blue nano

Material Safety Data Sheet

CNT Series Carbon Nanotubes

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1 – Identification of Substance

Trade Name: Carbon Fullerene
Chemical Family: Synthetic Graphite
Synonyms: Carbon Nanotube, CNT
CAS Number: 308068-56-6
Manufacturer/Supplier: Blue Nano
17323 Connor Quay Ct, Cornelius, NC 28031, U.S.
Phone: +1 (980) 225-1675
Email: bluenano@BlueNanoInc.com

2 - Composition / Information on Ingredients

Component	CAS Number	Amount (%)
Carbon Nanotube	308068-56-6	>99.9%
Amorphous Carbon		<2%
Alumina	1344-28-1	<8%

3 - Hazards Identification: Potential health effects

Eye contact	May cause eye irritation
Skin contact	No known hazards, but may be mildly irritating
Inhalation	May cause irritation to respiratory tract
Ingestion	No known hazards, but may irritate gastrointestinal tract. Acute and Chronic High concentration of dusts may be irritating to eyes, skin
Health Effects	Mucus membranes and respiratory tract
Information pertaining to particular dangers for man and environment	R 36/37 Irritating to eyes and respiratory system

4 - First Aid Measures

After inhalation	Remove to fresh air. If required, provide artificial respiration. Keep patient warm. Seek immediate medical advice.
After skin contact	Immediately wash with water and soap and rinse thoroughly. Seek immediate medical advice.
After eye contact	Rinse opened eye for several minutes under running water. Then consult a doctor.
After ingestion	Seek immediate medical advice.

5 - Fire Fighting Measures

Flash point	Not applicable
Explosion limits	Unknown
Extinguisher medium	Water, Carbon Dioxide, Dry Chemical, or Foam
Special procedures	None
Decomposition products	Carbon monoxide, carbon dioxide
Unusual Hazards	Thermal decomposition or combustion may produce dense smoke
Suitable extinguishing agents	CO2, extinguishing powder or water spray. Fight larger fires with water spray.
Special hazards caused by the material, its products of combustion or resulting gases	In case of fire, the following can be released: Carbon monoxide.
Protective equipment	Wear self-contained respirator. Wear fully protective impervious suit.

6 - Accidental Release Measures

Person-related safety precautions	Wear protective equipment. Keep unprotected persons away. Ensure adequate ventilation.
Measures for environmental protection	Do not allow material to be released to the environment.
Measures for cleaning/collecting	Ensure adequate ventilation.
Additional information	See Section 7 for information on safe handling. See Section 8 for information on personal protection equipment. See Section 13 for disposal information.

7 - Handling and Storage

Information for safe handling	Keep container tightly sealed. Store in cool, dry place in tightly closed containers. Ensure good ventilation at the workplace.
Information about protection against explosions and fires	Keep away from bright flashes of light. Flashes of light can cause spontaneous combustion.
Storage	Store in light proof packaging.
Requirements to be met by storerooms and receptacles	No special requirements.
Information about storage in one common storage facility	Store away from oxidizing agents. Store away from halogens. Do not store together with acids.
Further information about storage conditions	Keep container tightly sealed. Store in cool, dry conditions in well sealed containers.

8 - Exposure Controls / Personal Protection

Additional information about design of technical systems:

Properly operating chemical fume hood designed for hazardous chemicals and having an average face velocity of at least 100 feet per minute.

Components with limit values that require monitoring at the workplace:

Graphite	mg/m3
ACGIH TLV	2
Belgium TWA	2.5
Finland TWA	5
France VME	2
Germany MAK	6
Ireland TWA	5
Korea TLV	2
Netherlands MAC-TGG	2
Poland TWA	2
Sweden NGV	5 (dust)
Switzerland MAK-W	2.5
United Kingdom	5-LTEL
USA PEL	15 mppcf

Additional information	No Data
General protective and hygienic measures	The usual precautionary measures for handling chemicals should be followed. Keep away from foodstuffs, beverages and feed. Remove all soiled and contaminated clothing immediately. Wash hands before breaks and at the end of work. Avoid contact with the eyes. Avoid contact with the eyes and skin.
Breathing equipment	Use suitable respirator when high concentrations are present.
Protection of hands	Impervious gloves.
Eye protection	Safety glasses.
Body protection	Protective work clothing.

9 - Physical & Chemical Properties

General Information	
Form	Powders
Color	Black
Odor	Odorless
Value/Range Unit Method	
Melting Point / Melting Range	3652-3697°C (6605F-6686F)(subl/vac)
Boiling Point / Boiling Range	Not available
Sublimation temperature / start	Not available
Ignition temperature	Not applicable
Decomposition Temperature	Not available
Danger of explosion	Product does not present an explosion hazard
Explosion Limits	
Lower	Not available
Upper	Not available
Vapor pressure	Not available
Density	~ 2.1 g/cm³ at 20°C (68F)
Solubility in / miscibility with water	Insoluble

10 - Stability & Reactivity

Thermal decomposition / conditions to be avoided	Decomposition will not occur if used and stored according to specifications.
Materials to be avoided	Oxidizing agents, Acids, Halogens, Interhalogens, Alkali metals
Dangerous reactions	No dangerous reactions known.
Dangerous products of decomposition	Carbon monoxide and carbon dioxide

11 - Toxological Information

Acute toxicity	No
Primary irritant effect on the skin	Irritant to skin and mucous membranes.
Primary irritant effect on the eye	Irritating effect.
Sensitization	No sensitizing effects known.
Sub-acute to chronic toxicity	The inhalation of graphite, both natural and synthetic, has caused pneumoconiosis in exposed workers. The pneumoconiosis found is similar to coal worker's pneumoconiosis.
Additional toxicological information	To the best of our knowledge the acute and chronic toxicity of this substance is not fully known. No classification data on carcinogenic properties of this material is available from the EPA, IARC, NTP, OSHA or ACGIH.

12 – Ecological Information

General notes	Do not allow this material to be released to the environment.

13 – Disposal Considerations

Product	Carbon Nanotubes
Uncleaned packages	Consult all state, local or national regulations to ensure proper disposal. Specific care should be taken to insure that no carbon nanotubes or carbon nanotube packaging is released into the environment.
Recommendation	Disposal must be made according to official regulations.

14 – Transport Information

Classification	Not a hazardous material for transportation.
DOT regulations	
Hazard class	None
Land transport ADR/RID (cross-border)	
ADR/RID class	None
Maritime transport IMDG	
IMDG Class	None
Air transport ICAO-TI and IATA-DGR	
ICAO/IATA Class	None
Transport/Additional information	Not dangerous according to the above specifications.

15 - Regulations

Product related hazard information	This material is listed on the US Toxic Substances Control Act (TSCA) Inventory and the following chemical inventories: Canadian Domestic Substances List (DSL), European Inventory of Existing Commercial Chemical Substances (EINECS), Korean Existing Chemicals List (ECL), Australian Inventory of Chemical Substances (AICS), the Philippines Inventory of Chemicals and Chemical Substances (PICCS), and the Swiss Giftliste 1 Inventory of Notified New Substances. In addition, this substance 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).
Hazard symbols	Eye Irritant
Risk phrases	36/37 Irritating to eyes and respiratory system.
Safety phrases	26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
National regulations	All components of this product are listed in the U.S. Environmental Protection Agency Toxic Substances Control Act. Chemical Substance Inventory.
Information about limitation of use	For use only by technically qualified individuals.

16 – Other Information

Employers should use this information only as a supplement to other information gathered by them, and should make independent judgment of suitability of this information to ensure proper use and protect the health and safety of employees. This information is furnished without warranty, and any use of the product not in conformance with this Material Safety Data Sheet, or in combination with any other product or process, is the responsibility of the user.

HAZARDOUS MATERIALS IDENTIFICATION SYSTEM (HMIS)

Health Flammability Reactivity BASIS

100 Synthetic graphite powder

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

Health Flammability Reactivity BASIS

100 Synthetic graphite powder

Label Precautions:

Do not get in eyes, on skin or on clothing.

Do not breathe dust.

Wash thoroughly after handling.

Keep container closed.

Use with adequate ventilation.

Label First Aid:

If inhaled, remove to fresh air. If breathing difficulties persist, get medical attention. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. If irritation develops or persists, get medical attention.

CNT Safety Considerations

A Material Safety Data Sheet (MSDS) has been written by Blue Nano for its carbon nanotubes. In addition to the MSDS, the following excerpts in this document are recommended reading for further education. Blue Nano, by way of inclusion, does not endorse any particular selection.

Handling Carbon Nanotubes

(From Carbon Nanotubes and Related Structures: New Materials for the Twenty-First Century, by Peter J.F. Harris, Cambridge University Press, 2001, pp. 21-22)

"Opinions are divided on the possible health hazards of carbon nanotubes... Some workers have pointed out the physical similarities between nanotubes and asbestos fibers, which are both extended structures around 10nm in diameter and a few micrometers long... It has been known since the early 1960's that asbestos can be a cause of pneumoconiosis, a serious lung disease, and mesothelioma, a cancer of the lining of the chest which is often fatal.

However, the mechanism by which the silicate fibers cause the damage, at least in the case of mesothelioma, is believed to involve the catalytic formation of reactive oxygen compounds. It seems unlikely that (plain carbon) nanotubes would have the same effect. Nevertheless, in the lack of any definite information on the toxicity of Fullerene-related carbons, it is wise to err on the side of caution when preparing and handling these materials.

Particular care should be taken with the arc-evaporation method since the soot produced in this way is extremely light and can easily become airborne.

Precautions should therefore be taken to avoid inhalation. For this reason, it is recommended that the entire arc-evaporation apparatus be enclosed in a fume hood. A mask should also be worn when opening the chamber and it is advisable to wear gloves when handling the Fullerene-related materials. There are other safety considerations to take into account when carrying out the arc evaporation method. It is clearly important to check the machine for short circuits before carrying out the arc-evaporation, and the vacuum should be tested for leaks before introducing the inert gas. Since most chambers will have a viewing port, care must also be taken to protect the operator's eyes from the intense light of the arc using a high density optical glass filter."

(from "DuPont pinning its future on nanotechnology," by F. Biddle, The (Wilmington, Del.) News Journal and also Reno Gazette-Journal, Saturday, Dec. 27, 2003, pp .1D - 4D)

"Safety is one concern. Eva Oberdorster, an aquatic toxicologist at Southern Methodist University in Dallas, said the tendency of single strands of synthetic DNA to bind to nanotubes may add to longtime concerns that nanotubes can breach the cell membranes of living things. "Does real DNA ... interact with (carbon nanotubes)?" she said. "We don't know that yet. Certainly, if you're in a workplace and working with these nanotubes, there's a possibility of being exposed." That leads to the possibility that nanotubes could disrupt the normal lives and functions of cells, she said."

(from "Nano's Safety Checkup," by I. Amato, Technology Review, Feb. 2004, pp. 22-23)

SOME EFFORTS AND PROPOSALS ON NANOPARTICLE SAFETY ORGANIZATION EFFORT

U.S. Food and Drug Administration;

U.S. Environmental Protection Agency (Washington, D.C.)

Relying on existing protocols to regulate new nanomaterials, while developing data on toxicology, environmental fate, and tissue accumulation.

U.K. Royal Society, U.K. Royal Academy of Engineering (London, England)

Commissioned a blue-ribbon study to assess the risks and benefits of nanomaterials and make regulatory recommendations

Center for Biological and Environmental Nanotechnology, Rice University (Houston, TX) Director Vicki Calvin recommended that 5% of federal nanotechnology expenditures be devoted to the study of environmental and societal consequences.

ETC Group (Winnipeg, Manitoba)

Calling for moratoria on nanotechnology R&D until safety can be established; seeking an international convention to evaluate nanotechnology.

Greenpeace Environmental Trust(London, England)
Calling for far more research on nanotechnology's environmental impact, but not endorsing moratoria.

(from "Health Concerns in Nanotechnology," By Barnaby J. Feder, N.Y. Times, Published: March 29, 2004)

"...Bucky balls, a spherical form of carbon discovered in 1985 and an important material in the new field of nanotechnology, can cause extensive brain damage in fish...Eva Oberdörster, an environmental toxicologist at Southern Methodist University in Dallas, said the buck balls also altered the behavior of genes in liver cells of the juvenile largemouth bass she studied... . Other researchers, including Dr. Oberdörster's father, Günter Oberdörster, a professor of environmental medicine at the University of Rochester, have shown that such particles can enter the brain. The fish studies, however, were the first to indicate destruction of lipid cells, the most common form of brain tissue.
Dr. Oberdörster of S.M.U. said that the results underscored the need to learn more about how bucky balls and other nanoscale materials are absorbed, how they might damage organisms and what levels of exposure represent hazards. But she rejected arguments made by some nanotechnology critics that the limited toxicological research to date justified a moratorium on the development and sale of the new materials..."This is a yellow light, not a red one," Dr.Oberdörster said in a telephone interview last week."

*(from "Comparative Pulmonary Toxicity Assessment of Single-wall Carbon Nanotubes in Rats," D. B. Warheit, et al.,Toxicological Sciences **77**, 117-125 (2004))*

"Exposures to high-dose (5 mg/kg) SWCNT produced mortality in ~15% of the SWCNT instilled rats within 24 h post instillation. This mortality resulted from mechanical blockage of the upper airways by the instillate and was not due to inherent pulmonary toxicity of the instilled SWCNT particulate. Exposures to quartz particles produced significant increases versus controls in pulmonary inflammation, cytotoxicity, and lung cell parenchymal cell proliferation indices. Exposures to SWCNT produced transient inflammatory and cell injury effects."

*(from "Pulmonary Toxicity of Single-Wall Carbon Nanotubes in Mice 7 and 90 Days After Intratracheal Instillation,"C.-W.Lam, et al., Toxicological Sciences **77**, 126-134 (2004))*

"All nanotube products induced dose-dependent epithelioid granulomas and, in some cases, interstitial inflammation in the animals of the 7-d groups. These lesions persisted and were more pronounced in the 90-d groups; the lungs of some animals also revealed peri bronchial inflammation and necrosis that had extended into the alveolar septa. The lungs of mice treated with carbon black were normal, whereas those treated with high dose quartz revealed mild to moderate inflammation. These results show that, for the test conditions described here and on an equal-weight basis, if carbon nanotubes reach the lungs, they are much more toxic than carbon black and can be more toxic than quartz, which is considered a serious occupational health hazard in chronic inhalation exposures."

(from Nanoscience and Nanotechnologies," The Royal Society and the Royal academy of Engineering, July 2004)

"It is very unlikely that new manufactured nanoparticles could be introduced into humans in doses sufficient to cause health effects that have been associated with the nanoparticles in polluted air. However, some may be inhaled in certain work places in significant amounts and steps should be taken to minimize exposure. Toxicological studies have investigated nanoparticles of low solubility and low surface activity. Newer nanoparticles with characteristics that differ substantially from these should be treated with particular caution. The physical characteristics of carbon and other nanotubes mean that they may have toxic properties similar to those of asbestos fibers, although preliminary studies suggest they may not readily escape into the air as individual fibers. Until further toxicological studies have been undertaken, human exposure to airborne nanotubes in laboratories and workplaces should be restricted.

There is virtually no information available about the effect of nanoparticles on species other than humans or about how they behave in the air, water or soil, or about their ability to accumulate in food chains. Until more is known about their environmental impact we are keen that the release of nanoparticles and nanotubes to the environment is avoided as far as possible. Specifically, we recommend as a precautionary measure that factories and research laboratories treat manufactured nanoparticles and nanotubes as if they were hazardous and reduce them from waste streams and that the use of free nanoparticles in environmental applications such as remediation of groundwater be prohibited."

Catalysts

(Blue Nano)

CNTs can contain transition metals, such as Fe, Co, Ni, and Mo, or others, which are used during CNT fabrication. Catalysts may become part of the finished CNT material or byproducts. Accordingly, the raw CNT material, and/or applied technologies may also contain these elements, and should be treated accordingly.

Flammability and Explosion Hazards SOLIDS.

(written by staff, 2003; reference: Dust Explosions, by P. Field, Elsevier Scientific, 1982)

In general, it should be noted that explosions can occur when fine combustible particulates, having a particle size less than 500 micrometers and capable of becoming airborne, are handled. For all combustible particle types, the rate of pressure rise during explosion increases as the particle size decreases. Moreover, the minimum amount of energy required to start the explosion decreases as the particle size decreases. Particulates also exhibit lower and upper explosion limits, as for flammable gases. Any flammable dust may burn at an even more rapid rate if it burns also in the presence of H2.

The specific case of the sensitivity of Carbon Nanotubes (CNTs) to flammability and explosivity has not yet been established. Carbon nanotubes are somewhat similar to graphite in composition and structure. One might therefore expect the reactivity of graphite to predict the reactivity of CNTs. Fortunately; powdered graphite has not been seen to be an explosive dust [Field, p. 201-202].

However, CNTs exist as small-sized individual particles. Moreover, CNTs are produced along side with other carbon materials, such as Fullerenes and amorphous carbon. The amounts of these other components will depend on the process equipment and conditions. The main point is for all workers using CNTs to understand the flammability and explosive potential of nanoparticulates, and to understand the increased risks if:

(1) the particle is known to be combustible

(2) the particle becomes airborne

(3) the particle size is small (<500 nm), or decreases as a result of a process change

(4) the oxidation potential increases due to the composition of product or by-product particulates

(5) oxidizers (e.g. oxygen) are present in sufficient concentrations

(6) the particles also are exposed to flammable gases (e.g. hydrogen)

(7) the particulate concentration falls between the lower and upper explosion limits

(8) an ignition source is present (one or more of the following are true:

(a) temperature is high enough to support combustion,

(b) one of the following comes into contact with the airborne particles:

i) electric spark,

ii) flames,

iii) hot surfaces,

iv) incandescent material (e.g. glowing particles),

v) welding or cutting operations,

vi) friction or impact sparks,

viii) electrostatic discharge sparks .)

(9) The size of the vessel is small and/or will not support the resulting pressure increase The risk of a dust explosion may be minimized by using inert process gases where possible (e.g. nitrogen).

Disclaimer:

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