



NoPo Nanotechnologies India Private Limited

#26D, Veerasandra Industrial Area, Electronic City P.O, Bengaluru 560100, INDIA

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N A N O T E C H N O L O G I E S

NoPo HiPCO SWCNT

Jul 4
2022

NoPo HiPCO Single Walled Carbon Nanotubes

Technical Data sheet



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Certificate of Analysis

Single-walled carbon nanotube of High-pressure carbon monoxide (HiPCO) method:

| Properties | Requirement | Explanation |
|--------------------------|------------------------|--|
| Morphology | SWCNT powder | Visual appearance. |
| TGA Residue as Fe | <35wt% | TGA is used to measure the Fe content. The residue content will be Fe ₂ O ₃ . Which is ~35%. |
| Individual SWNT Diameter | 0.8-1.2nm | RBM of Raman analysis gives the average diameter of Nanotubes. The wavenumber ~272cm ⁻¹ . |
| Maximum Density | 1.6 g/cm ³ | In powder form |
| Bulk Density | ~0.1 g/cm ³ | In powder form (Packing Box) |
| Maximum Surface Area | 1315 m ² /g | In powder form (analyzed using BET) |
| Moisture Content | <5 wt% | Analyzed using the TGA |

Prepared By,

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Morphology



Figure: Physical Appearance of NoPo HiPCO SWCNT

The digital image of as-produced NoPo HiPCO SWCNT taken using SONY-SLT-A57 digital camera containing ~50mg of SWCNT.

Imaged at NoPo Nanotechnologies India Private Limited, Bangalore.

TGA Analysis

Asprepared Material:

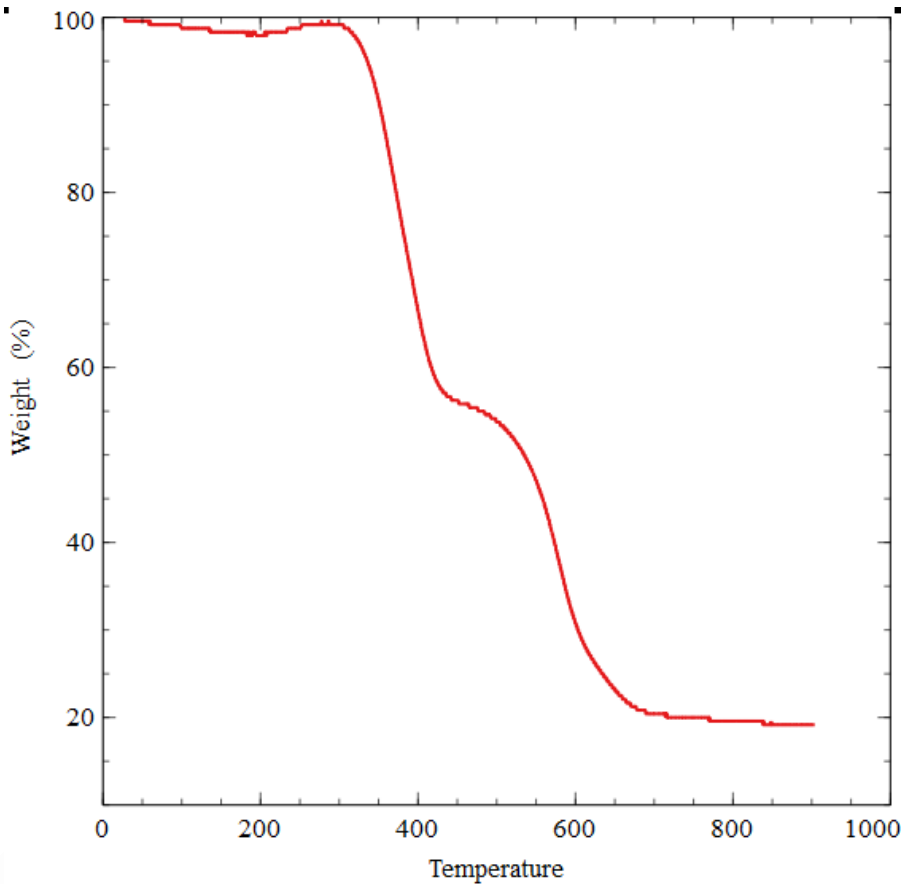


Figure: TGA plot of NoPo HiPCO SWCNT Powder (*Produced in June 2022*)

The material contains ~85% of carbon and ~15% of residue (non-carbonaceous impurity), estimated by the thermogram. There is no significant weight loss around 100-200°C which indicates very less or no moisture content in the material.

Analysis Details:

The TGA analysis was done at Centre for Incubation, Innovation, Research and Consultancy (CIIRC), Jyothy Institute of Technology Campus, Bangalore.

TGA Analysis follows protocol specified by ISO/TS 11308:2011:

<https://www.iso.org/standard/50357.html>

SEM Images

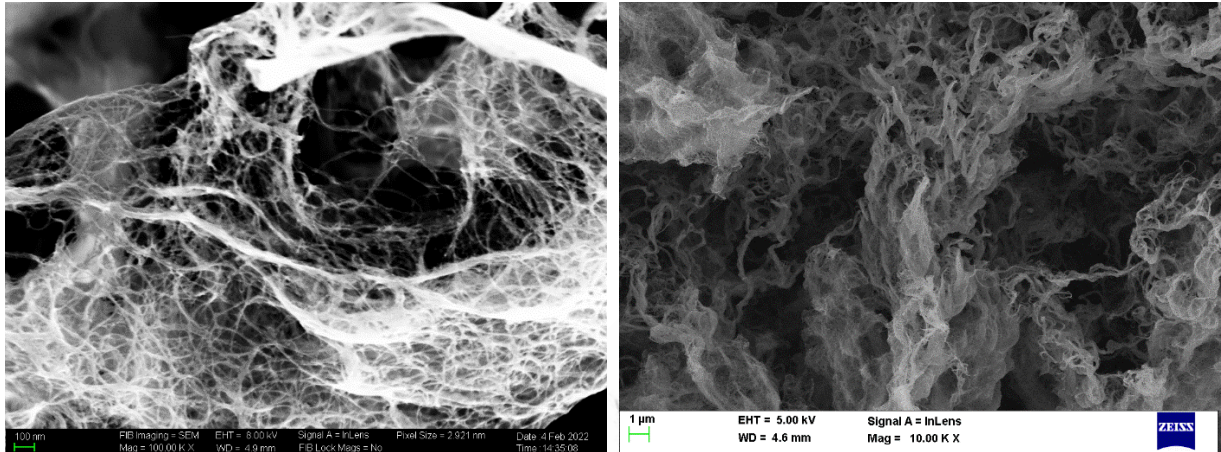


Figure: SEM images of NoPo HiPCO SWCNT (*Produced in May 2022*)

The SEM image showcases fibrous carbon nanotubes. It shows clean tubes which has very less amorphous carbon in it. The nanotubes were magnified up to 200K times to visualize the bundles of the nanotubes.

Analysis Details:

The SEM analysis was done at Central Manufacturing Technology Institute, Bangalore

Raman Analysis

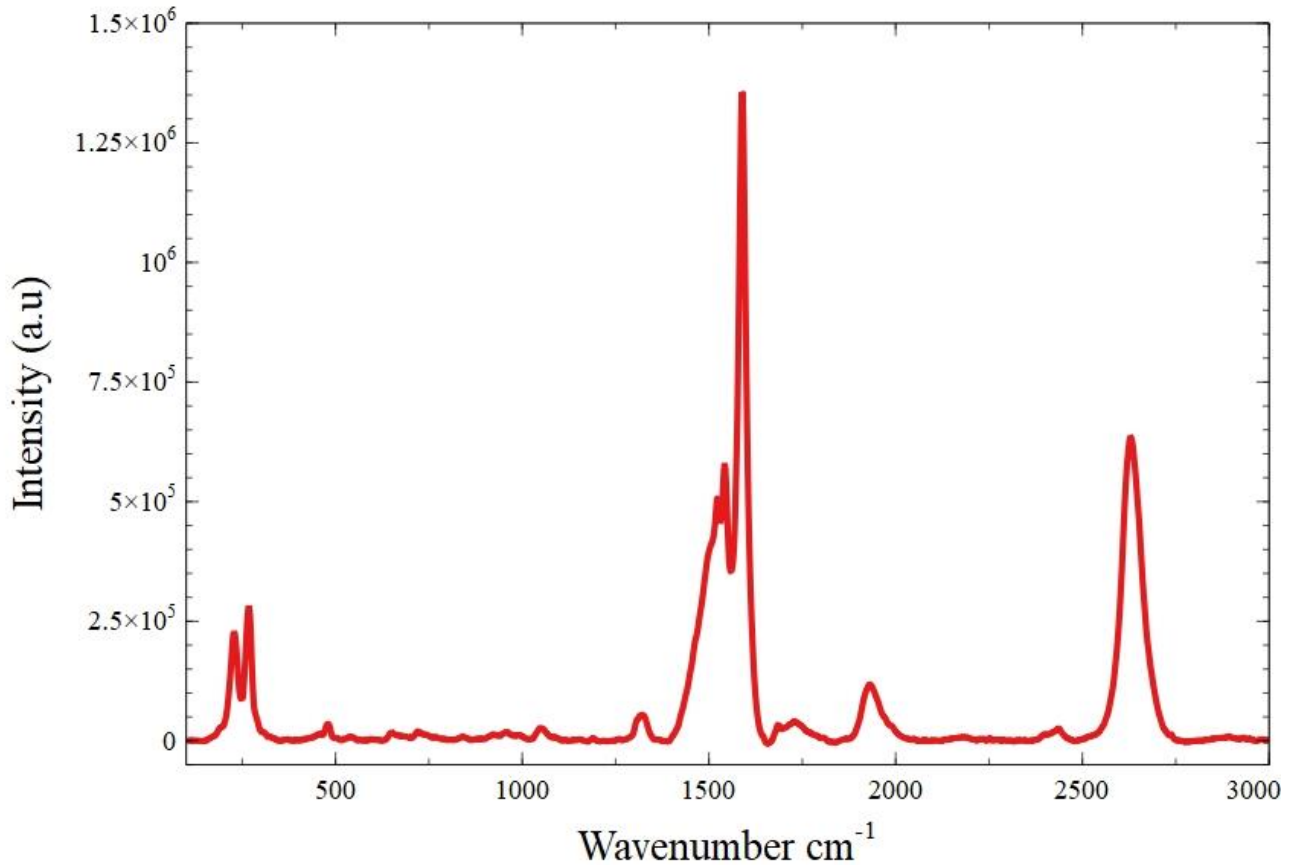


Figure: Raman Spectrum of HiPCO SWCNT (June 2022) (514nm green Laser)

G/D ratio: 24, **RBM Peaks:** 272, 228cm⁻¹

Average diameter of the nanotubes is ~ 0.8nm.

"Determination of SWCNT diameters from the Raman response of the radial breathing mode", Eur. Phys. J. B 22, 307–320 (2001)

Analyzed at NoPo Nanotechnologies India Private Limited, Bangalore using 514nm green laser

UV-Vis-NIR Spectrum

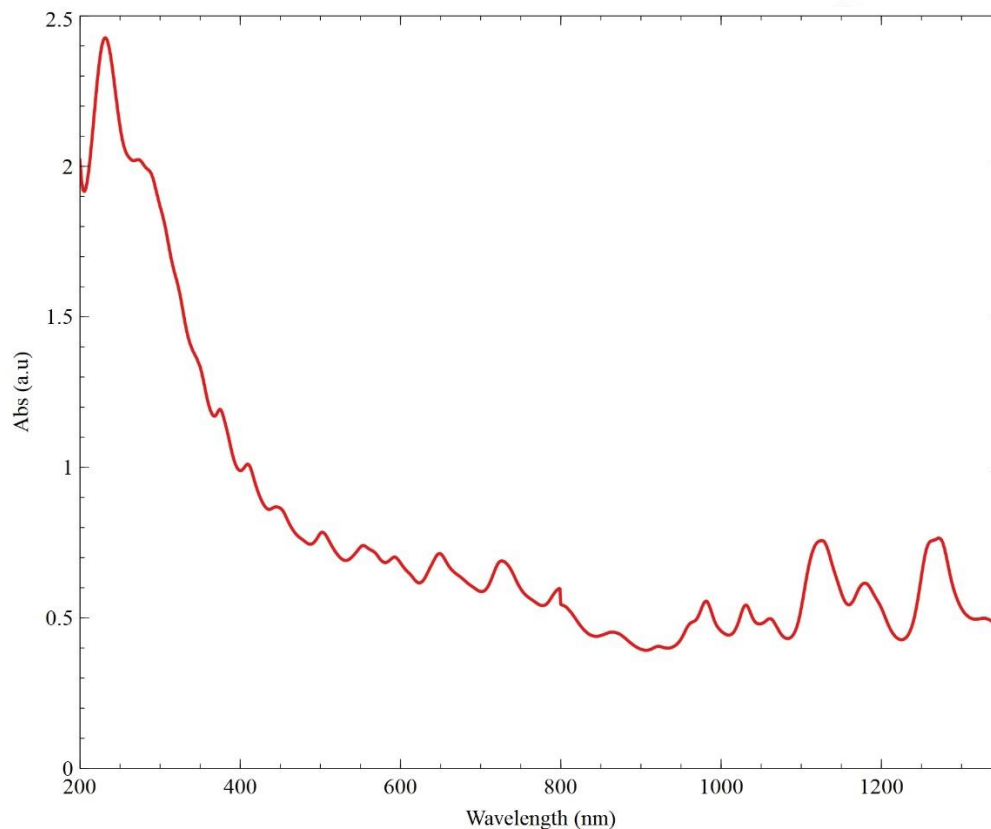


Figure: UV Vis NIR Spectrum of HiPCO SWCNT/ SDS solution. (Jan 2021)

Analysis Details:

The UV-Vis NIR analysis was done at Bangalore Bio innovation Centre (BBC), Electronic city, Bangalore.



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Material Safety Datasheet

1. 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name : NoPo HiPCO Single-walled Carbon Nanotubes (SWCNT)

Product Code : SWCNT

HS Code : 28030090 CARBON (CARBON BLACKS AND OTHER FORMS OF CARBON NOT ELSEWHERE SPECIFIED OR INCLUDED) - CARBON (CARBON BLACKS AND OTHER FORMS OF CARBON NOT ELSEWHERE SPECIFIED OR INCLUDED): OTHER

MANUFACTURER: *NoPo Nanotechnologies India Private Limited,*

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2. COMPOSITION/INFORMATION ON INGREDIENTS

| Ingredient Name | CAS Number | Weight % |
|--------------------------------|------------|----------|
| Single walled Carbon Nanotubes | None | >70% |
| Metal impurities(iron) | various | <20% |

3. HAZARDS IDENTIFICATION

Potential Health Effects

General Overview

Product is in the form of odorless black fibrous powder and is not expected to cause environmental hazard under good industrial hygiene plan. Dusts from handling or processing may cause eye, skin and respiratory tract irritation when exposed. Product contains small amount of metal oxides and consequently may produce an allergic reaction. Wear appropriate personal protective equipment. Keeps the product handling in confined space. Proper air ventilation system is advised in handling the product.



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Eye

Contact with the eyes may cause irritation due to abrasive action of the dust. Not expected to cause prolonged or significant eye irritation.

Skin

There is no known hazard, but may be mildly irritating to the skin. It is not expected to cause prolonged or significant irritation, even at high concentration. Not expected to be absorbed through the intact skin. We've found that when touched with bare hands, the nanotubes tend to stick to skin, they can be washed off easily by using soap and water.

Inhalation

The SWCNT tend to agglomerate into large bundles, the dust cannot enter your lungs through nostrils but if they enter lungs through other means, it may cause respiratory irritation.

Ingestion

No known hazards. The Nanotubes are not expected to be harmful if swallowed but the catalyst particles could be reactive. Hence it is advisable to use anti vomitives in case of ingestion.

Acute and Chronic Health Effects

High concentration of dusts may be irritating to eyes, skin, mucus membranes and respiratory tract. No applicable chronic information at this moment, but none of the components is known to be a carcinogen or a suspected Page carcinogen.

Target Organ Effects

No data

Developmental Information

There are no data available for assessing risk to the fetus from maternal exposure to this material

4. FIRST AID MEASURES

General

Remove all contaminated clothing immediately.

Eyes

Hold the eyes open and rinse with water for a sufficiently long period of time (at least 10 minutes). Obtain medical attention if pain, blinking or redness persists.

Skin

In case of skin contact, rinse thoroughly with soap and plenty of water. Obtain medical attention if irritation persists.



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Inhalation

If dusts are inhaled, move the person into fresh air, keep warm and allow to rest. If breathing is difficult, oxygen may be administered and medical attention should be obtained

Ingestion

Rinse mouth with water and obtain medical attention.

5. FIRE FIGHTING MEASURES

Flash Point

Not applicable

Explosive Limit

No data

Auto ignition Temperature

No data

Hazardous Products of Combustion

Carbon oxide, small quantity of metal oxides

Fire and Explosion Hazards

No special fire hazards are known to be associated with this product

Extinguishing Media

Water, Carbon Dioxide, Dry Chemical, or Foam

Fire Fighting Instructions

Wear a self-contained breathing apparatus for fire fighting

6. ACCIDENTAL RELEASE MEASURES

Personal precautions

Equip cleanup crew with proper protection. Ensure adequate ventilation.

Environmental precautions

Prevent entry to sewers and public waters

Spill Procedures

Sweep or vacuum according to normal housekeeping practices



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7. HANDLING AND STORAGE

General

Keep in closed container. Additional sealing may prevent accidental dust release

Precautions in handling and storage

Good ventilation of the workplace required. Contact with the skin and the eyes as well as inhalation of dusts must be avoided

Storage

Keep only in the original container in a dedicated place

Handling

Handle in accordance with good industrial hygiene and safety procedures

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Eye Protection

Chemical goggles, safety glasses or full-faced shields

Skin Protection

Suits, gloves and other items of protective clothing. Protecting gloves including, for example: nitrile, latex, and rubber

Respiratory Protections

Wear suitable respiratory equipment with High Efficiency Particulate Air Filter (HEPA), such as NIOSH P100 filter, or air-supplied respirators when directly exposed or handling the powder

Engineering Controls

Provide sufficient mechanical (general and/or local exhaust) ventilation for dust

Exposure Guidelines

In case of contact, ensure prompt removal from eyes, skin and clothing. Wash hands and other exposed areas



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9. PHYSICAL AND CHEMICAL PROPERTIES

| | | | |
|---------------------------------|-----------------------|--------------|-----------------|
| APPEARANCE: | Black fibrous powder. | | |
| PHYSICAL STATE: | Solid. | | |
| ODOR: | None. | | |
| SPECIFIC GRAVITY (water = 1.0): | Not determined. | | |
| SOLUBILITY IN WATER (weight %): | Insoluble. | | |
| pH: | 4-10 | | |
| BOILING POINT: | Not determined. | | |
| MELTING POINT: | Not applicable. | | |
| VAPOR PRESSURE: | Not applicable. | | |
| VAPOR DENSITY (air = 1.0): | Not determined. | | |
| EVAPORATION RATE: | Not determined. | COMPARED TO: | Not applicable. |
| % VOLATILES: | Not determined. | | |
| FLASH POINT: | Not determined. | | |

10. STABILITY AND REACTIVITY

Stability

Thermal decomposition or combustion in presence of air/Oxygen may produce smoke of carbon oxide and metal oxide. Can withstand ~3000K in inert atmosphere.

Incompatibility

Avoid contacting very strong oxidizing and reducing agents. No hazardous reaction when used as directed.

Conditions to avoid

Avoid excessive heating (above 400 C) in oxygen rich atmosphere



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11. TOXICOLOGICAL INFORMATION

Rat oral LD50 [mg/kg]

No lethal dosage observed (<http://dx.doi.org/10.1080/10408444.2016.1206061>)

Rabbit dermal LD50 [mg/kg]

No conclusive data

Rat inhalation LC50 [mg/l/4h]

No conclusive data

Health Hazard Data

Experimentations performed on reconstituted human epidermis have shown no sign of toxicity of even very large doses (full skin coverage for 24 hours) of carbon nanotubes (results to be published). However, preliminary reports, based on pre-studies on rats which were instilled with severe, high-level doses of carbon Nanotubes material, indicate that, if inhaled in large quantities, carbon nanotubes are potentially toxic for humans. Such an exposure scenario is however unrealistic. Nevertheless it is recommended that respiratory protection should be used to prevent inhalation exposure to carbon nanotubes.

12. ECOLOGICAL INFORMATION

The product is not expected to present environmental hazard.

13. DISPOSAL CONSIDERATION

Disposal

As prepared the product is considered as non hazardous. It can then be either disposed in an approved landfill or destroyed by incineration. Volatile dust must be collected during incineration. Liquids containing significant amount of carbon nanotubes must be filtered before being released to the sewer.

14. TRANSPORT INFORMATION

Not regulated. Use precaution during transport in order to prevent accidental spill. Not dangerous cargo. Keep separated from foodstuffs. According to IATA rules this product can be carried through any transportation mode.

15. REGULATORY INFORMATION

Symbol(s): None

R Phrase(s): None

S Phrase(s): S22 Do not breathe dust

S29 Do not empty into drains S36/37/39 Wear suitable protective clothing, gloves, eye/face protection



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Regulations

This product is listed in TSCA (US Toxic Substances Control Act) Canadian Domestic Substances List (DSL) European Inventory of Existing Commercial Chemical Substances (EINECS) Korean Existing Chemicals List (ECL) Australian Inventory of Chemical Substances (AICS) Philippines Inventory of Chemicals and Chemical Substances (PICCS) Swiss Giftliste 1 Inventory of Notified New Substances This product is not regulated in Japan and excluded from the Japanese Chemical Substances Control Law according to the Japanese Ministry of Economy, Trade and Industry, formerly the Ministry of International Trade and Industry (MITI).

Disclaimer

NoPo Nanotechnologies India Private Limited or its affiliates herein referred to as “NoPo” are not responsible for any mistakes in the data presented here. All care has been taken to ensure that the most accurate data are presented. SWCNT toxicity is debatable and the end user is advised to exercise maximum caution.

Nanotube Powered

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