How nanotubes could be released into the environment

**Carbon nanotubes (CNT)** are a group of nanoparticles with remarkable physical and chemical properties. They are a promising material for a wide range of future technologies, including sports equipment, textiles and rechargeable batteries. However, questions have been raised about their safety. It is therefore important to understand how they could be unintentionally released into the environment in order to implement precautionary measures.

CNT consist of tiny hollow carbon cylinders, a few nanometres in diameter. They have a unique shape and do not degrade easily as they are mechanically and chemically resistant. Nanoparticles are biologically more active than larger particles due to their large surface area. Animal tests suggest they may be toxic to the lungs and cause cardiopulmonary diseases (disorders of the heart and lungs).

The prospective widespread use of synthetic CNT in industrial applications and consumer products has provoked concern that they could pose environmental and health risks. A recent study investigated possible ways in which CNT can be released from products leading to exposure of humans. Taking a lifecycle perspective, the researchers assessed two classes of mass produced products that may contain CNT in future. These were rechargeable batteries (to be used in mobile phones, for instance) and synthetic textiles (likely to be used in expensive, fashionable sportswear).

Although the researchers found that CNT are unlikely to be released from batteries during normal use, they could be emitted during the production, recycling and disposal stages of their life-cycle. Improper processing can cause CNT to be released into the air as dust. Battery recycling and recycling of metal from waste incineration residues in particular could cause occupational exposure to CNT. Incinerating batteries together with household waste would probably not degrade the CNT in the batteries. Environmental exposure could also occur if batteries are disposed of in landfills or dumpsites.

Release of nanotubes from textiles during use cannot be ruled out. Wear-and-tear could release CNT and lead to human exposure as garments are worn close to the body. CNT could also be released during recycling and disposal of used textiles. Used textiles are not subject to hazardous waste management. They are either exported overseas as second hand clothes or disposed of as household waste. While the fate of old textiles in developing countries is uncertain, the researchers assume that they may be disposed of in these regions through open burning. This would cause emissions of CNT since only incineration above 850°C eliminates CNT. Only modern waste incinerators operated properly could reach the required temperatures to degrade CNT.

Both case studies demonstrate that CNT can be released at various stages during the life cycles of products, and in an uncontrolled manner. Until, or unless, the adverse health effects of CNT can be ruled out, human exposure represents a risk.

The researchers adopt the precautionary principle and conclude that release of CNT from products should be avoided. Responsible product development is necessary in order to ensure the safety of workers and consumers, and should be implemented at an early stage in the innovation process of nanotechnology. Product designers should ensure that CNT are integrated into the product in a way which prevents release throughout the product’s life cycle.


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