NANOECOTOXICOLOGY AND HUMAN HEALTH: WHERE DO WE STAND?

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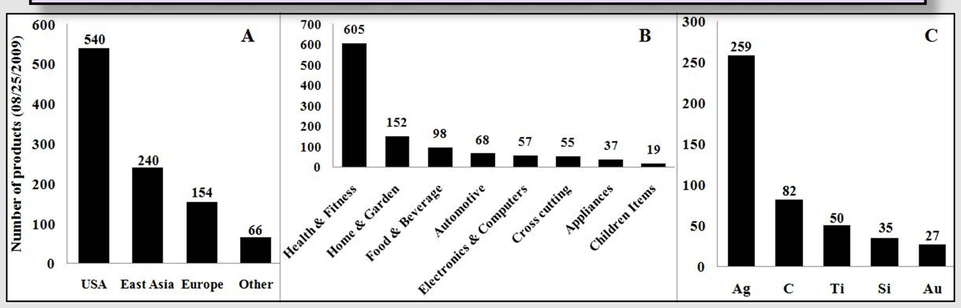
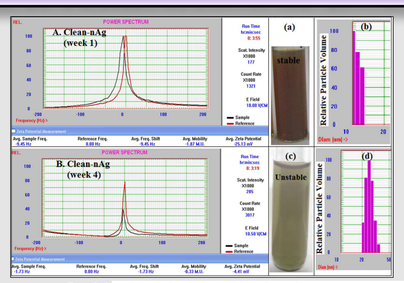
ABSTRACT: Globally rising applications of engineered nanomaterials (ENMs)—materials with ever-smaller dimension (1-100nm)—necessitate better understanding of their characteristics, which render them unique compared to their bulk counterparts, because of their higher potential for environmental release and associated risks to the ecosystems and human health. Rapid advancement in material science, including ENMs and their novel use, has left concerned regulatory agencies far behind from mitigating potential hazards upon exposure to ENMs. Minute particle size, higher surface area, and surface charge are features of ENMs which are generally attributed for their toxicity to various life forms. Besides several *in vitro* studies conducted in a variety of human cell lines, toxicity of ENMs on both the aquatic and terrestrial organisms has also been explored. However, there is yet no consensus on how ENMs should be regulated, handled, or disposed of. Toxicity varies not only with the size, shape, and surface charge of the particles, but also with the methods of synthesis, functionalization with capping agents, as well as with the solvent chemistry. This poster offers the state-of-the-art of ecotoxicity and human health effects upon exposure to nanomaterials, highlights the research gaps and needs for better understanding biologically and environmentally significant near-real-end points, and makes recommendations on how the current shortcomings in nanotoxicology should be addressed in order to determine whether nanotechnology should be envisioned as a potent tool for sustainability or a potential environmental liability for humankind.

APPLICATIONS OF ENGINEERED NANOMATERIALS

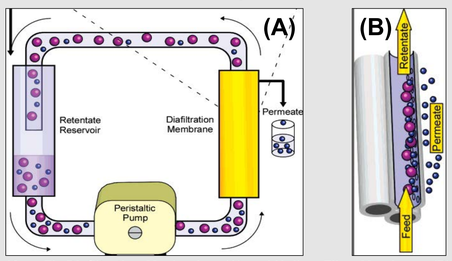


DIAFILTRATION & CHARACTERIZATIONS OF ENMS

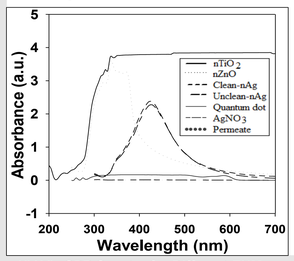
Kros *Flo Research Ili* TFF *System*



Particles Stability and Size Distributions

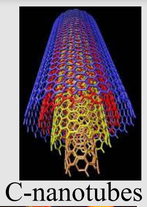


Kros *Flo* Diafiltration Mechanism (A) and Hollow Fiber Membrane (B)

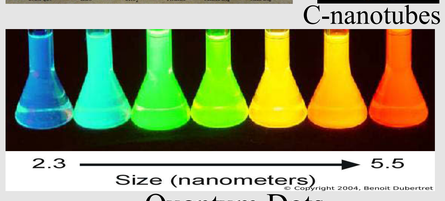


UV-Vis SPR Spectra for Different ENMs

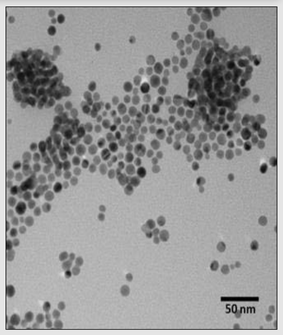
TYPES OF ENGINEERED NANOMATERIALS



C-nanotubes



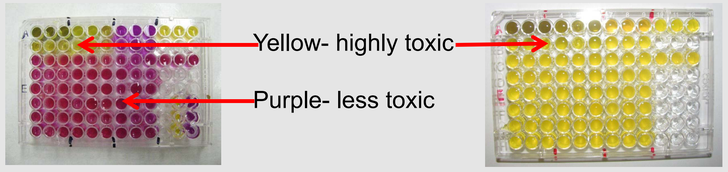
Quantum Dots



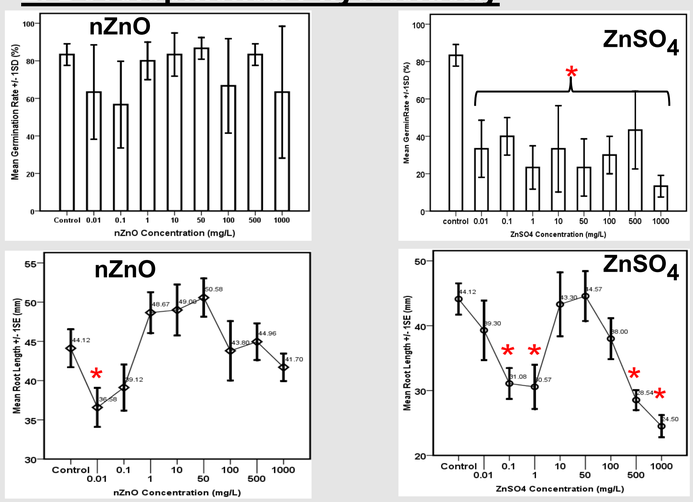
Au-NPs

NANOECOTOXICITY

1. MetPLATE Bioassay (*E. coli*)



2. Developmental Phytotoxicity

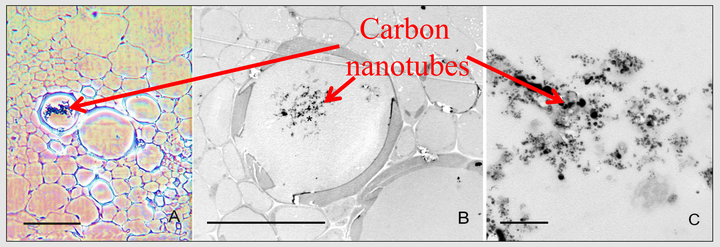


3. *Daphnia* Mortality

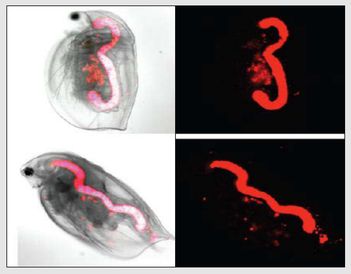
- 48-h Acute Toxicity Test

FATE , TRANSPORT & BIOUPTAKE OF ENMs

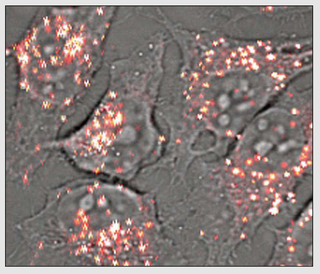
Plant & Animal Models



CNT localization in the Xylem vessel of *Cucurbita pepo*[1]

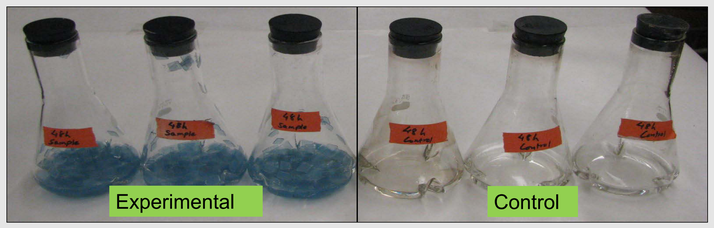


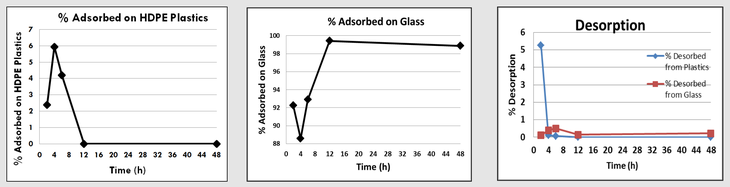
Quantum Dots uptake by *Daphnia*[2]

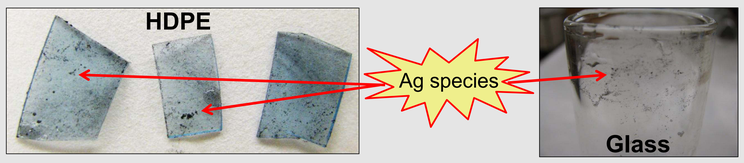


Streptolysin-O capped Au-NPs uptake by HeLa cells[3]

Solid Waste Components







RESEARCH GAPS

1. Industrial synthesis methods for ENMs relatively unknown
2. Lack of SOPs and analytical techniques to detect and characterize ENMs in environmental samples
3. Fate, transport, and transformation of ENMs from consumer products under environmental conditions are unclear
4. Exact mechanisms of toxicity unknown for ENMs
5. Toxicity studies on terrestrial organisms are lacking, while most studies conducted are for aquatic models and *in vitro*

RECOMMENDATIONS

1. Urgent need to develop rigorous risk-based standards, SOPs, and sensors for environmental detection of ENMs
2. Apply ***Precautionary Principle*** until much is known about risk from ENMs
3. Regulators should mandate industries to disclose all available information on ENMs which are incorporated into consumer products
4. Epidemiological studies using the human subjects from nano-industries should cultivate better understanding on potential risks to humans

REFERENCES:

1. Corredor, E., et al. Nanoparticle penetration and transport in living pumpkin plants: in situ subcellular identification. *BMC Plant Biology* 2009, 9:45.
2. Lewinski, N.A., et al. Quantification of water solubilized CdSe/ZnS Quantum Dots in *Daphnia magna. Environ. Sci. Technol.*, 2010, 44 (5):1841–1846.
3. Levy, R., et al. Gold nanoparticles delivery in mammalian live cells: a critical review. *Nano Reviews* 2010, 1:4889.

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