entirely new form of matter. There are two types of nanotubes[2] :

a. Single walled carbon atom tubes: one atom thick layer of graphite wrapped into a seamless cylinder is known as Single walled carbon atom tube (SWCNT). Single-walled nano tubes can be either semiconductor or metallic.

b. Multiwalled carbon nano tubes: They consist of multiple layers of graphite rolled in themselves to form a tube shape.

Nano tubes are also very stiff and very stable. They are built with their length exceeding thickness thousands of times. Cluster of C-atoms in cylindrical forms (carbon nano tubes) have novel properties which make them useful in many application in nanotechnology, electronic, optics and other field of materials science as well as potential uses in architectural fields[3,4.]

Material and Method

To prepare carbon nano tube, 1 gm normal metal salt solution of Cr+3 was prepared in ethyl alcohol. It is

allowed to react with egg albumin to form a complex of egg albumin with chromium ion. The metal albumin complex, so formed was decomposed in muffle furnace at higher temperature.

Preparation of Amino-acid metal Complex

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

When aqueous solution of Cr+3 salt is allowed to react with amino acid 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 Cr+3 forming cross links between two amino acid chains.

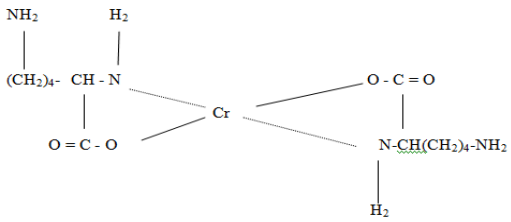
The structure of egg-albumin is very complex to produce exact structure of amino acid metal complex. Egg albumin contains a number of different chemical compounds for example:

Egg albumin contain Lysine (NH_2 $(CH_2)_4$ CH (NH_2). COOH) and arginine

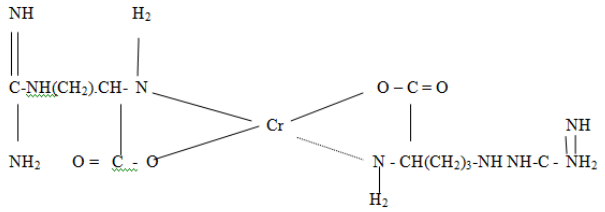
NH

– (NH2 – C- (CH2)3 CH, (NH_2 COOH)

They react with Cr+3 metal ion solutions to give the following complex.



Lysine – Chromium (III) Complex



Arginine – Chromium (III) Complex

Characterization

Spectral studies: Since egg albumin has a complex structure. So, it is very difficult to analyze albumin and metal. Certain important properties can be identified which give valuable information about the structure.

IR Spectra: An IR spectrum of chromium amino acid complex is shown in fig.1.

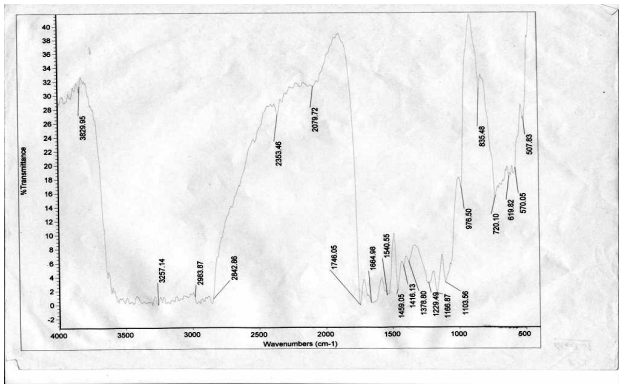


Fig. 1 IR spectrum of chromium amino acid complex

Table: 1

Typical infrared absorption bands for chromium amino acid complex is –

Prominent absorption band (cm^{-1})	**Functional group**
2983.87	O-H Stretch (hydrogen bonded)
1746.05	C=O stretch (strong signal in Amino acid)
1664.98	C=O asymmetric stretch
1540.55	NH_2 or NH_3^+ symmetric bending
1103.56	C-C stretching in R and C in amino acid

In infra red spectroscopy, the band at 2983.87 cm-1 is due to O-H Stretch. Strong signal in amino acid at 1746.05 cm-1 is due to C=O stretching. The strong intense bands at 1664.98 cm-1 is due to C=O asymmetric stretch. The band at 1540.55 cm-1 is due to NH2 or NH3+ symmetric bending and band at 1103.56 cm-1 indicates the C-C stretch in b/w R and C in amino acid.

NMR Spectra: NMR spectra of chromium amino acid complex is shown in fig.2. The information which we get by the NMR spectra is summed up in the Table 2.

Table: 2

Characteristics protons chemical shift :

Types of proton	Chemical shift s (ppm)
R- CH_3	0.822
$R_2.CH_2$	1.204
H-C-COOH	2.470
NH_2	3.290

The NMR peak at 3.290 indicates NH_2 proton. Further, chemical shift at 2.470 ppm corresponds to C-H attached to the - COOH group in the amino acid. The NMR signal at 1.204 ppm is due to R_2-CH_2 protons (secondary type) and finally the NMR signal with chemical shift at 0.822 ppm indicates the presence of R-CH_3 (primary type) protons.

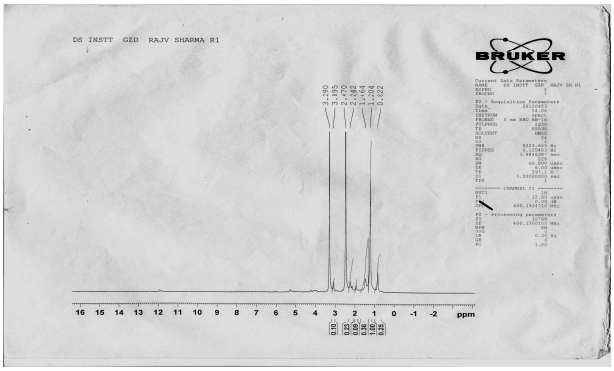


Fig. 2 NMR peak

Characterization by scanning probe Instruments

AFM (Atomic Force Microscopy): It is used to measure the particle size. By the investigation, we came to know that metal chromium complex on decomposition give metal carbon nano tubes with nano dimension.

STM (Scanning Tunneling Microscopy): It measures the amount, the electrons current flowing between a scanning tip and a surface. By the STM measurement, we measured electrical conductivity characteristics of prepared chromium metal carbon nano tube.

Result and Discussion:

Carbon metal nanotubes, prepared by the decomposition of amino acid chromium complex. The carbon metal nano tube are found to exhibit conductivity[5,6]. This shows the presence of unpaired electron. It is also predicted to exhibit paramagnetism.

Conclusion:

Metal carbon nano tube can also be prepared by chemical method[7]. In this method CNTs are prepared by adding chemical and by decomposing the compound formed.

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