

Willkommen  
Welcome  
Bienvenue



Materials Science & Technology

The background of the slide is a grayscale micrograph of a material surface, possibly showing cracks or grain boundaries. Overlaid on this is a vibrant, wavy pattern of orange and yellow, resembling a thermal map or a fluid flow visualization. A solid red horizontal bar is positioned above the title text.

# Aging and Transformations of Nanoparticles Relevant to Product Use

Dr. Denise M. Mitrano

# Project Goals

- **Nanomaterials safer by design**



- Correlate specific ENP properties to their aging, transformation, and behavior
- Classify nanomaterials according to their impacts

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- **Nanomaterials safer by design**

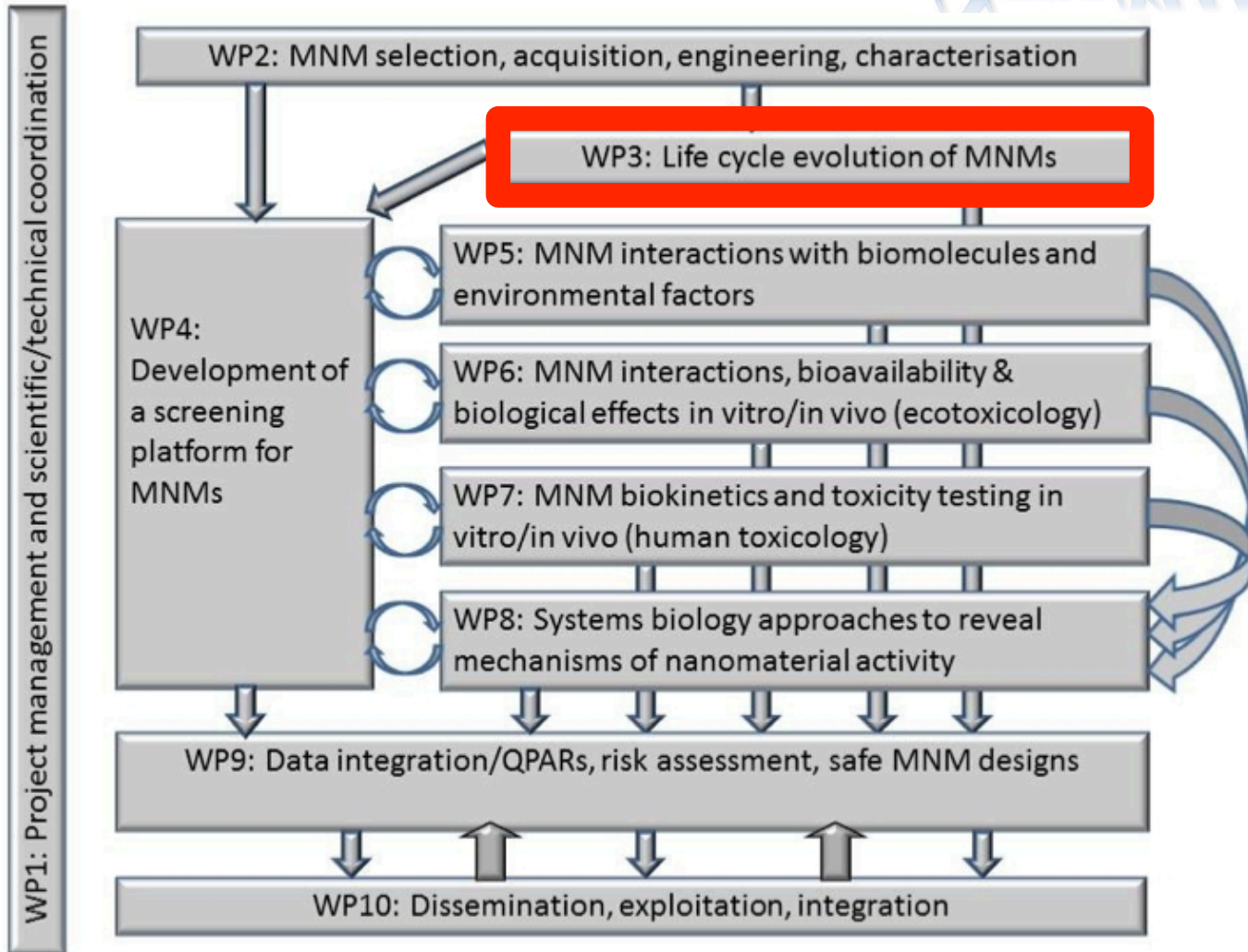
- Correlate specific ENP properties to their aging, transformation, and behavior
- Classify nanomaterials according to their impacts

- **Expected Impacts**

- Protocols for ENP synthesis, characterization, and safety assessment
- Relate specific characteristics to impacts
- Predictive ENP risk assessment according to biological and environmental impacts
- Provide guidance for future safer design

# Project Goals

Nanomaterials safer by design





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- **Work Package: Life Cycle Evolution of ENP**
  - Aging nanomaterials; study transformations relevant to product use
  - Provide aged particles to other consortium members to compare toxicological effects to pristine materials

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  - Aging nanomaterials in air (Ag, CeO)



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- **CEA (Commissariat à l'Energie Atomique), France**

- Aging nanomaterials in air (Ag, CeO)



- **University of Birmingham, UK**

- Develop specialized particles for aging tests
- Aging nanomaterials in water (ZnO, CeO)



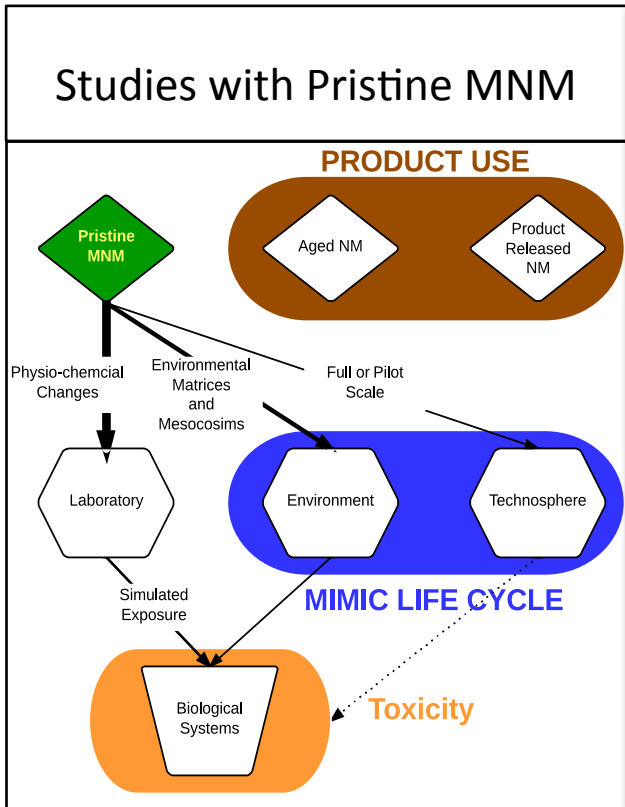
# Project Goals

## ■ Work at Empa:

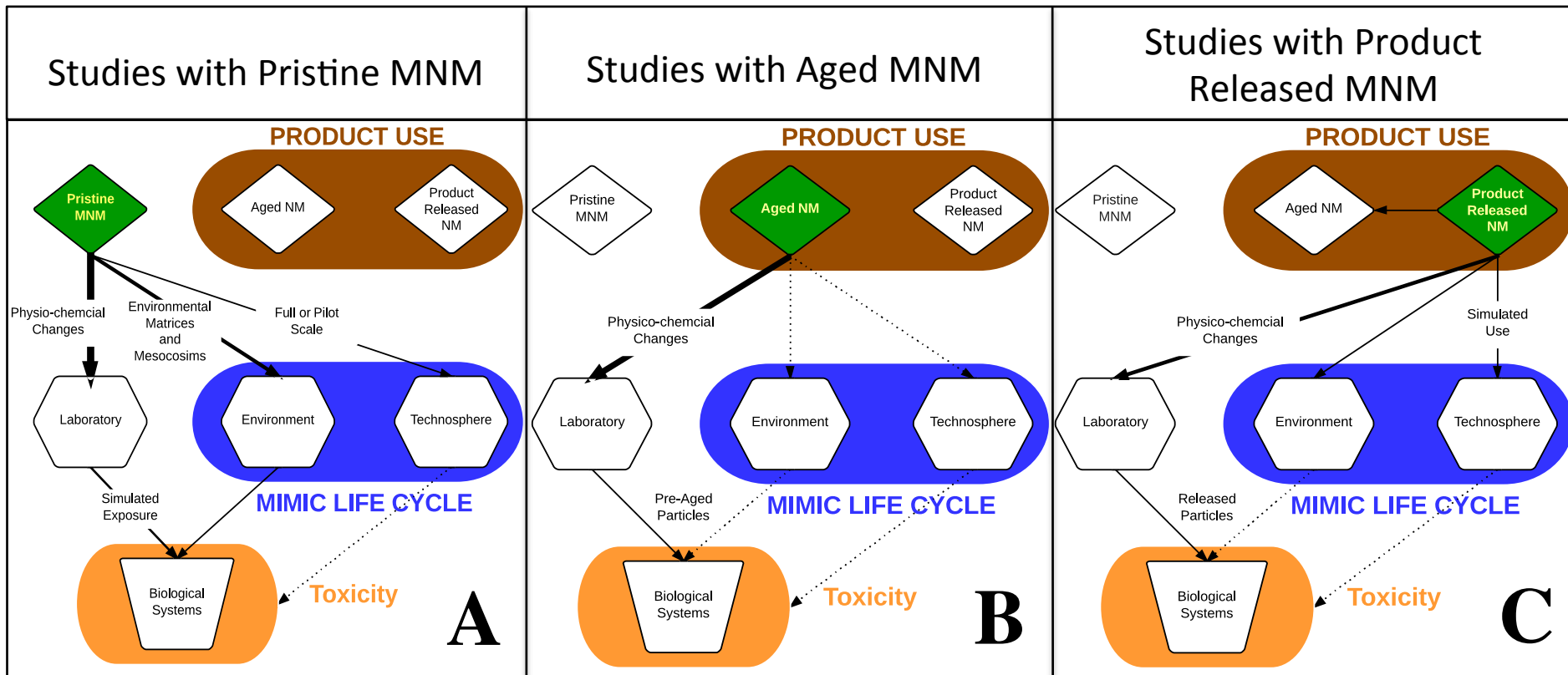
- Aging nanomaterials in water; study transformation(s) relevant to product use

1. Provide literature review of ENP aging: determine relevant particle transformation(s) and where gaps in knowledge exist
2. Conduct experiments of ENP aging processes
3. Determine which properties make particles more similar or more varied after aging
4. Age consortium particles to determine varied toxicity compared to pristine counterparts

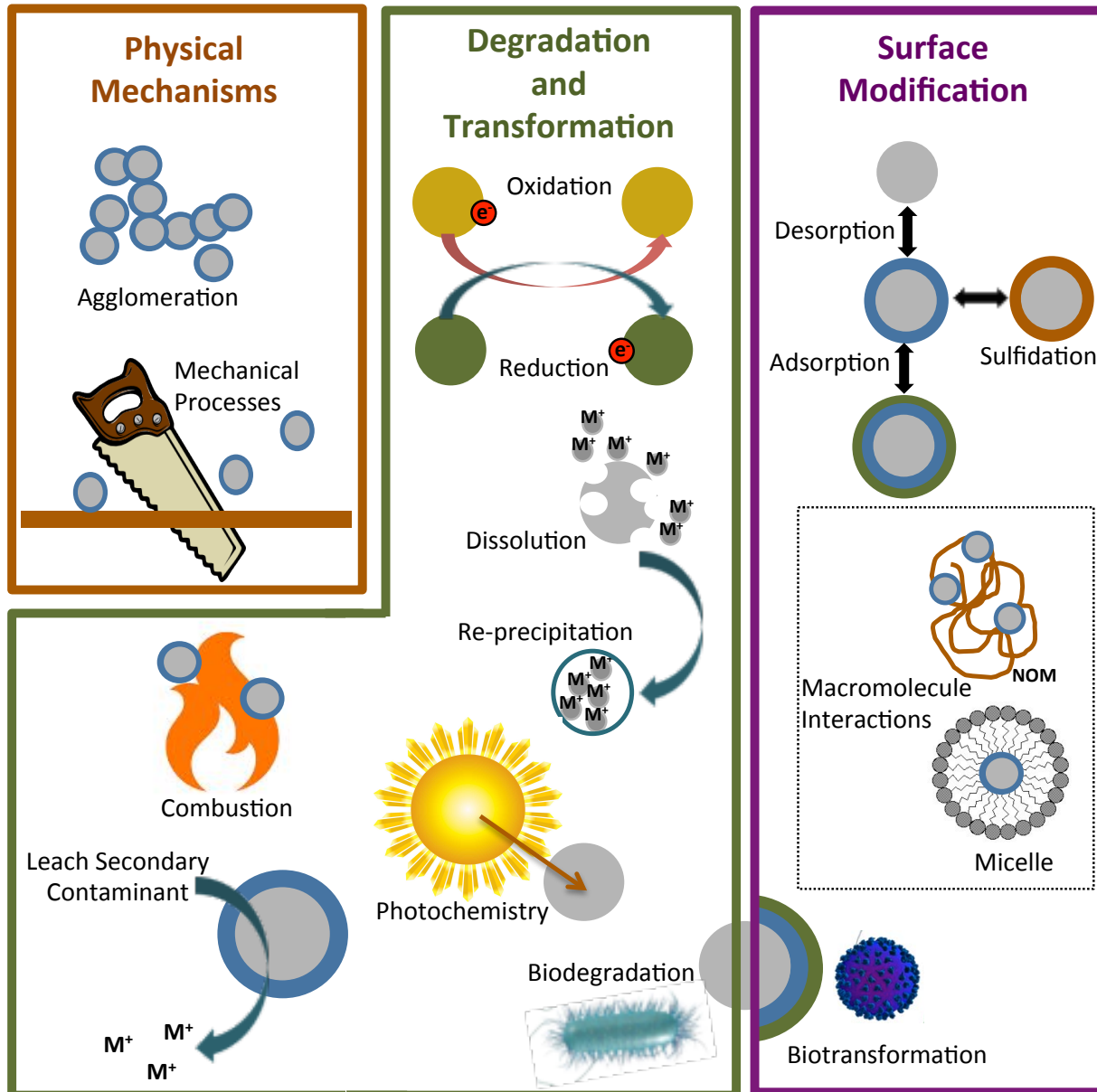
# Present Aging/Transformation Studies



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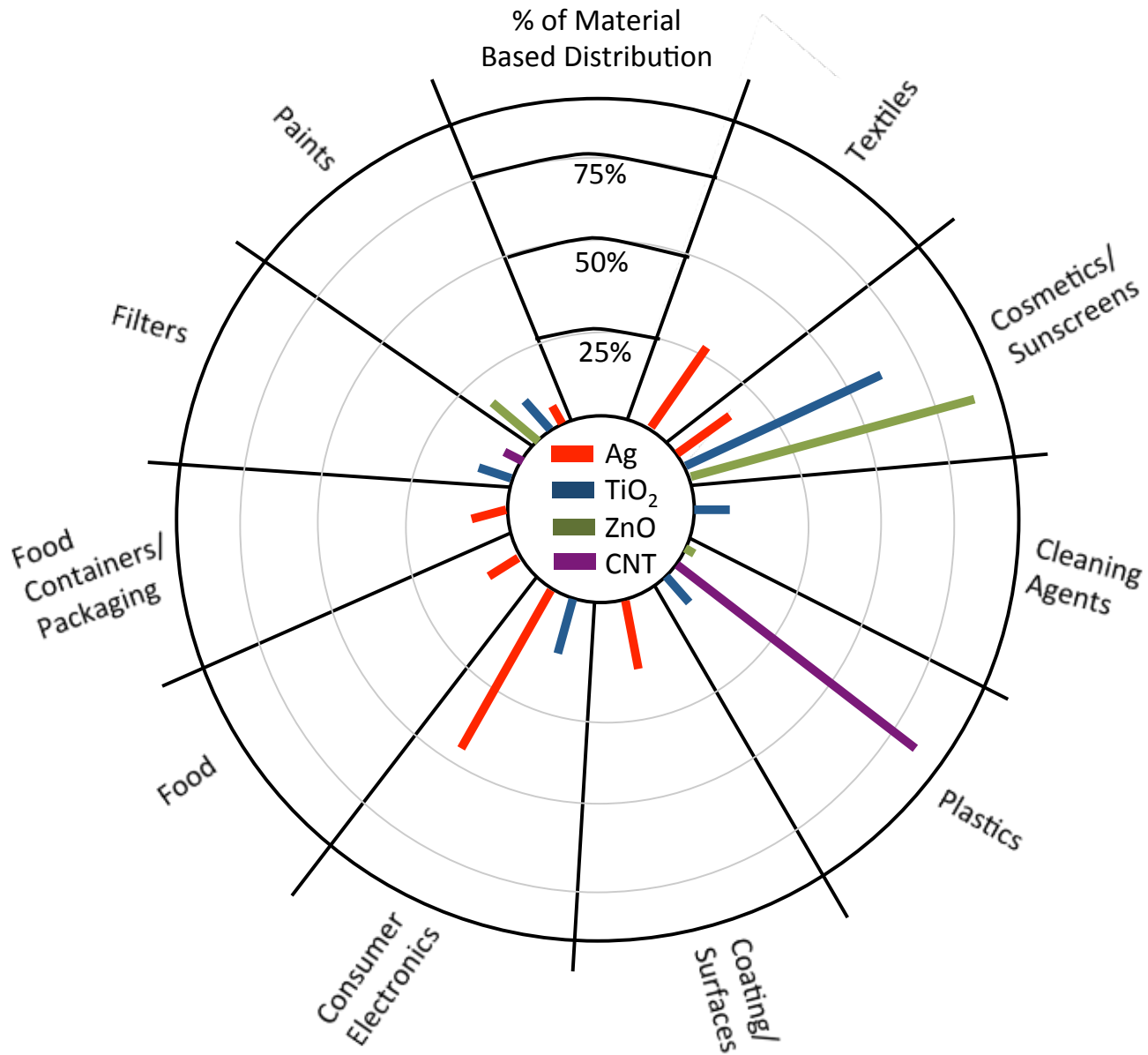


# Particle Aging/Transformations

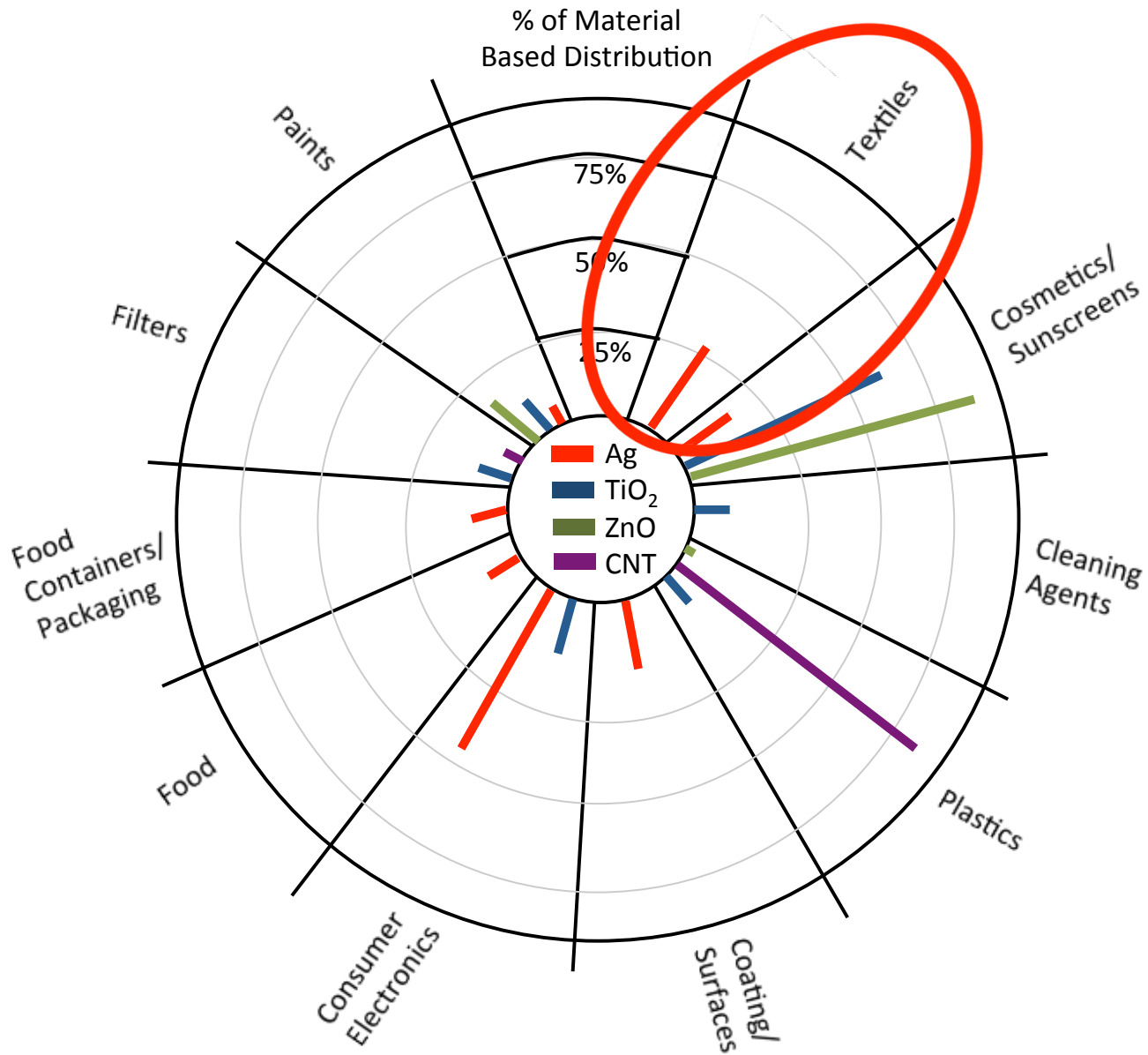




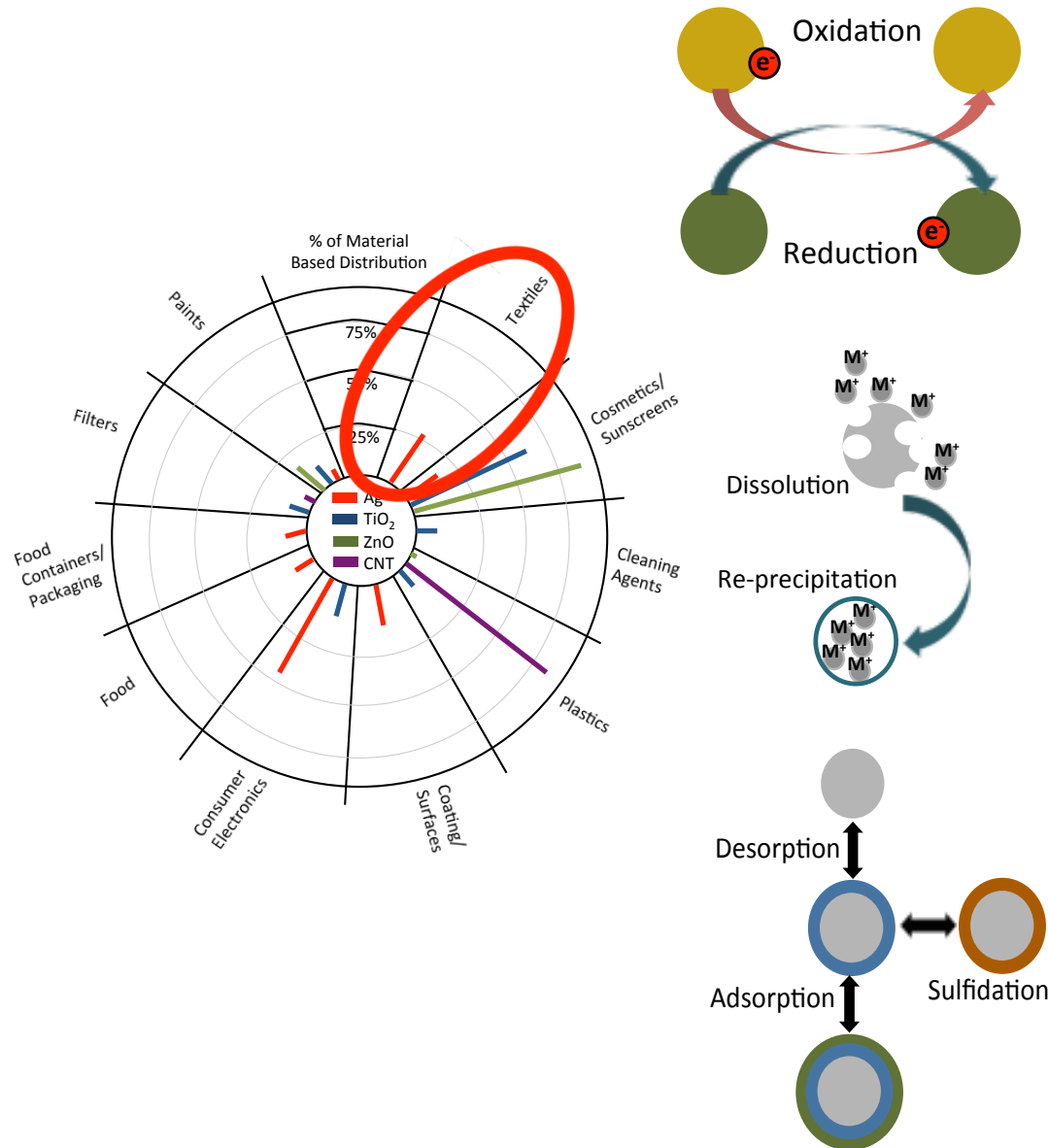
# Nanomaterial Distribution in Products



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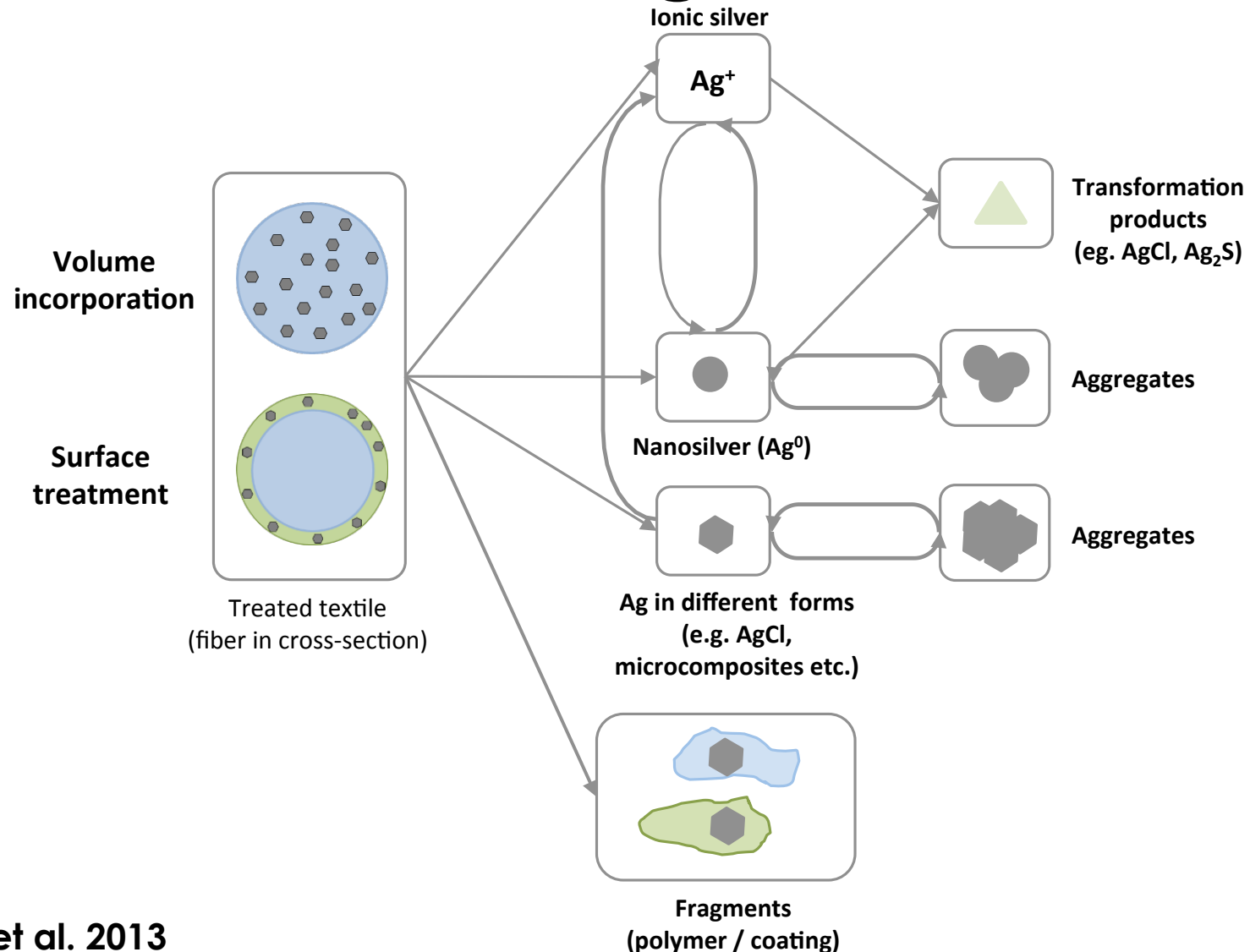


# Nanomaterial Distribution in Products



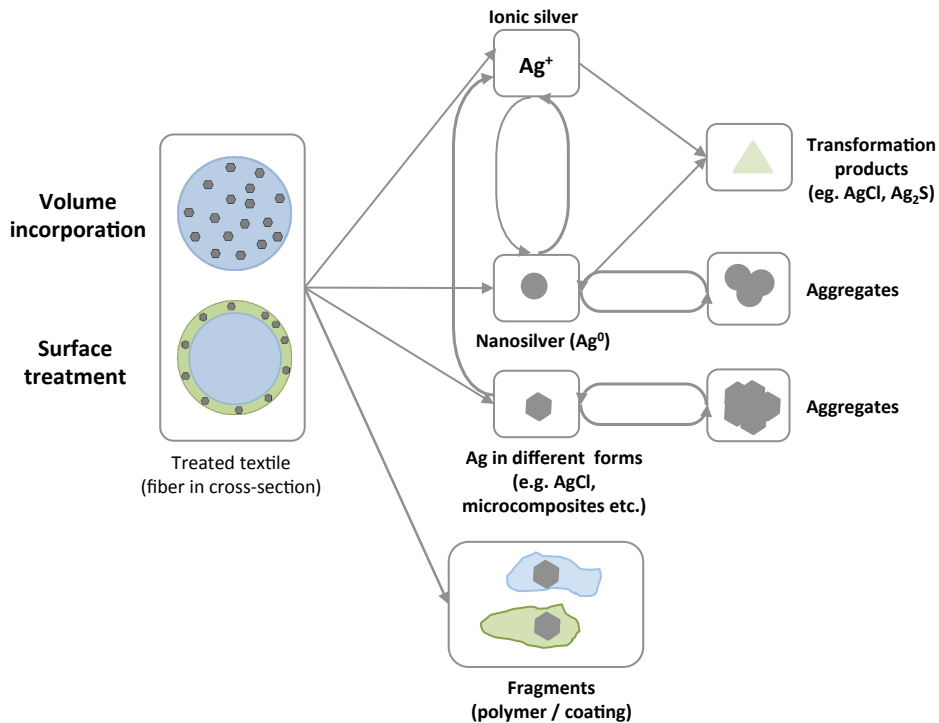
- Interconnected transformations
- Oxidation from cleaners and washing powders
- Complexation/precipitation with surfactants and other washing powder constituents
- Surface modifications affect particle stability: additionally future fate, transport and toxicity

# Ag Release and Transformation after Laundering Fabrics

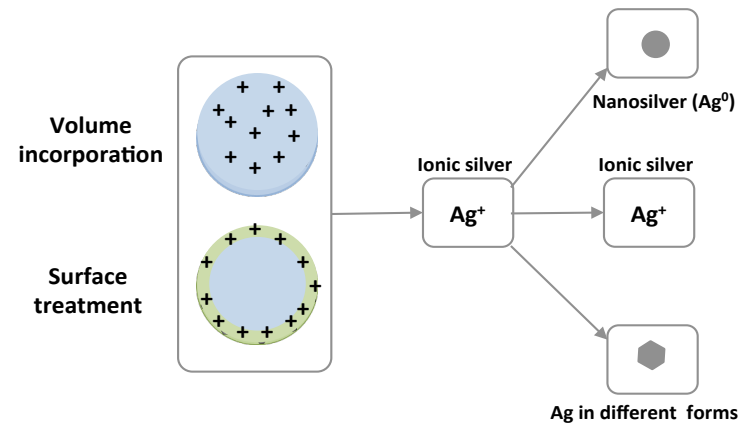


# Comparison of NP and Traditional Ag after Release

## NP Incorporation



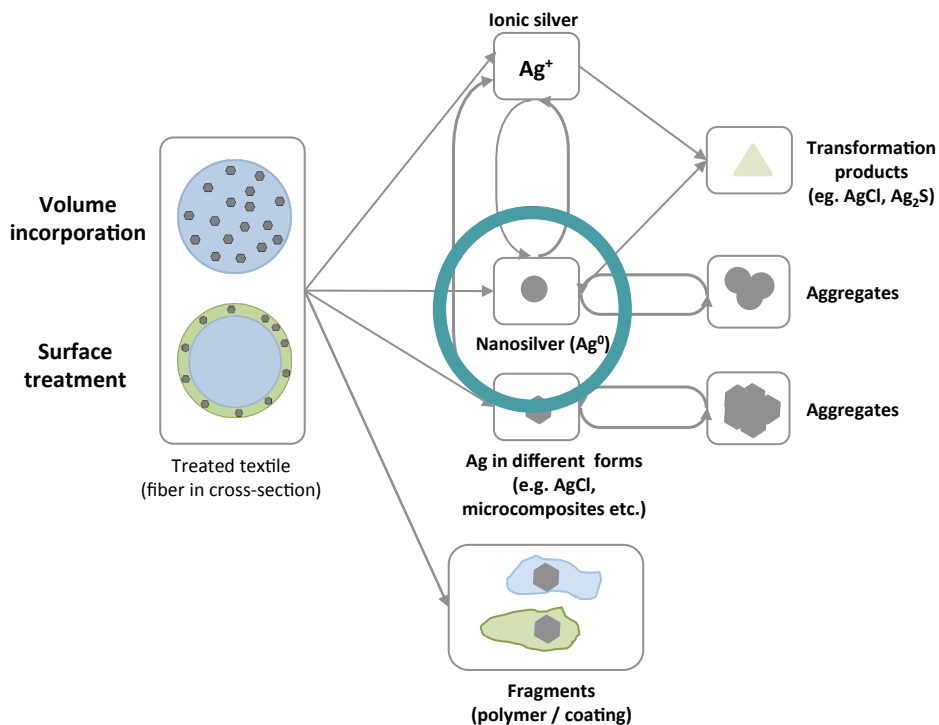
## Traditional Ag Additives



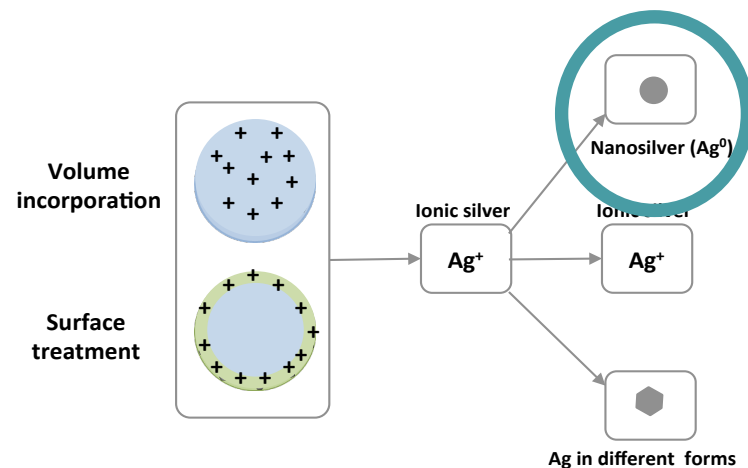
Ag salts: AgCl, AgCl on  $\text{TiO}_2$  carrier  
Ag ion exchange: AgZeolite  
Metallic Ag: Ag threads

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NP Incorporation

Traditional Ag Additives



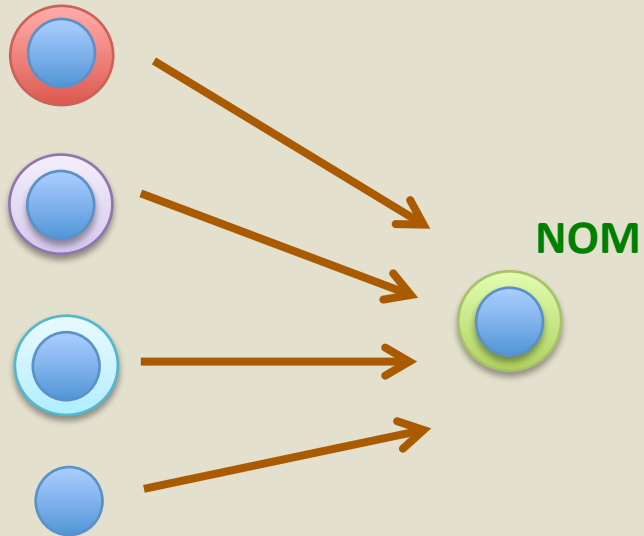
Similar?

Distinguishable?

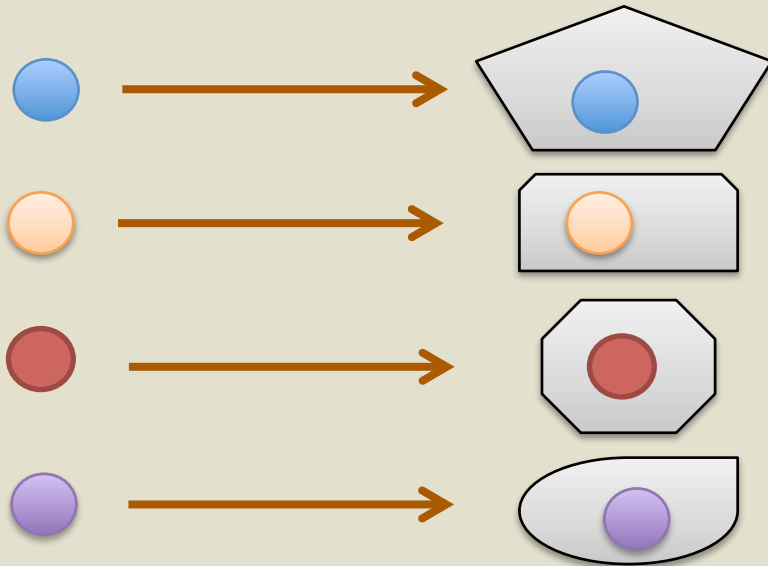
Depends on washing conditions?



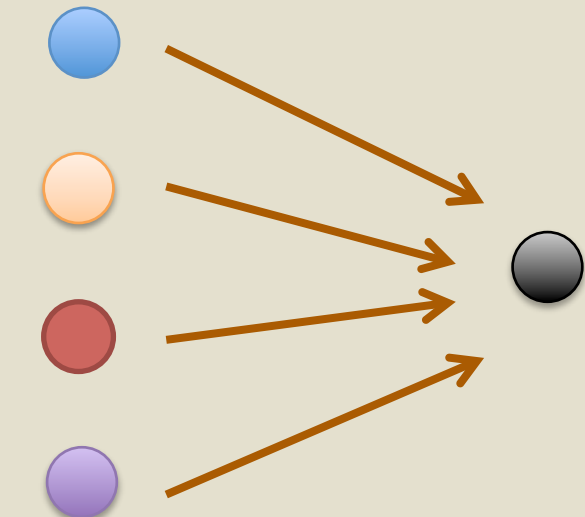
# Transformation Increases Similarity



*Transformation of coating*

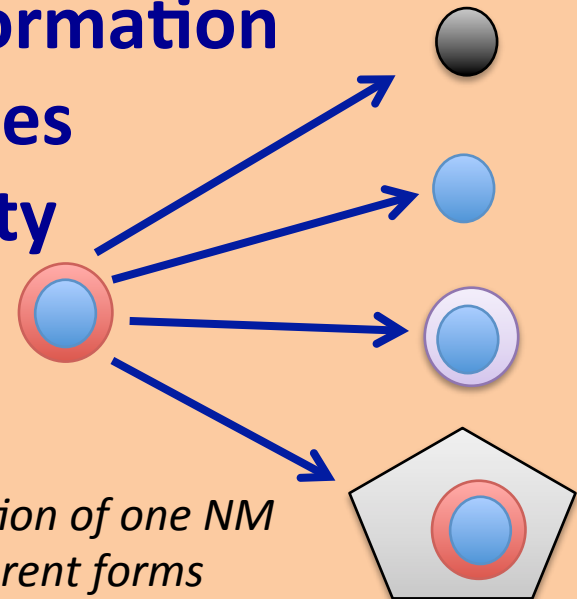


*Release of different MNM in the same matrix*



*Transformation of different NM into the same material*

## Transformation Increases Diversity



*Transformation of one NM into different forms*

# Conclusions

- Aged and/or product released NP will have different qualities than pristine ENP
- Product use dictates relevant aging/transformation
- Multiple, subsequent transformation possible and likely
- “Traditional” additives to textiles, etc. may also release nano-sized materials

