



Safe handling and use of carbon nanotubes in the workplace

INFORMATION SHEET

What are carbon nanotubes?

Carbon nanotubes are a type of nanomaterial with physical and chemical properties that can be applied in a variety of industrial and biomedical applications including:

- catalysts
- biosensors
- composite materials with improved structural and electrical properties, and
- drug carriers.

They are up to 100 times stronger than steel while being much lighter and are good conductors of electricity and heat.

Hazards

All carbon nanotubes and structures of carbon nanotubes should be considered hazardous unless evidence shows otherwise. Carbon nanotubes can be biopersistent and some forms have the potential to exist as fibre-like structures.

The results of animal studies have indicated that all biopersistent carbon nanotubes or aggregates of carbon nanotubes of pathogenic fibre dimensions could be considered as presenting a potential fibrogenic and mesothelioma hazard, unless demonstrated otherwise by appropriate tests. Carbon nanotube structures which are not fibre-like can also have hazardous properties and animal studies have shown adverse lung effects including pulmonary inflammation and fibrosis.

Carbon nanotubes are not considered to be dangerous goods as they are difficult to combust and ignite. However dust clouds of carbon nanotubes may present safety hazards.

Regulations

Australia's work health and safety legislation aims to protect the health and safety of researchers and other workers developing, manufacturing or using carbon nanotubes. General duties under the legislation apply to working with carbon nanotubes as they do to technologies, substances and materials generally. The model Work Health and Safety (WHS) Regulations for workplace chemicals cover carbon nanotubes in the same way as other chemicals.

The WHS Regulations for workplace chemicals include but are not limited to the following:

- The manufacturer or importer must determine whether the substance is a hazardous chemical. If it is, they must prepare a safety data sheet (SDS) and correct label. Carbon nanotubes should be considered to be hazardous unless data indicate otherwise and therefore an appropriate SDS and label should be provided.
- The supplier of a product containing carbon nanotubes must ensure a current safety data sheet is provided to workplaces receiving the product.
- A person conducting a business or undertaking must ensure hazards in relation to using, handling or storing carbon nanotubes or products containing carbon nanotubes at the workplace are identified. The associated risks must be eliminated or minimised so far as is reasonably practicable.

Risk management approach

A precautionary approach to handling carbon nanotubes and preventing adverse health effects from exposure is recommended. The document *Safe Handling and Use of Carbon Nanotubes* provides advice on how people can work safely with carbon nanotubes in the workplace. It was prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) that has lengthy experience in working with carbon nanotubes.

The guidance in this document is applicable to other forms of carbon nanofibres like carbon nanorods and carbon nanowires. It is also applicable to products containing carbon nanotubes and other forms of carbon nanofibres where these nanomaterials may be released during handling.

A general risk management process can be applied for working safely with carbon nanotubes, as shown in Figure 1. It shows that risks may be controlled with or without conducting a detailed risk assessment. If after identifying a hazard you already know the risk and how to control it effectively, you may implement the controls without further assessment.

FIGURE 1: The risk management process



Safe Handling and Use of Carbon Nanotubes provides guidance on two options to manage risks. Either or both methods may be used, depending on the circumstances.

Method 1 - Carbon nanotubes risk management with detailed hazard analysis and exposure assessment

This approach should be used when it is necessary to gather and evaluate information on the following to assess the risk:

- characteristics of the carbon nanotubes and structures of carbon nanotubes, and/or
- potential levels of exposure throughout the process and associated work.

Method 2 - Carbon nanotubes risk management by Control Banding

This is a simplified approach that can be used when:

- production and manufacturing processes are well understood
- potential exposure routes are known, and
- safe work procedures are developed.

Controls are recommended based on the potential level of exposure.

Choice of controls

The approach to choosing controls for working with carbon nanotubes is the same as for working with chemicals generally. The most important step in managing risks involves eliminating them so far as is reasonably practicable. If this is not possible then the risk of working with carbon nanotubes should be minimised so far as is reasonably practicable by using one or more of the following approaches, in line with the hierarchy of control (most to least preferred):

- substitution or modification of carbon nanotubes to reduce the hazard
- isolation or process enclosure
- implementing engineering controls like local exhaust ventilation (LEV)
- administrative controls, and
- personal protective equipment (PPE).

When used on their own, administrative control measures and PPE are generally the least effective ways of minimising risks. PPE should be used where the use of other control measures is not practicable or as an additional option to help support higher levels of exposure control.

Controls effectiveness

Measurement data have shown that exposure to carbon nanotubes can be controlled by using conventional control methods like process enclosure and LEV where the equipment is appropriately designed for the process involving carbon nanotubes.

Work is being done in Australia and overseas to validate and improve measurement techniques for carbon nanotubes in the workplace. Information on measurement of engineered nanomaterials in general can be found in the Organisation for Economic Co-operation and Development (OECD) Working Party on Manufactured Nanomaterials document Emission Assessment for Identification of Sources and Release of Airborne Manufactured Nanomaterials in the Workplace: Compilation of Existing Guidance.

The United States National Institute for Occupational Safety and Health (NIOSH) has proposed a Recommended Exposure Limit of $7\mu\text{g}/\text{m}^3$ for carbon nanofibres including carbon nanotubes determined as elemental carbon by NIOSH Method 5040.

Current work

To inform the regulation of carbon nanotubes, Safe Work Australia commissioned the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) to undertake a human health hazard assessment and classification of carbon nanotubes. Results are expected to be published in mid-2012.

More information

Safe Handling and Use of Carbon Nanotubes and more information on the nanotechnology work health and safety program are available at www.safeworkaustralia.gov.au

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