The Relationship Between Nanoparticle Characterization and Risk

QEEN II: 2nd Quantifying Exposure to Engineered Nanomaterials from Manufactured Products Workshop
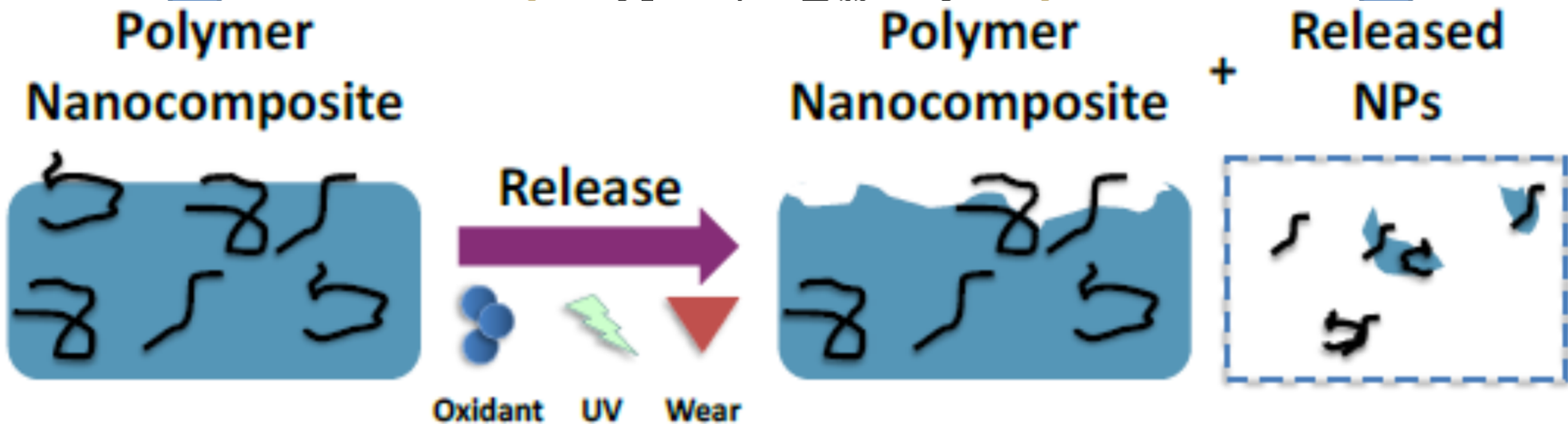
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October 10th 2018
Elon University

Risk Assessment Process (greatly simplified)

Hazard Identification
What is the chemical?

Polymer Nanocomposite

Release
Oxidant   UV   Wear

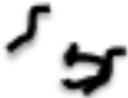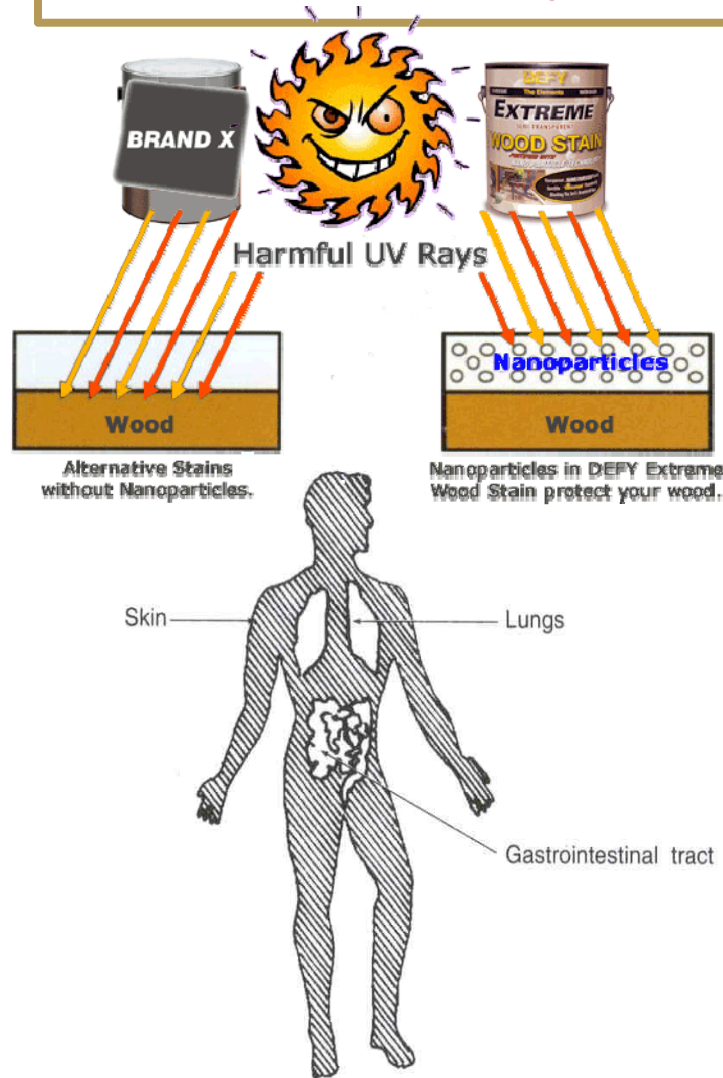Polymer Nanocomposite + Released NPs

What is the fate (e.g. toxicity) of   vs.   ?

Figure 5.1 Concept of carbon nanotubes released from polymer nanocomposite. (Source: H. Fairbrother.)

Population Weighting Factors

Case Study: Inorganic UV absorbers

Harmful UV Rays

Nanoparticles

Wood

Wood

Alternative Stains without Nanoparticles.

Nanoparticles in DEFY Extreme Wood Stain protect your wood.

Skin — — Lungs

— Gastrointestinal tract

Figure 1.2 Barriers between the inner and outer environments

Environmental Health, 3rd Edition. Dade W. Moeller

Exposure Scenarios
- **Inhalation During Application Spray Coatings**
- **Ingestion During Application**
- **Dermal Contact Post Application**
  - **Followed by Ingestion?**

Inorganic UV absorbers: Dermal Contact
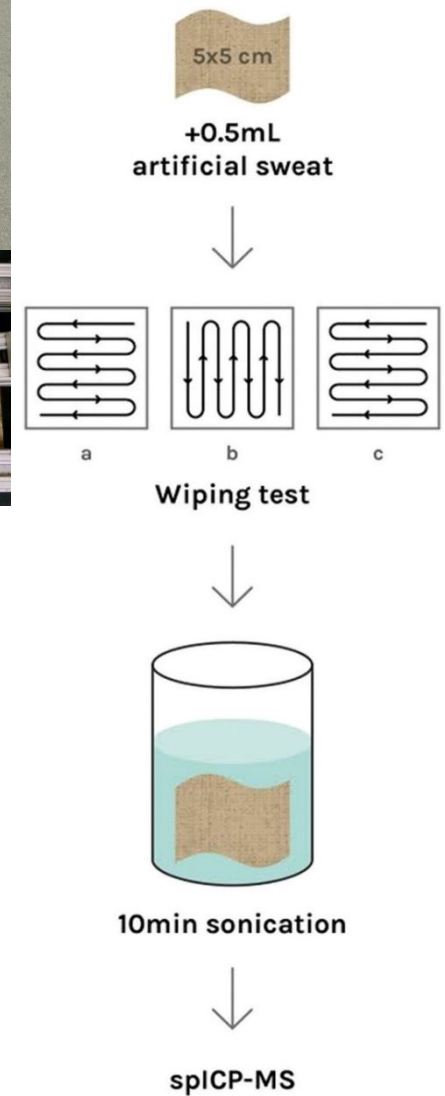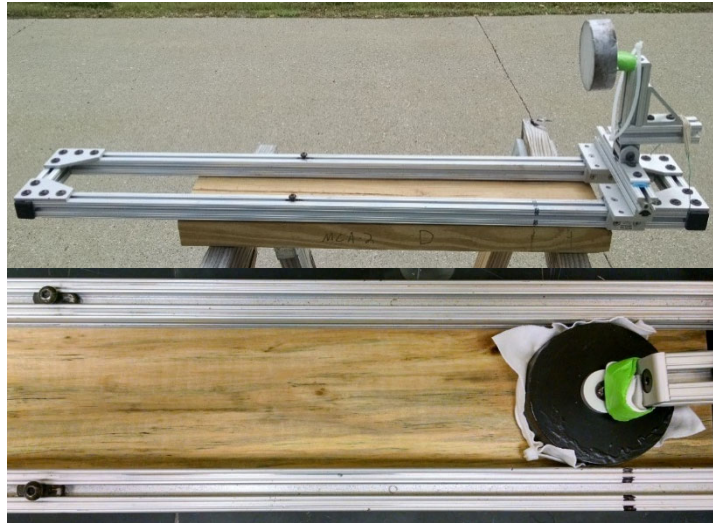
What Method to Use?
OECD, ISO, ASTM
NIOSH, CPSC

Test Duration?
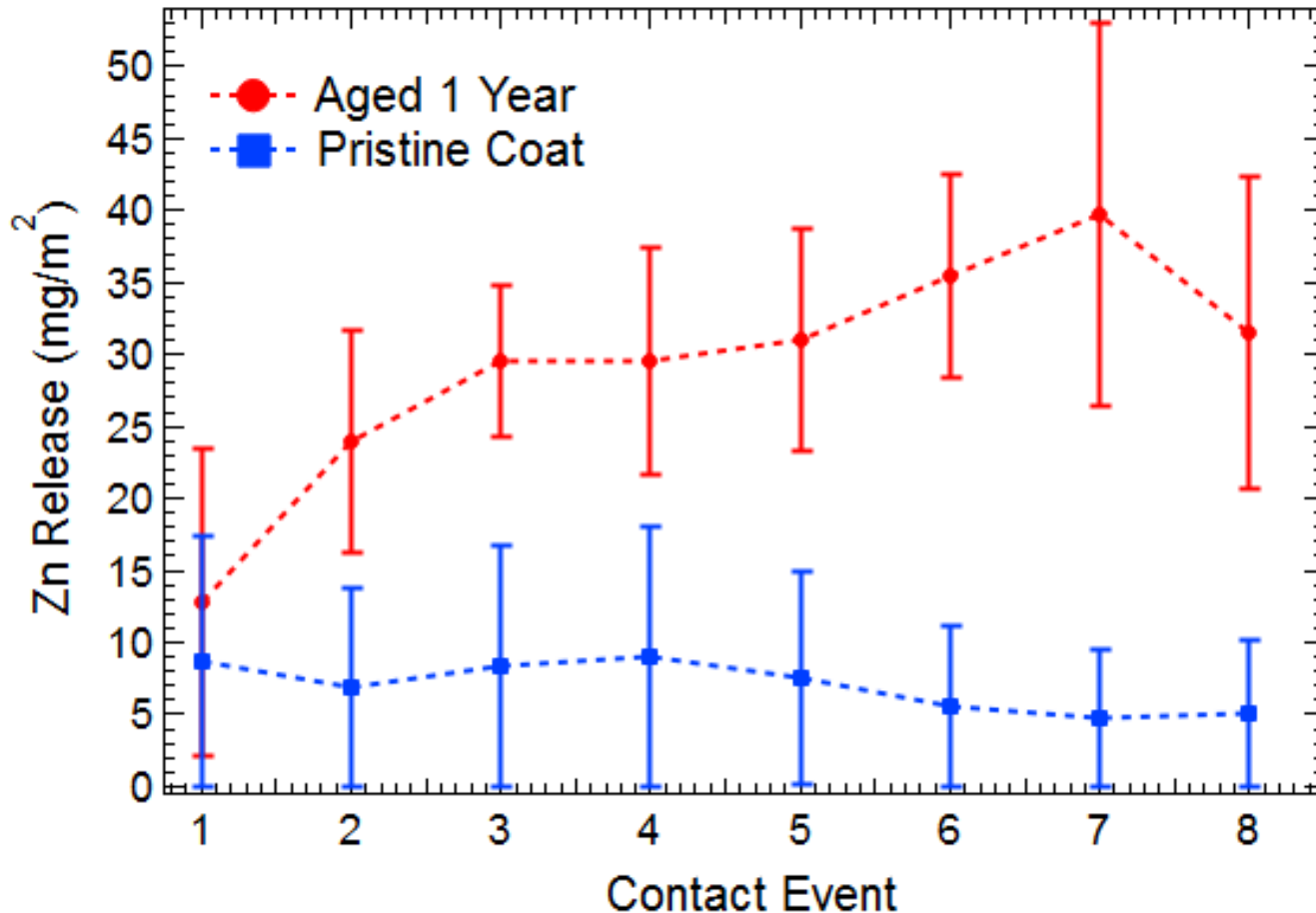Long term release or
only near field?

Surface Character?
Aged vs. Pristine

Use Profile
Intended &
Foreseeable Misuse?

Mackevica et al., *NanoImpact.,* 2018

Inorganic UV absorbers: Dermal Contact

Total Zn Release between 3-25 mg /m²
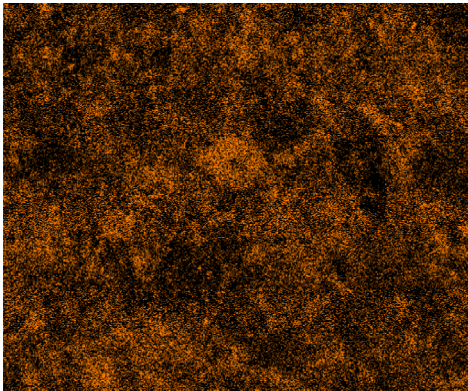
Focus on realistic use scenarios

Attempt to track both short term and long term exposure

Totals provide no information on physical state of the dislodged material

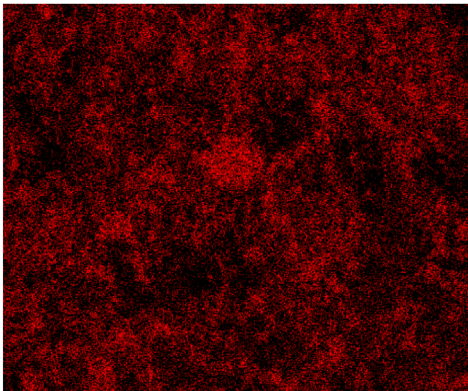Clar et al., *Sci. Tot. Env., (In Prep*)
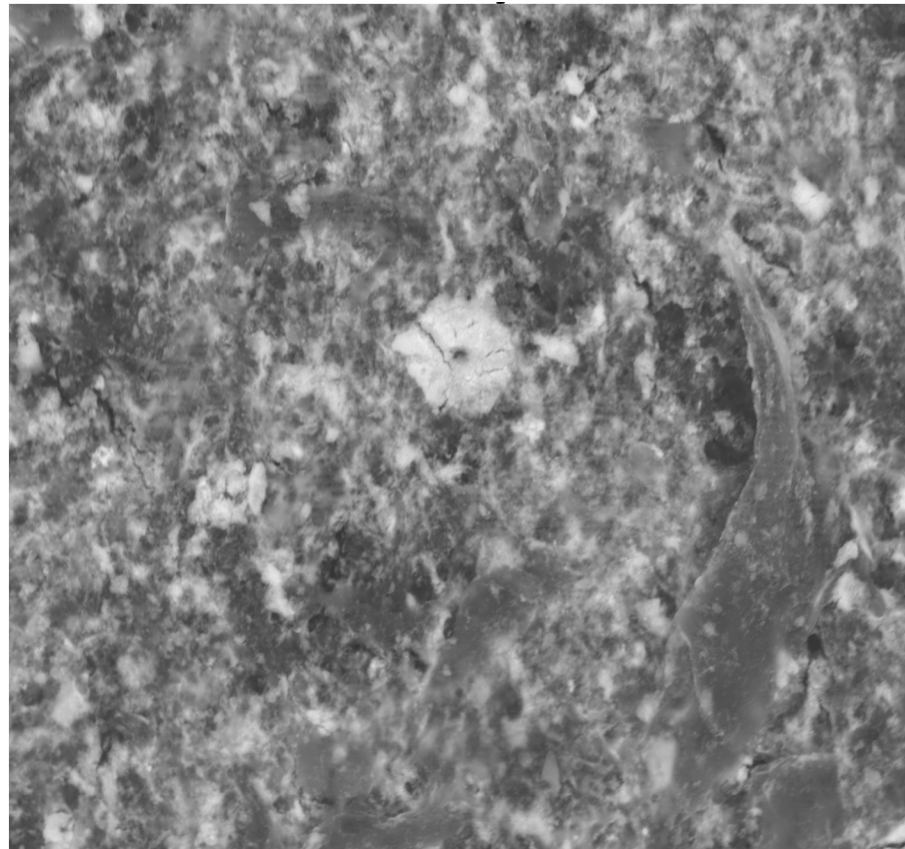
Dermal Contact & Ingestion

Cu Lα1_2

10μm

Zn Kα1

10μm

10μm

- **Heteroaggregates dislodged from the surface**

- **Wood Stuffs**

- **Heavy location of Zn with Cu in the lumber.**

- **Does this quality as a true "Nano Exposure" Scenario**

Big Picture

- **Urgent Need to develop/modify <u>reliable, reproducible Standard Methods</u> to study NP and NP byproduct release from consumer products**
  - **Current techniques are designed to best suite needs/capability of laboratory**
  - **Focus on method development that makes critical data easily accessible**

- **Methods must focus on both <u>intended use and reasonably foreseeable misuse</u> of nano-enabled products**
  - **Aged Surface vs. Pristine Surface**

- **Detailed Characterization of released/transformed materials is a <u>critical component</u> of risk assessment and management**

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Dr. Andrew Remsen
Treye Thomas - CPSC

Ideal Risk Analysis Tool for NPs

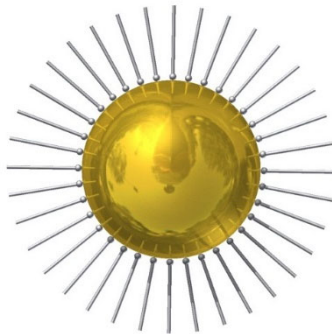Initial Desire for "Read Across" Tables to Predict Ultimate Fate & Risk

Nanoparticle   Coating

+

Environmental Fate

Human Health Risk

Intrinsic Properties:
- Identity (Cd/Se QD vs. ZnO
- Size
- Shape
- Surface Charge
- Core/Shell
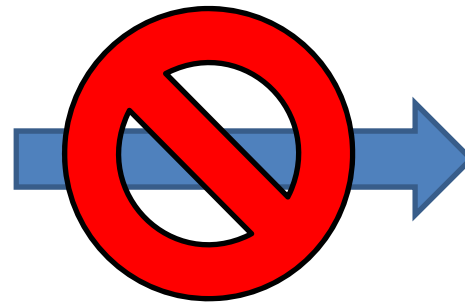
- Polymers
- Surfactants
- Organic Matter

Extrinsic Properties:
- **Dissolution Rate**
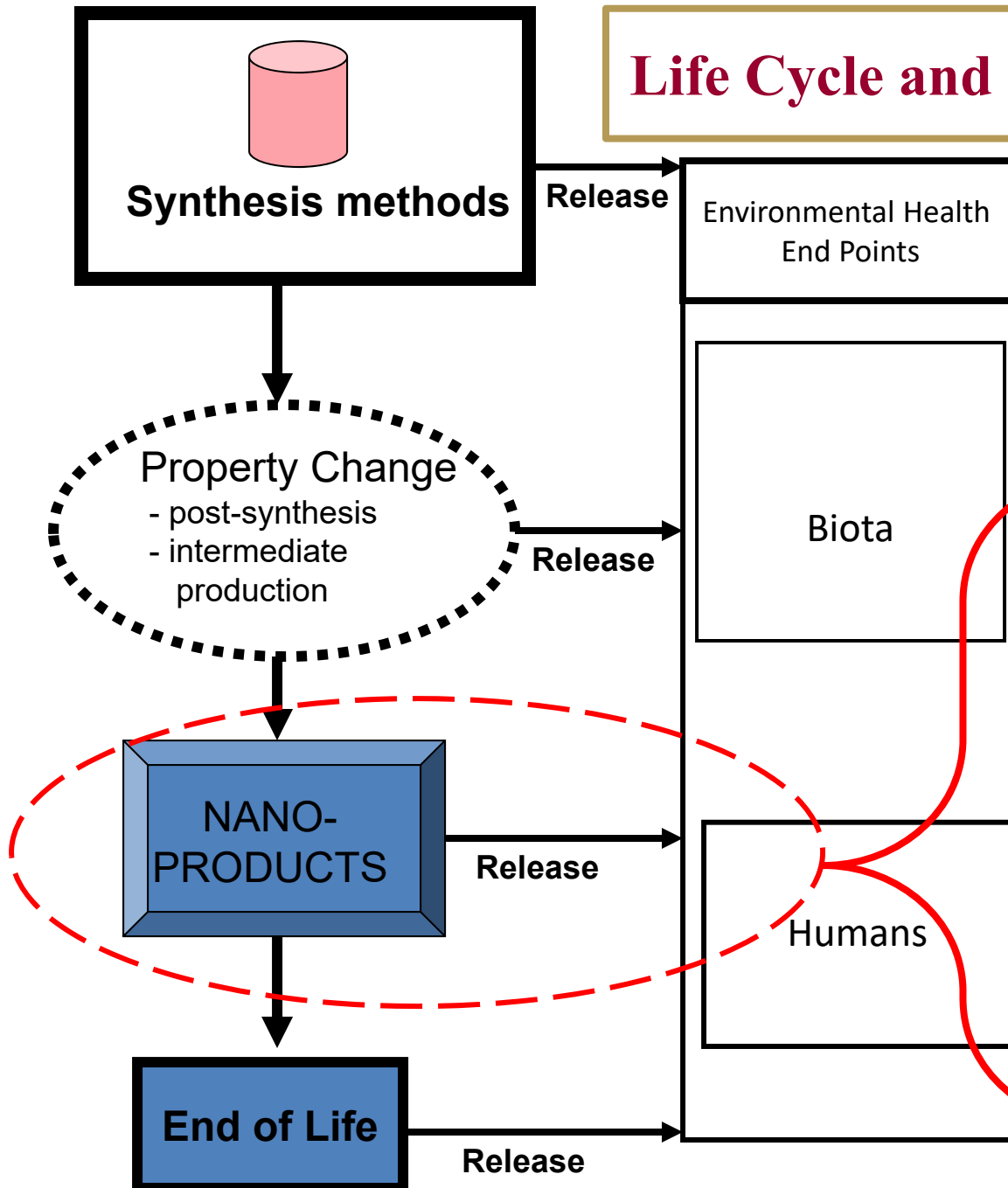- **Sedimentation Rate**
- *Attachment Efficiency*

- **Process is much more complicated**
- **Once imbedded in a product, NP characteristics properties Change**
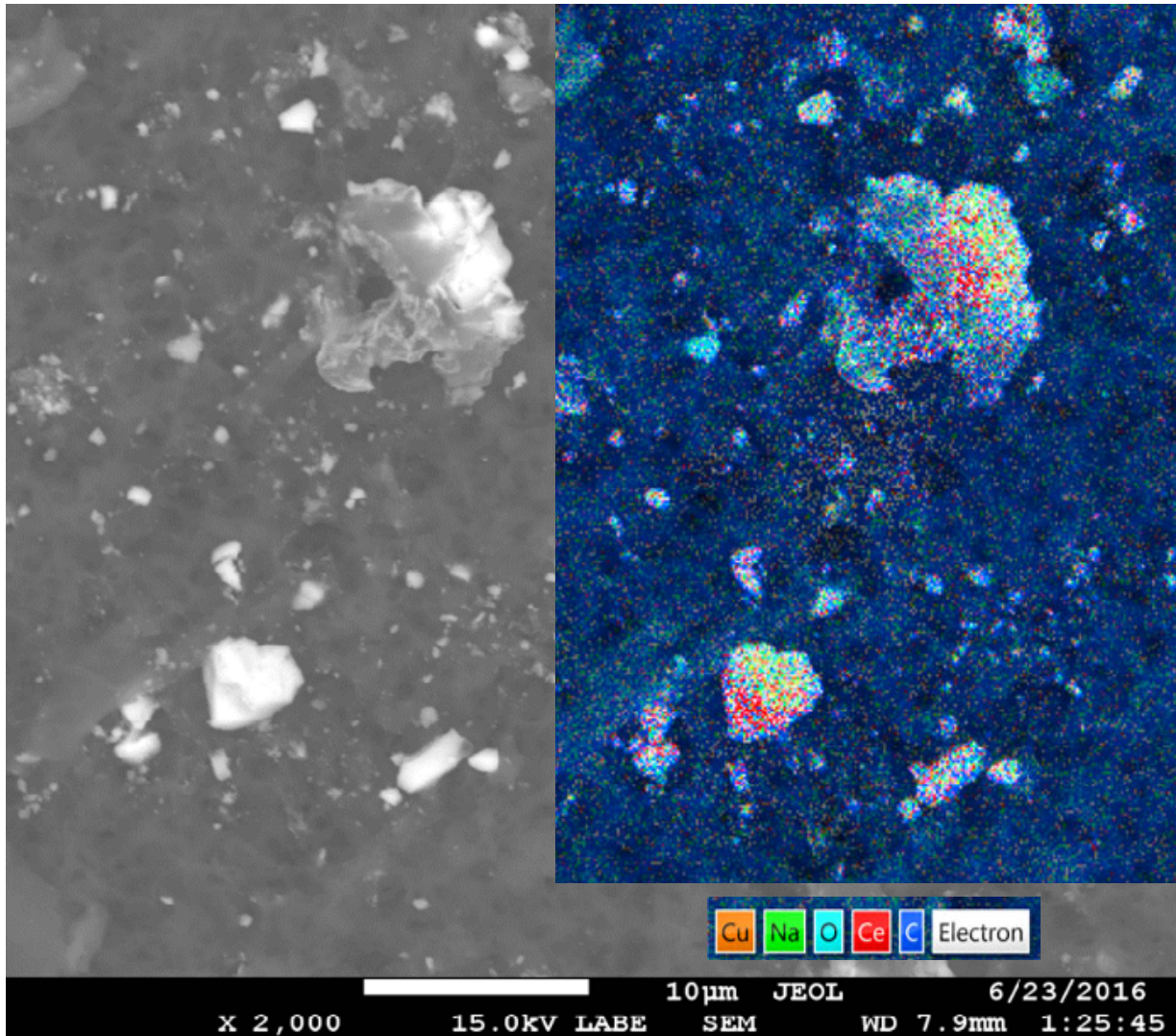- **Release is also depending on use conditions**

Life Cycle and Fate of Nanomaterials

Dermal Contact & Ingestion

- **Heteroaggregates dislodged from the surface**

- **Larger chunks of lumber with CeO2 attached**

- **Very few "Free" NPs released**

- **Does this quality as a true "Nano Exposure" Scenario**