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Caz Scislowicz
Director, Environment, Health, & Safety
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January 22, 2010

DIRECTOR'S OFFICE
DEPT OF TOXIC SUBSTANCES CONTROL
JAN 20 2010
RECEIVED

Jeff Wong, PhD
Chief Scientist
Department of Toxic Substances Control
1001 "I" Street
P.O. Box 806
Sacramento, CA 95812-0806

Re: Chemical Information Call-In: Carbon Nanotubes use at Caltech

Dear Dr. Wong,

In response to the January 22, 2009 information call-in request by DTSC, California Institute of Technology (Caltech) respectfully submits the following information regarding use of carbon nanotubes (CNT) at the Institute.

1. What is the value chain for Caltech?

Caltech is an independent, privately supported university, dedicated to teaching and research. Currently, about 11 research groups on campus use CNT in various types of basic research, including electronic and energy storage devices and fundamental material science research. There are three sources of CNT on campus: (a) vendors such as CarboLex, Inc. and Carbon Solutions, Inc.; (b) some limited supply from collaborators off-campus; (c) and laboratory scale amounts synthesized on campus. Synthesis is typically done via the chemical vaporization method, either in the gas phase or liquid phase.

Attachment 1 lists some typical fields of CNT study and the respective departments in which the work takes place.

2. What sampling, detection and measurement methods are you using to monitor (detect and measure) the presence of your chemical in the workplace and the environment?

Caltech's approach to determine the potential presence of CNT is by conducting personal interviews with researchers about their practices and perform workplace safety evaluations in laboratories that use CNT. The information gathered, indicates a minimum risk of personnel exposure and release to the environment. Factors that contribute to this conclusion are (a) the laboratory scale micro-quantities of CNT utilized, (b) the engineering controls and work practices deployed, and (c) an

appropriate use of personal protective equipment. As additional information becomes available with regard to the potential health and safety risks associated with engineered nanomaterials, additional protective steps will be considered.

3. What is your knowledge about the current and projected presence of your chemical in the environment that results from use, and end-of-life disposal?

The quantities of nanomaterial on hand are representative of laboratory scale, estimated to be about 11 grams per year for the Caltech campus. Current usage is stable and well defined with no drastic change in inventory anticipated in the future. Much of the research involves testing the performance of the CNT, which are bound to substrates and either stored for repeat experiments or disposed of as hazardous waste. Conceivably, trace amounts of CNT could be released via the laboratory exhaust systems such as fumehoods and ventilated furnaces.

Given the small inventory of nanomaterials at Caltech, its presence is a negligible percentage of laboratory waste. Caltech collects all laboratory waste, including engineered nanomaterials, and treats it as hazardous waste. Caltech contracts with a qualified waste broker who packages the hazardous waste in tightly sealed containers, and disposes of the waste in a permitted waste treatment facility.

The risk assessment approach used for conventional hazardous material is generally acceptable for engineered nanomaterials. The potential release of any hazardous material, including nanomaterial, typical at an academic research setting occurs during normal storage and handling of nanomaterials in the laboratory, during waste management procedures, and from accidental spills. If an accidental spill did occur, the potential release quantities of nanomaterial are quite small, in the range of microgams. Response and clean-up procedures are in place and are similar to those applied to any other hazardous material.

4. What is your knowledge about the safety of your chemical in terms of occupational safety, public health, and the environment?

National and international exposure standards have yet to be established for engineered nanoparticles (Safe Nanotechnology 2008). Caltech will continue to monitor new information from sources such as the National Institute of Health (NIOSH) http://www.cdc.gov/niosh/topics/nanotech/ and the International Council of Nanotechnology (ICON) http://icon.rice.edu/ . These organizations provide the much needed analysis from peer-reviewed publications to guide the community on the potential impacts from CNT to occupational safety, public health, and the environment.

5. What methods are you using to protect workers in the research, development and manufacturing environment?

Caltech's Chemical Hygiene Plan http://www.safety.caltech.edu/documents/28-chemical_hygiene_plan.pdf provides environmental, health and safety guidance to researchers working in Caltech's laboratories with hazardous material, although engineered nanomaterials are not specifically identified. However, until the potential health risk of handling nanomaterials is better understood, researchers working at

Caltech are implementing a standard and prudent approach of engineering controls, work practices, and personal protective equipment to minimize potential exposures. Caltech Environment, Health, & Safety staff does meet with researchers working with nanomaterials to provide consultation and direction on minimizing occupational exposures and avoiding releases to the environment.

A guide on the use of engineered nanomaterial is in development, which once completed, will be distributed to the relevant research groups and posted on the Caltech EHS website. This guide reinforces engineering and administrative controls, guides researchers on best work practices, and gives direction on storage and waste management techniques.

6. What are your waste handling practices for CNT?

Nanoparticle wastes are managed as a part of the normal laboratory hazardous waste stream in compliance with federal, state, and local requirements. Hazardous waste is collected in closed containers, labeled appropriately, and disposed of properly via a qualified waste broker.

See http://www.safety.caltech.edu/documents/50-hazwaste_ref_guide.pdf for additional information on hazardous waste management.

Please direct any inquires regarding this response or future information call-in and rule making to Caz Scislowicz, Director, Environment, Health, and Safety, caz@caltech.edu (626-395-6727).

Sincerely,

Caz Scislowicz
Director, Environment, Health, & Safety

cc: Jean-Lou A. Chameau, President, Caltech

Stephen L. (Steve) Mayo, Vice Provost, Caltech

Attachment 1. Fields of CNT Study and Respective Departments

Field of CNT research / examples	Department / Division
Transport and electrical properties Atomic-Scale Mass Sensing Using Carbon Nanotube Resonators Mott Insulating State in Ultraclean Carbon Nanotubes	Applied Physics/ Engineering and Applied Science (EAS)
Sharp Carbon-Nanotube Tips and Carbon-Nanotube Soldering Irons Entanglement and the nonlinear elastic behavior of forest of coiled carbon nanotubes	Graduate Aerospace Laboratories (GALCIT) and Applied Physics / EAS
Mechanical properties Strain rate effects in the mechanical response of polymer anchored carbon nanotube foams	Materials Science / EAS
Mechanical properties A Cohesive Law For Carbon Nanotube/Polymer Interfaces Based On The Van Der Waals Force	GALCIT / EAS
Nanocarpet: nanostructured surface comprised of densely packed, well-aligned, and vertically oriented carbon nanotubes supported on a substrate.	GALCIT / EAS
Catalysis - Theory Coupling of Raman Radial Breathing Modes in Double-Wall Carbon Nanotubes and Bundles of Nanotubes (Theory) Dynamic admittance of carbon nanotube-based molecular electronic devices and their equivalent electric circuit (Theory)	Chemistry, Materials Science, Applied Physics
Electrochemical characterization of parylene-embedded carbon nanotubes nanoelectrode arrays	Electrical Engineering / EAS
High Aspect Ratio Silicon Dioxide-Coated Single-Walled Carbon Nanotube Scanning Probe Nanoelectrodes Contact angles, ordering, and solidification of liquid mercury in carbon nanotube cavities - electrowetting	Chemical Engineering / CCE