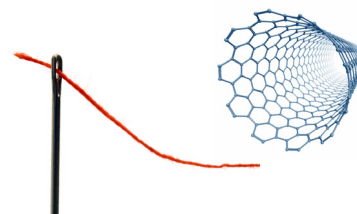




## Textiles and Carbon Nanotubes

### Helping Business with Risk, Regulation and Responsibility



#### Background

**SAFENANO** has contributed to a lifecycle analysis study of CNT-containing textiles, to identify critical stages where there may be potential for the release of CNTs, and to give a qualitative assessment on the subsequent exposure inhalation risk posed. The lifecycle study has identified the following groups that could be at risk of inhalation exposure to CNTs:

- production personnel involved with **powder handling** and **processing** of CNTs, including **maintenance** and **cleaning**.
- production personnel involved with **fibre coating**, **spinning** and **weaving** processes.
- personnel working at **recycling** facilities.

#### Risk, Regulation & Responsibility

The use of carbon nanotubes (CNTs) in the textiles sector has so far been restrained due to the prohibitively high cost of the materials. However, as production costs come down the use of CNTs is likely to become more prevalent as manufacturers seek to exploit the exceptional properties that these materials confer when incorporated into or coated onto a range of natural and synthetic fibres.

A clear barrier to growth is the significant risk presented to business from :

- uncertainty that remains regarding the potential **toxicity** of these innovative raw materials.
- uncertainty regarding current **regulation** on nanomaterials coupled with the problem that many CNTs are supplied with MSDS data corresponding to graphite.
- results from recent studies<sup>1,2</sup> which have indicated that some CNTs may manifest **asbestos-like** pathogenic effects through inhalation exposure.

Regulators in the United States<sup>3</sup> and Europe<sup>4</sup> continue to introduce further measures to regulate CNTs. Manufacturers and importers must therefore exercise appropriate duty of care measures and prepare for further regulatory compliance.

#### Who can help?

**SAFENANO** is a recognised **leader** in the **characterisation**, **exposure assessment** and **toxicology** of **particles**. We can help you identify, understand and address the potential risks from manufactured nanomaterials to your employees, your customers and the environment. Using a best practice approach SAFENANO can provide you with a basis for responsible stewardship to help meet your duty of care responsibilities.

1 – Poland, C et al. "Carbon nanotubes introduced into the abdominal cavity of mice show asbestos-like pathogenicity in a pilot study"; Nature Nanotechnol, vol, 3, no.7, pp. 423-428.

2 – Porter DW et al. "Mouse pulmonary dose- and time course-responses induced by exposure to multi-walled carbon nanotubes"; Toxicology, 2010 Mar 10;269(2-3):136-47.

3 – Unites States EPA - "Toxic Substances Control Act Inventory Status of Carbon Nanotubes"; FR Doc E8-26026.

4 – European Commission - Removal of exemption status of carbon and graphite from REACH Amended Annex IV and V.

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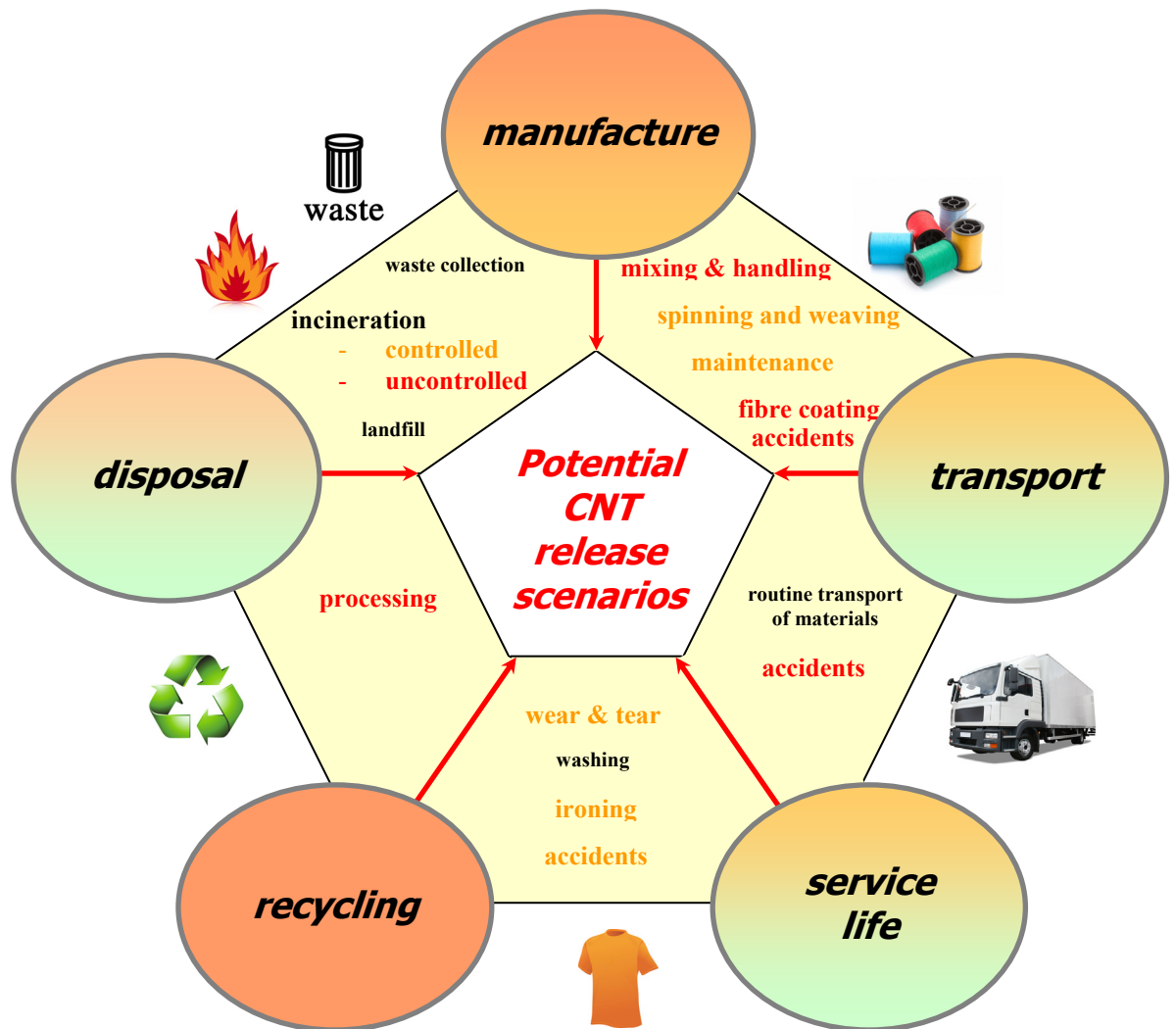
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## Lifecycle Analysis of CNT-Containing Textiles

The lifecycle analysis below provides information to help identify potential for inhalation exposure to carbon nanotubes used in textiles, allowing you to evaluate the potential risks to your business.



The full report "*NANOLIFECYCLE – A Lifecycle Assessment Study of the Route and Extent of Human Exposure via Inhalation for Commercially Available Products and Applications Containing Carbon Nanotubes*" is available on the SAFENANO website, [www.safenano.org](http://www.safenano.org)

Lifecycle Stage	Potential Release Scenarios	
	Incorporated into the Material	Coated onto the Material
Manufacture	<b>Initial Handling / Mixing</b> The potential risk of inhalation to CNTs is possible under conditions where exposure to powder dust is conceivable during the preparation stage ( handling, weighing, mixing etc ). Exposure would vary depending on the nature of the CNTs as delivered ( dry, in suspension, masterbatch etc ).	
	<b>Fibres Coating</b>	A CNT containing suspension is likely to be applied by either dipping or spraying techniques. It's unlikely that a dipping activity would lead to exposure of airborne CNTs whereas spray coating has significant potential for inhalation exposure if the process is not controlled adequately.
	<b>Spinning</b> Synthetic fibres are generally produced by a hot process at temperatures around 270°C. As the filaments are drawn, spun and wound on the bobbin the high energy and mechanical contact between fibres may lead to some shedding. Fibres that have been shed however will likely to be of the composite rather than CNT material alone.	

# Lifecycle Analysis of CNT Containing Textiles

Lifecycle Stage	Potential Release Scenarios	
	Incorporated into the Material	Coated onto the Material
Manufacture	<b>Weaving</b> As with spinning some shedding of fibres may be expected during the weaving process due to mechanical contact. As with spinning any fibres exfoliated from the yarn will be of the composite rather than free CNTs	Shedding of fibres during weaving is possible as noted previously. As the CNTs are on the surface of the fibres for this production process then it is likely that these will be released first.
	<b>Equipment Maintenance and Waste</b> Disposal of any CNT containing waste generated or particulate emissions released during equipment maintenance may present an inhalation exposure risk.	
	<b>Accidents</b> <b>Spillage</b> This could include spillage of CNTs or CNT formulation, contamination of the workplaces and exposure during subsequent clean up. In many industrial processes clean up after spillage is a major source of exposure. <b>Fire</b> Major accidents, such as fire in a storage facility, may create the potential for release into the environment and the potential for occupational exposure to those attending or involved. Whilst controlled incineration ( 740°C ) will result in complete incineration of CNTs, uncontrolled incineration at lower temperatures may not result in destruction of the CNTs.	
Transport	<b>Fire</b> Exposure to high temperatures such as a fire may have the potential for CNT release.	
	<b>Routine Transport</b> Release and inhalation exposure is not anticipated under normal circumstances.	
Service life	<b>Wearing</b> Garments typically experience a 10% weight loss during use from various processes ( abrasion, thermal degradation, weathering etc ) where it is likely that most takes place during washing. Wearing may cause some CNT containing fibres to be shed although these are likely to be transferred to the skin or other clothing and washed off. Shedding of fibres, however, could present a chronic low level exposure to the wearer and those in contact ( family and children ) although these fibres would be of the composite rather than the free CNT.	As noted shedding of fibres is possible during the wearing of garments. If the CNTs are applied to the outside of the fibres then these would be expected to be released first and would subsequently be of concern. Whilst they would also be expected to be transferred to the skin or clothing, rather than being aerosolised, they could present a chronic low level of exposure to the wearer and to those in contact with the wearer in the home environment.
	<b>Washing</b> Washing may cause some fibre release but these are likely to be retained within the waste water stream and subsequently will not provide an inhalation exposure.	
	<b>Ironing</b> Normal ironing would not be expected to result in fibre release. Accidental burning by ironing may cause thermal degradation of the material leaving an ash cake which contains free CNTs. It may be possible for these CNTs to enter the smoke emitted.	
Recycling	Textiles undergo various mechanical, thermal and chemical treatments as part of the recycling process. All of these could potentially lead to CNT exposure	
Disposal	<b>Uncontrolled Incineration</b> Uncontrolled incineration ( e.g. uncontrolled fires ) is unlikely to destroy the CNT. The resulting ash cake may contain CNTs which present a risk of potential exposure.	
	<b>Controlled Incineration</b> Incineration conditions ( >850°C ) are likely to destroy CNT materials and should pose no risk of inhalation exposure.	
	<b>Landfill</b> The land filling process may involve some mechanical processes resulting in some shedding of fibres which may cause exposure to the workers involved in the activity. Once landfill has been completed then release to the air is unlikely.	

Potential Risk :  - low  - medium  - high

# Multidisciplinary expertise ...

Our expertise covers occupational hygiene and health, laboratory services, toxicology, ecotoxicology, review of existing data or knowledge and training provision. We offer first class client care from start to finish, using an approach that ensures each customer has access to our multidisciplinary scientific team via a single point of contact.

As recognised leaders in the field, our authoritative reports are guaranteed to be independent, and can be trusted by you, your employees, insurers and investors

**Our approach is professional, with an emphasis on delivering multidisciplinary solutions tailored to your needs**

**Our services span six interconnecting areas :**



## The SAFENANO Team ...

In addition to its extensive in-house expertise through the IOM, **SAFENANO** has access to a multidisciplinary consortium of internationally recognised researchers through SnIRC – the Safety of Nanoparticles Interdisciplinary Research Centre. SNIRC was formed in 2004 to address nanoparticle risk issues, and is based on long-standing collaborations between the IOM, Edinburgh, Aberdeen and Edinburgh Napier Universities and the Central Science Laboratory (CSL).

The combined expertise of the IOM and SnIRC provides **SAFENANO** clients with a

unique and extensive wealth of experience in particle toxicology, exposure, ecotoxicological and human studies/epidemiology.

Members of the **SAFENANO** team are actively involved in advising government agencies such as DEFRA and NIOSH on the potential risks of nanotechnology to health, and management of these risks.



SAFENANO has also been heavily involved in the writing of landmark reports and papers such as BSI PD 6699-2 " **Good practice guide to safe handling and disposal of nanoparticles** " the Nature paper " **Safe handling of Nanotechnology** " and the DEFRA report " **EMERGNANO** ".



## Who to Contact ...

**To discuss how SAFENANO's comprehensive and responsive approach can provide the support you need to stay safe with nanotechnology, contact:**

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