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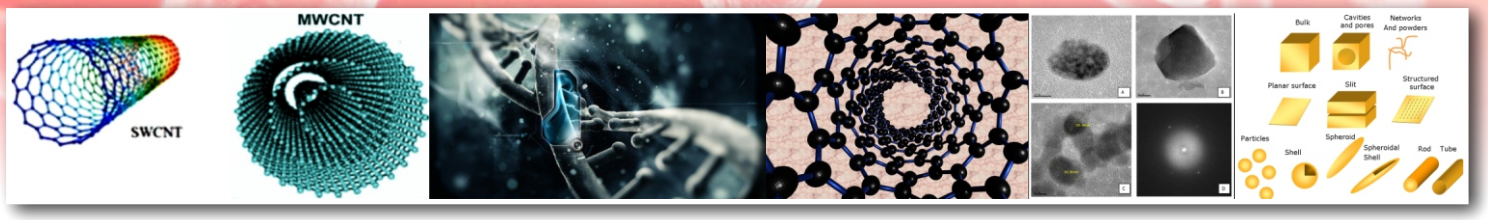

Nanomaterial Contaminants of Emerging Concern (CECs) in South African Water Resources

THE KNOWLEDGE HUB

What are nanomaterials?

Nanomaterials are ultrasmall materials, which have an initial size range between 1 - 100 nm. Since 1 nm is a millionth of a mm, specialized transmission electron microscopy is required to be able to observe them. Nanomaterials are characterized based on their size, shape, composition and surface functionalisation. Their production and use are ever increasing and they are being developed as products in various industries, which include cancer treatment (drug delivery), rapid test kits (Covid-19 detection, drug use), antibacterial products (socks, toothbrushes), energy production (batteries and solar cells), cosmetics (sunscreens), electronics, agriculture (nanopesticides, nanofertilizers) and various imaging technologies (optical probes).

Where do nanomaterials originate from?

Nanomaterials can be categorized into four main classes based on their origin:

1) Engineered nanomaterials are manufactured materials (organic or inorganic) which are used for various applications and can be produced in several tons.
2) Incidental nanomaterials are produced as a by-product of processes such as welding fume and diesel emission particulates.
3) Natural nanomaterials are as a result of natural processes such as sea spray, volcanic emissions, and atmospheric gas-to-particle conversion.
4) Engineered nanomaterials which mimic natural nanomaterials (metallic Organic Frameworks have similar structure and characteristics of volcanic ash).

What are the dangers associated with nanomaterials?

Due to their small size, nanomaterials are able to evade the biological protection seen in their ability to cross the blood-brain barrier. Exposure to different types of nanomaterials (quantum dots, nanogold, nanosilver, carbon nanotubes, titanium dioxide) all have unique toxicity associated with them. Another unique property of metallic nanomaterials is their ability to release ions in different pH ranges based on their composition (i.e. nanosilver can release silver ions). Therefore toxicity can be nano-specific or due to leaching of traditional chemicals. Generally nanomaterials cause an increase in reactive oxygen species, decreased fertility, behavior abnormalities and physiological changes in aquatic organisms.

How to prevent contamination of water resources with nanomaterials

Chemical transformation, aggregation, and disaggregation are all processes that cause nanomaterials to age in the environment. The interaction of these mechanisms with nanomaterials dictates the fate of nanomaterials and, in turn, their ecotoxicological potential.

- Exposure can occur in various stages of nanomaterial lifecycle: production, product usage and end of life of products.
- During production various additional filters need to be in place to avoid atmospheric deposition.
- Proper waste disposal from industries and end users is required.
- Medications should not be flushed down the toilet.
- Currently there are significant gaps in our scientific understanding of the transport, fate and toxicity of nanomaterials.

How to remove nanomaterials from water

- Various nanomaterials are used to purify water, but their use can also contaminate water as they age.
- Emulsification of contaminated water with oil in order to extract nanomaterials in the oil phase.
- Magnetization can be used to remove certain metallic nanomaterials.

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