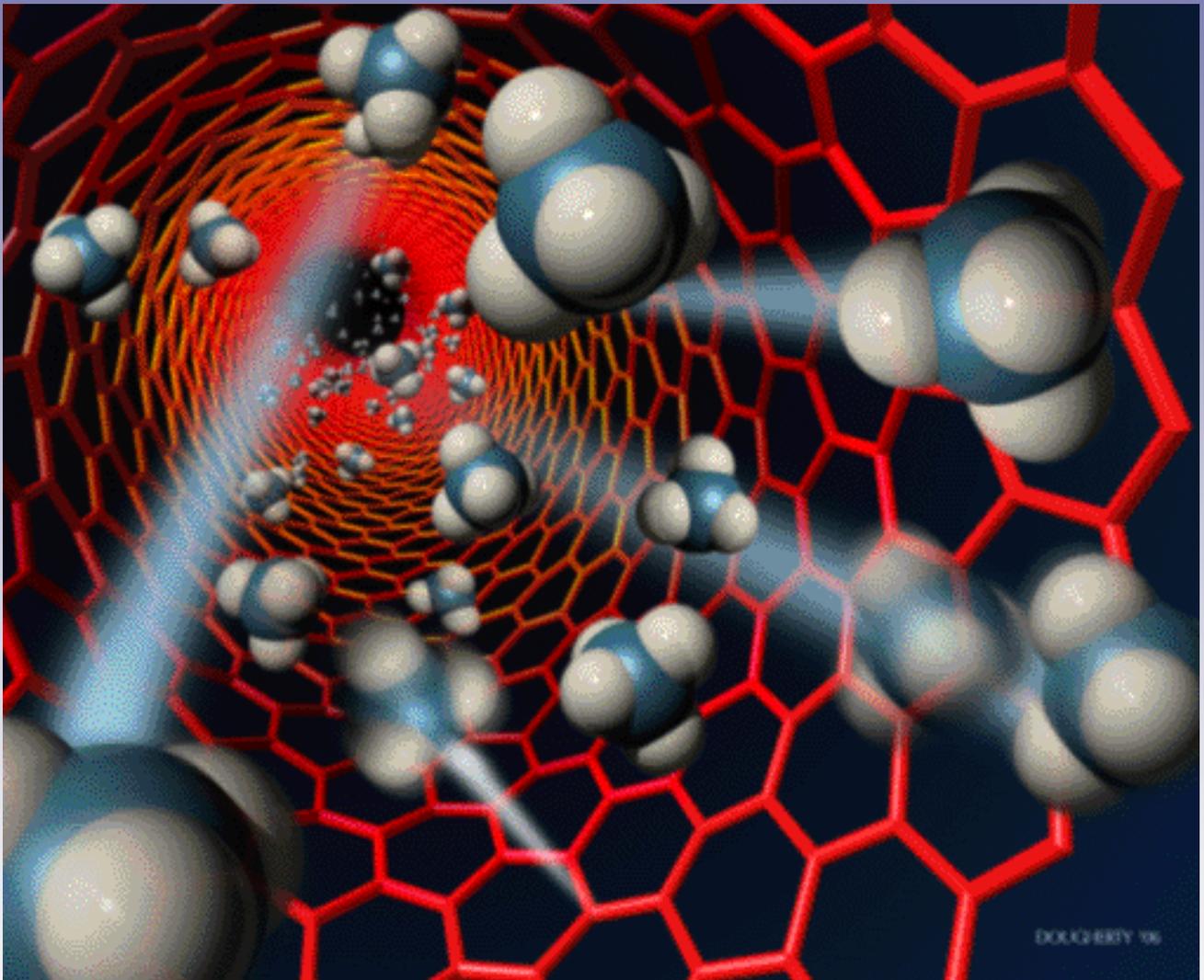


CRO briefing

CRO Forum Emerging Risk Initiative (CRO ERI)

# Carbon Nanotubes (CNTs)

December 2009



The aim of the CRO Forum Emerging Risks Initiative Risk Briefings is to highlight a risk topic by introducing the risk background, the relevance for the insurance industry as well as a short outlook



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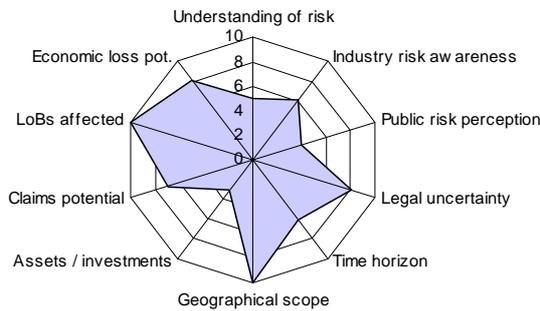


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# Carbon Nanotubes' Characterisation



Rating Description			
	1	5	10
Understanding of risk	very good	medium	very poor
Industry risk awareness	high	medium	none
Public risk perception	low	medium	high
Legal uncertainty	none	medium	high
Time horizon	long term (>20yrs)	medium (10-20yrs)	short term (<5-10yrs)
Geographical scope	Africa or Asia or EU	US	worldwide
Assets/investments	few	several	many
Claims potential	none	medium	high (class action)
Lines of business	<2	=2	>2
Economic loss pot	>100m	>1bn	>10bn

## Risk Description

**Carbon Nanotubes (CNTs) are one of the most prominent nanomaterials. Due to potential asbestos-like effects of CNTs with needle like shape they are at the center of attention.**

CNTs are cylindrical structures which resemble a rolled-up piece of nano-scale 'chicken wire'. This hexagonal grid, composed of carbon atoms, forms a single involuted layer of graphite just one atom thick. Those CNTs composed of only one of these cylindrical structures are called Single Wall Carbon Nanotubes (SWCNT), and those composed of multiple, concentric cylinders are called Multi Wall Carbon Nanotubes (MWCNT) (Figure 1).

### CNT use and value chain

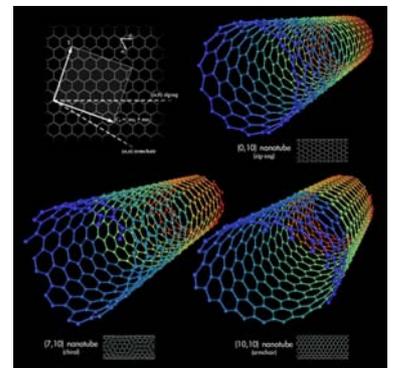
The novel, extraordinary properties of CNT make them potentially useful for many applications of nanotechnology: in electronics (e.g. rechargeable batteries, memory chips and sensors), optics (e.g. TV displays, computer monitors and military imaging) and other fields of materials science (e.g. composite materials for sports, automobiles or aerospace), as well as various uses in construction. However, additional findings on potential toxicity may limit their usage and economic significance.

### Marvelous but potentially troublesome material

The length-to-diameter ratio of CNTs is significantly larger than that of many other materials. They have about 100 times the tensile strength of steel at one sixth of its weight. Other properties vary depending on a CNT's particular structure: Some demonstrate metallic or semi-conducting qualities, some are elastic and can be bent and twisted without breaking. Others, especially some MWCNT, have a needle-like shape and properties similar to those of asbestos.

### Carbon nanotubes – fast growing new technology

CNTs are produced on an industrial scale, and the market is growing fast: In 2006 the estimated market size was USD 49m and is projected to grow to USD 460m in 2011 (primary production only). There are many manufacturers, inter-mediaries and processors all over the world; and the various types of CNT find applications in a host of different intermediates, products, and composites (Figure 2). In case suspicions of an asbestos-like effect are substantiated, claims are likely to follow, although presently known facts limit exposure to some forms of MWCNT and sub-standard working conditions.



**Figure 1:**  
3D model of three types of single-walled carbon nanotubes  
(Source: Michael Ströck / Wikipedia)

CNT inter-mediate	Industries exposed
Coating	Automotive, consumer electronics, textiles, packaging
Composite	Automotive, aerospace, consumer goods, construction, textiles, packaging
Catalysts	Energy, automotive
Display	Consumer electronics
Drug delivery	Pharmaceutical
Energy storage	Consumer electronics, automotive
Memory	IT
Solar cells	Energy
Sensors	IT, Pharmaceutical
Therapeutics	Pharmaceutical

**Figure 2:**  
CNT intermediates and industries exposed

## Risk Assessment

### Hazard profile

Potential critical points during life cycle of CNTs are likely to occur:

- during production and shipping of CNTs (e.g. in powder form) when the risk of release into the air is highest
- following unexpected releases due to incidents (e.g. blast wave, spilling)
- during production of final product, e.g. as commercial waste
- during use (e.g. textiles and pharmaceuticals; in many other products, CNTs are bound in matrix)
- during disposal or recycling (abrasive/dust)

Particular types of MWCNT with a long, fibrous structure and a needle-like shape similar to asbestos have been linked to various pulmonary diseases and inflammatory responses, while short-fibre CNT have not. Conclusion: If released to the air and inhaled (mainly by workers), most probably particular CNTs will have the same effects as asbestos. Early "proof of principle" studies, however, have been limited to high doses of MWCNT injected directly into the abdominal cavity of mice: Although these studies are not perfect they have triggered regulatory action and given rise to precautionary measures.

### Regulation

Nanospecific modification of existing regulation is mostly still lacking. While in the EU the precautionary principle is established, the US and Japan still prefer a case-by-case regulatory framework:

- Europe: on Oct. 8, 2008, the European Commission's chemicals registration legislation REACH was adopted to address the specific risks of carbon nanotubes. In March 2009 the EU legislation on cosmetics was adopted for nanomaterials: labelling, definition and safety assessment needed
- U.S: in June, 2009 the Environmental Protection Agency (EPA) proposed two Significant New Use Rules (SNUR) of the Toxic Substances Control Act (TSCA) for multi-walled and single-walled carbon nanotubes. California's Division of Toxic Substances Control (DTSC) has issued a data call-in regarding CNT safety, uses, life cycle fate, transport, and human-health and environmental protection measures
- Asia: existing regulation has not yet been modified specifically for nanomaterials.

## Considerations for the insurance industry

How can the insurance industry best cope with this uncertainty? In light of all that is known to date about exposure to asbestos-like effects of CNT, there are a number of considerations for individual insurance companies in terms of pre-emptive risk mitigation strategies, e.g.:

- Raise clients' awareness
- Map risk exposure (e.g. improve understanding of how individual clients deal with CNT)
- Level of risk management practice has to be taken into consideration
- Consider whole life cycle of CNTs and impacts on traditional LoBs
- Development of appropriate UW measures - on a company by company basis - and adaptation to the facts and circumstances of the individual risks being underwritten.

### Outlook

Nanotechnologies in total are very rapidly developing technologies with a huge market potential. The risks related to carbon nanotubes are a moving target and have to be monitored closely. Substantial developments with regard to products, hazard profiles and regulation are to be expected in the next decade.

#### Nanotechnology, an umbrella term

Nanotechnology is increasingly being used in broadly different industries. It is thus becoming an indispensable part of tomorrow's industrial landscape, enabling manufacturing and products unthinkable so far.

Nanotechnology is an umbrella term for a wide number of technologies that aim at producing, manipulating, or assaying materials with dimensions of 100 nm (nanometres) or less.

Nano-technology, in its immense diversity, is developing more rapidly than risk can be characterised and knowledge gaps can be closed.

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## The CRO Forum's Emerging Risks Initiative

The Emerging Risks Initiative (ERI) was launched in 2005 to raise awareness of major emerging risks relevant to society and the (re)insurance industry. The initiative is currently chaired by AXA and consists of eight members representing Allianz, Hannover Re, Munich Re, RSA, Swiss Re, Zurich Financial Services as well as AIG, and AXA.

Emerging risks are by far the biggest challenge for the insurance industry. Emerging risks are risks which may develop or which already exist that are difficult to quantify and may have a large loss potential. Further, emerging risks are marked by a high degree of uncertainty; even basic information, which would help adequately assess the frequency and severity of a given risk, is often lacking. Insurers have extensive experience in assessing risks but the ever-faster changing risk landscape and its increasingly complex and interconnected risks are making new demands on stakeholders – be they legislators, regulatory authorities, the scientific community, the private sector or civil society – to assume their respective responsibilities in the risk management process.

Governments bear key responsibilities for risk mitigation in society. Jointly with the regulatory authorities, they play a vital role in ensuring the viability of private insurance by creating appropriate legislative and regulatory frameworks. Yet, a systematic approach to risk management has, to date, often been lacking at governmental level, and affecting a nation's ability to identify, assess and manage global risks. Professional and systematic risk management would enable governments to prioritise risk mitigation and response measures more adequately. Individual or corporate insureds need to participate in sharing the risk of financial losses. A significant retention of potential loss is a powerful incentive to prevent or mitigate losses and reduces administrative costs by absorbing small, high frequency losses. The insurance industry can create incentives for these mitigation measures by raising awareness of the cost of having undiversified peak exposures. The insurance industry can further add value by contributing risk analysis and management expertise to help insure that entities and regulatory authorities handle their risks optimally.

By absorbing financial and insurance risk, the insurance industry plays an indispensable role in today's economic system. If this is to continue in the future, the industry must minimise surprises. It is therefore crucial to identify and communicate emerging risks to a broader community, thereby fostering a stakeholder dialogue with representatives of a community bound by a shared risk.

This risk briefing is supported by the CRO forum, which comprises the Chief Risk Officers of the major European and US insurance companies and financial conglomerates. The CRO forum is a professional risk management group focused on developing and promoting industry best practices in risk management. It seeks to present large company views, with three core aims:

- Alignment of regulatory requirements with sophisticated / best practice risk management
- Acknowledgement of group synergies, especially diversification benefits
- Simplification of regulatory interaction

The CRO Forum's views are communicated through its publications and made available to wider audiences, for example, through the CRO Forum web page at [www.croforum.org](http://www.croforum.org). The CRO Forum supports the activities of the Emerging Risk Initiative. This Initiative pursues the following goals:

- Raising awareness and promoting stakeholder dialogue
- Developing best practice solutions
- Standardising disclosure and sharing knowledge of key emerging risks

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