



*Emerging Pollutants: Protecting Water Quality for the Health of People and the Environment*

## **Environmental exposure assessment of product-released engineered nanomaterials (PR-ENMs) from commercial products**

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*(10:00 CET)*



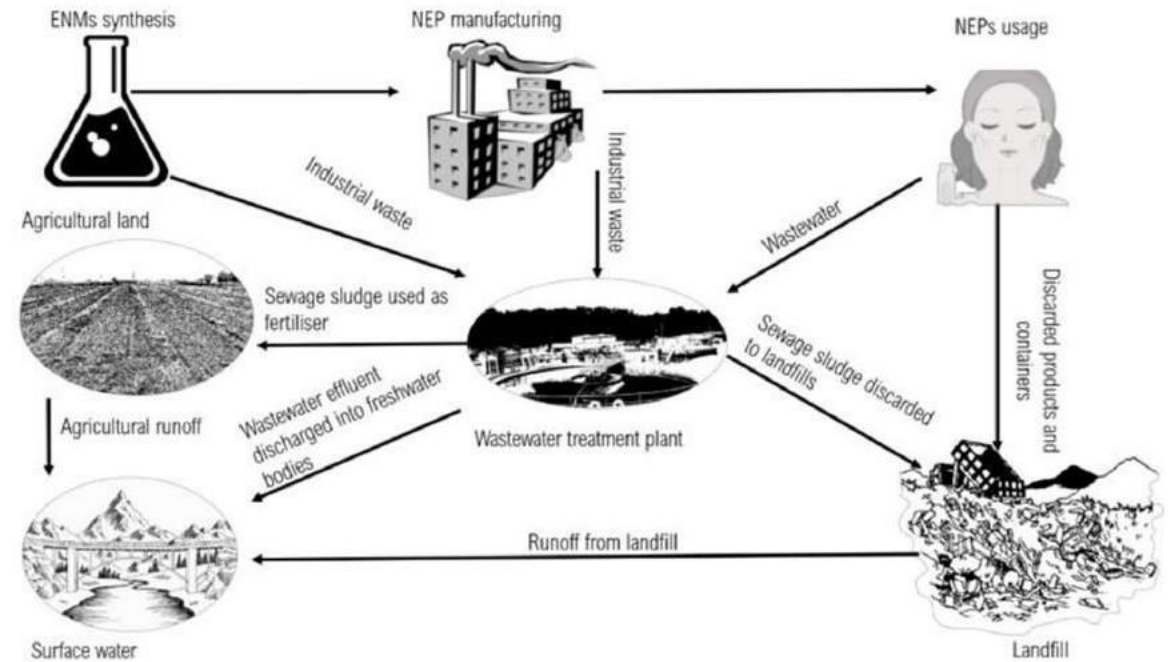
## Engineered nanomaterials use and release into the aquatic environment

PRECEDENCE  
 RESEARCH

**NANOTECHNOLOGY MARKET SIZE, 2021 TO 2030 (USD BILLION)**



<https://www.precedenceresearch.com/nanotechnology-market>



Moloi *et al.* 2021

# Methods

## Product selection

- Medium to high environmental exposure potential products (Hansen *et al.* 2008)

2 Sunscreens → **1 Sunscreen**

1 Topical cream → **Cream**

2 Textiles

\*ENMs indicated by manufacturer

\*Suspected to consist of ENMs/active ingredient at nano-level

## Characterisation (ENMs)

Solvent extraction (sunscreens & creams)

Pretreatment (textile)

Electron microscopy

- Particle morphology
- Elemental analysis

Surface area

Pore volume

Crystalline phases

## Environmental exposure

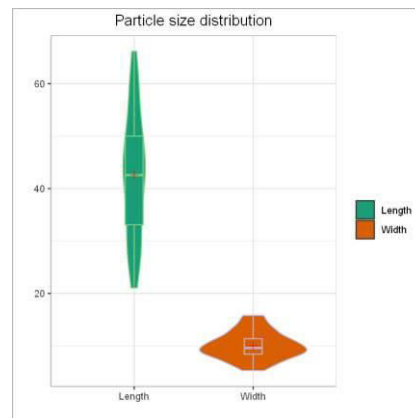
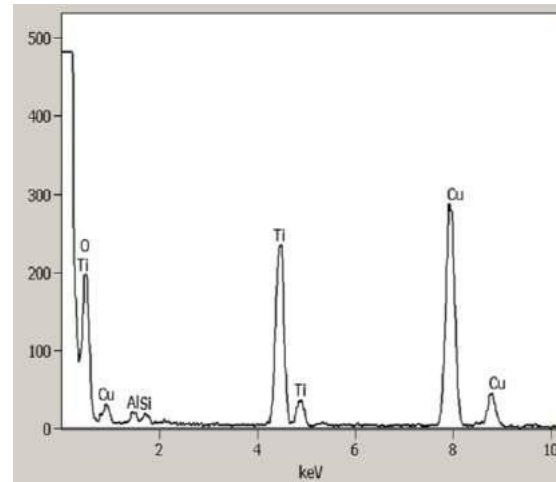
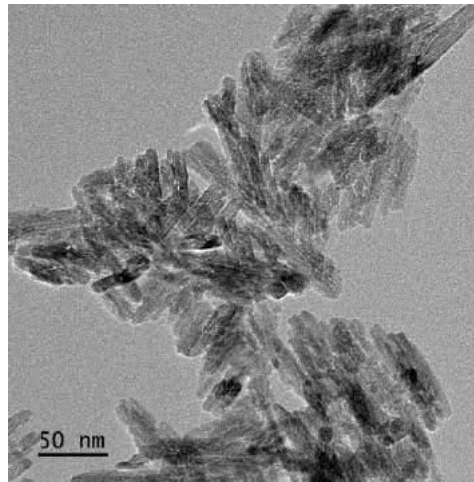
Release

Transformation & fate

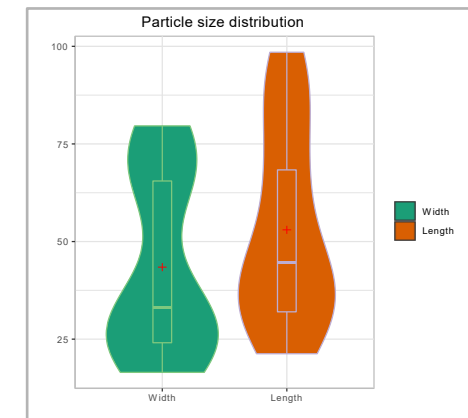
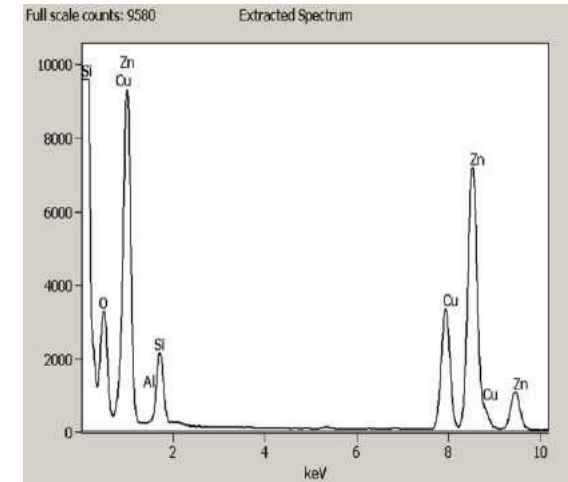
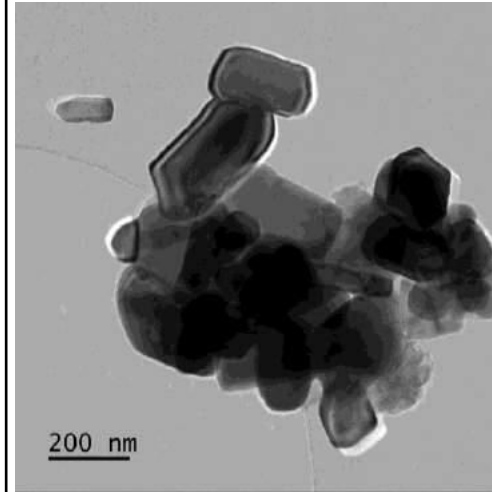
## Characterisation (PR-ENMs)

- Morphology
- Size
- Shape
- Elemental composition
- Hydrodynamic sizes
- Particle size distribution
- Zeta potential
- Particle concentrations
- Elemental concentrations

## Results (ENMs in NEPs)

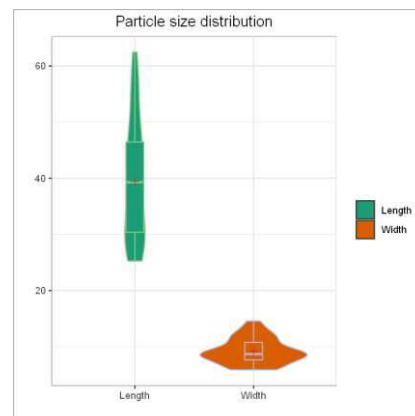
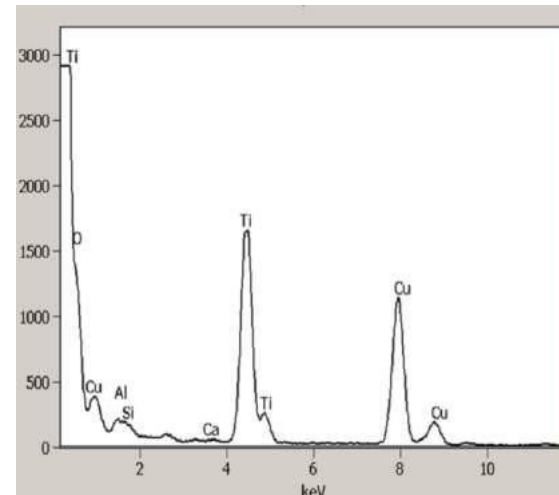
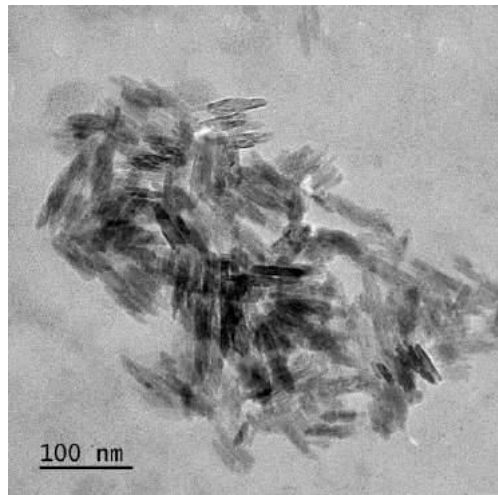


Sunscreen:  
 Titanium dioxide ENMs (Rutile)  
 $18 \pm 1 \times 75 \pm 4$  nm  
 $\zeta = -1.2$  mV  
 $83.103$  m<sup>2</sup>/g

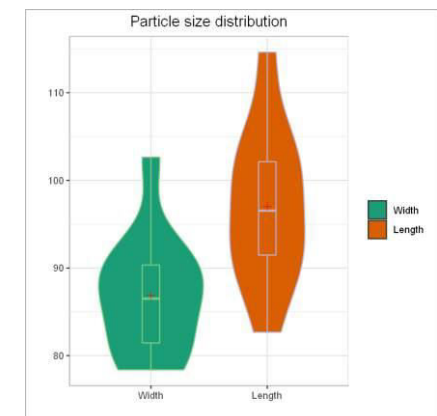
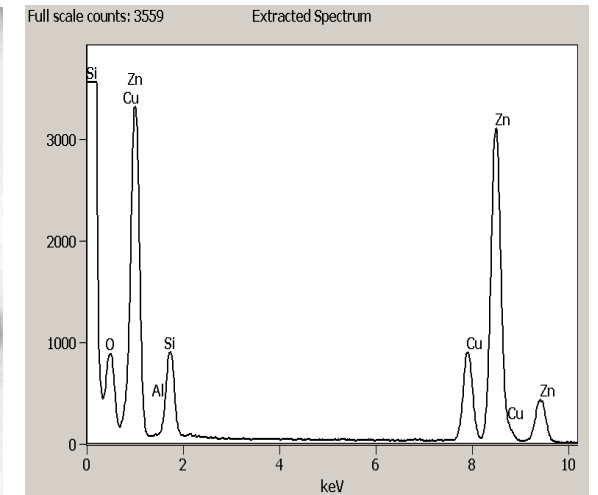
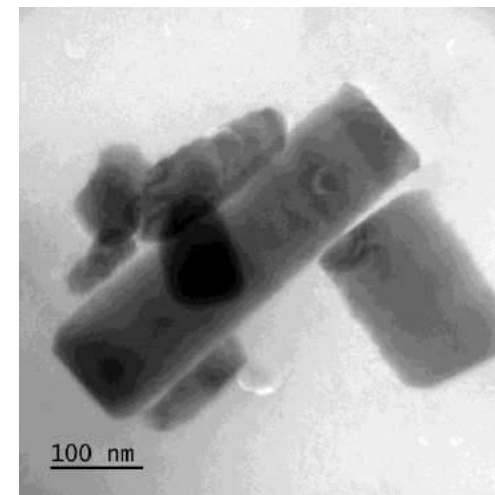


Topical cream:  
 Zinc oxide ENMs (Zincite)  
 $44 \pm 5 \times 53 \pm 6$  nm  
 $\zeta = -15.5$  mV

## Results (PR-ENMs)

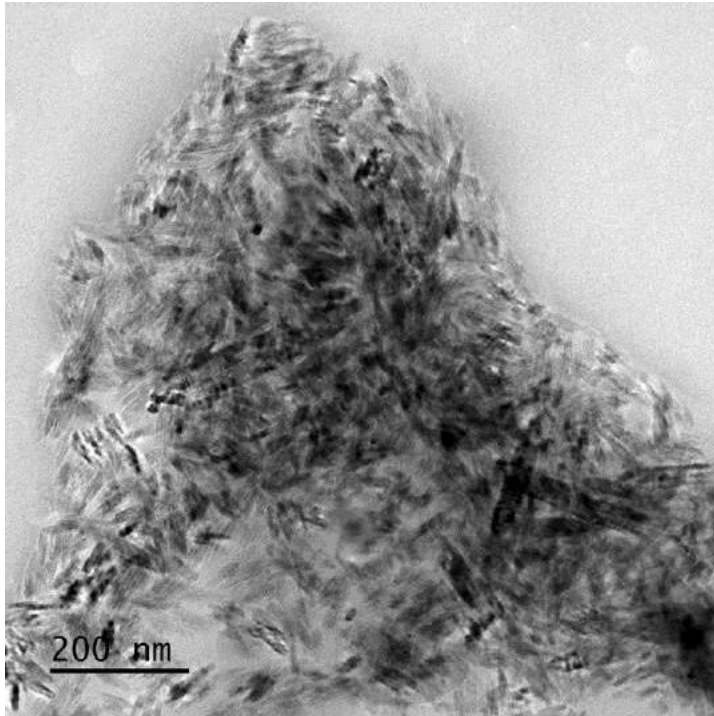


Sunscreen:  
 Titanium dioxide ENMs  
 $39.5 \pm 1.5 \times 9.2 \pm 0.5$  nm  
 $\zeta = -94.5$  mV  
 27.3%

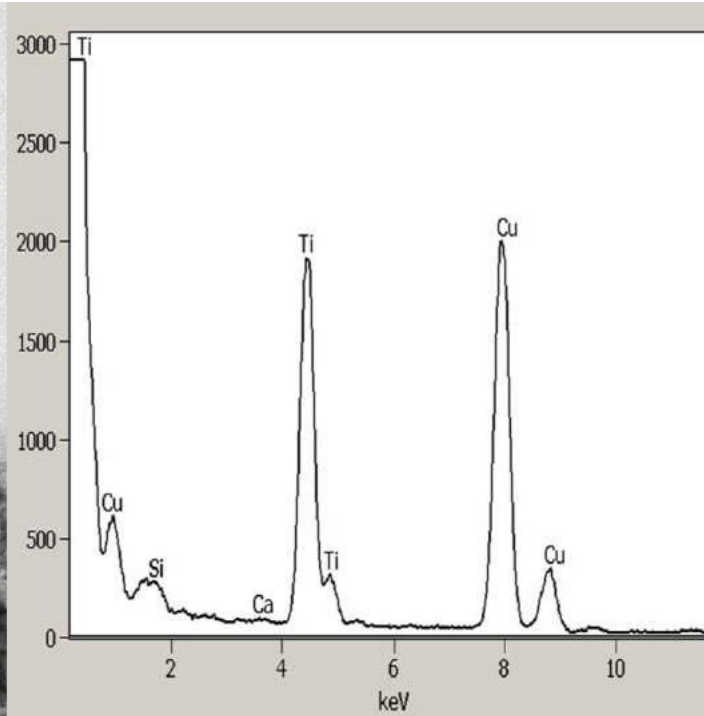


Zinc oxide ENMs (Zincite)  
 $109.6 \pm 6.6 \times 55.7 \pm 3.9$   
 $\zeta = -45.3$  mV  
 24.8%

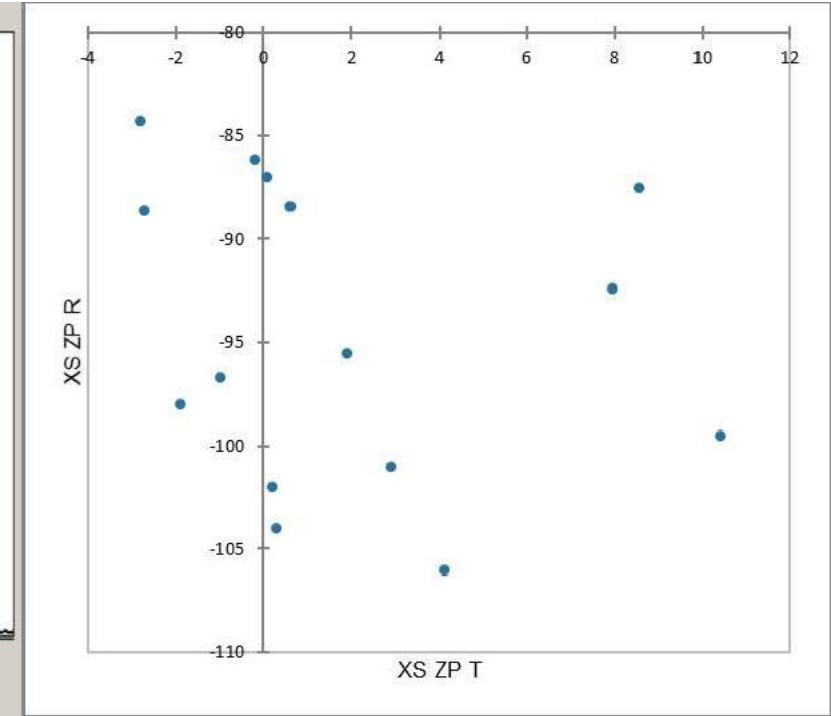
## Results (PR-ENMs – Fate & Transformation)



PR-nTiO<sub>2</sub>:  
 Shaped & size maintained, settling in the sediment



PR-nTiO<sub>2</sub>:  
 Higher Ti peak  
 Maintains coating (Si)



PR-nTiO<sub>2</sub>:  
 Negative ZP for released nTiO<sub>2</sub>  
 Positive ZP from medium spiked with salt (10%)

## Conclusions and policy implications

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- Increasing discharge of PR-ENMs into the aquatic environment
- Need for method development for release and characterisation
- Investigation of factors influencing exposure dynamics which ultimately influence bioavailability, effects and risk potential
- Robust data generation (exposure and risk) to conclusively advise on the need for policy development for environmental safety

Thank  
you

