Nanomaterials Safety Considerations –

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A Material Safety Data Sheet (MSDS) has been written by Cheap Tubes Inc for It's carbon nanotubes & other nanomaterials. In addition to each MSDS, the following excerpts in this document are recommended reading for further education. Cheap Tubes Inc, byway of inclusion, does not endorse any particular selection.

Government Agencies

To receive documents or other information about occupational safety and health topics, contact NIOSH at
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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 alsoReno 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;
NIOSH
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
(Winnepeg, 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)
"...Buckyballs, 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 buckyballs 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 buckyballs 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 SWCNTinstilled rats within 24 h postinstillation. 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 peribronchial inflammation and necrosis that had extended into the alveolar septa. The lungs of mice treated with carbon black were normal, whereas those treated with highdose 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 fibres, although

preliminary studies suggest they may not readily escape into the air as individual fibres. 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 abilty 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

(Cheap Tubes Inc)
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. Acxcordingly, 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 H_2. 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 (<500μ m), 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, vii) 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).