

# Categorization Framework to Aid Exposure Assessment of Nanomaterials in Consumer Products

Steffen Foss Hansen, Evan Michelson, Anja  
Kamper, Pernille Borling, Frank Stuer-  
Lauridsen, Anders Baun

# Exposure Assessment

- Risk =  $f(\text{hazard, exposure})$
- Exposure assessment is key in risk assessment
- How to do exposure assessment for NMs is unclear

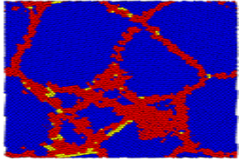
# Research approach

- Developed Categorization Framework to Aid Exposure Assessment of Nanomaterials
  - Location of “nano”
  - Expected, possible & no exposure
- Applied on the Woodrow Wilson Center Consumer product inventory
- Assessment of consumer exposure to  $\text{TiO}_2$  used in sun lotion using the EU Tech. Guidance Document

# NANOMATERIALS



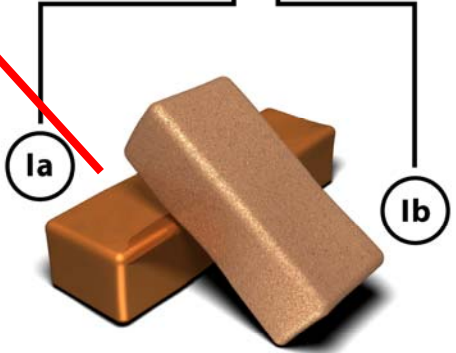
Nanothick film



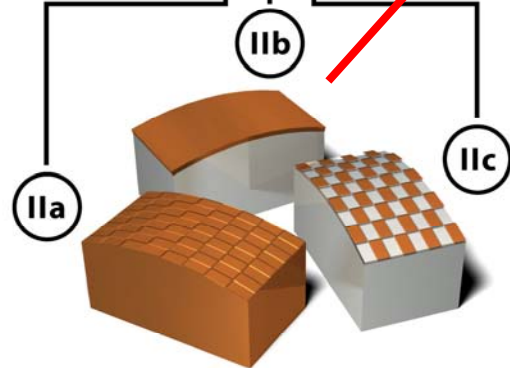
Copper nanocrystals

## BULK

## SURFACE



One phase or Multi phase

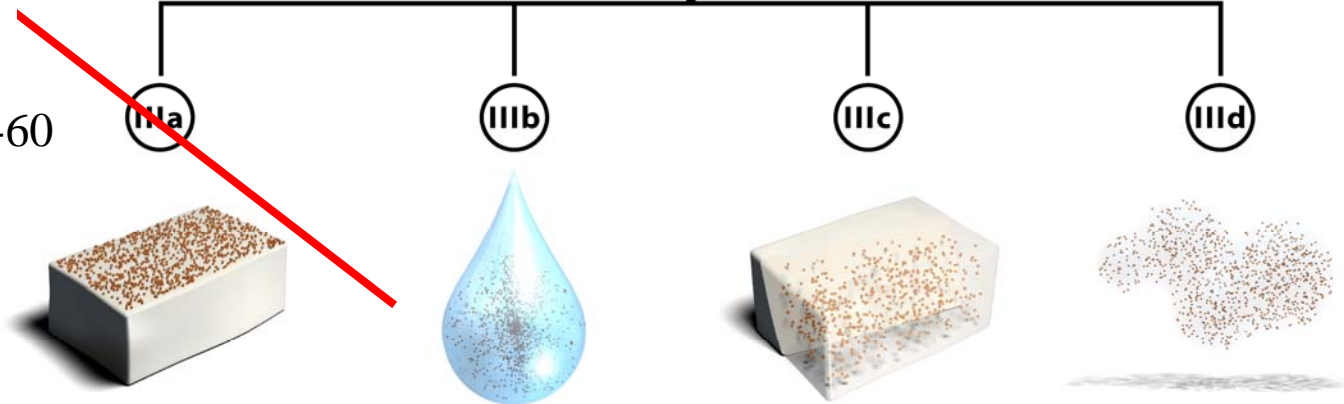


Structured surface, film and structured film

## PARTICLES



Zelens®  
Fullerene C-60  
Eye Cream



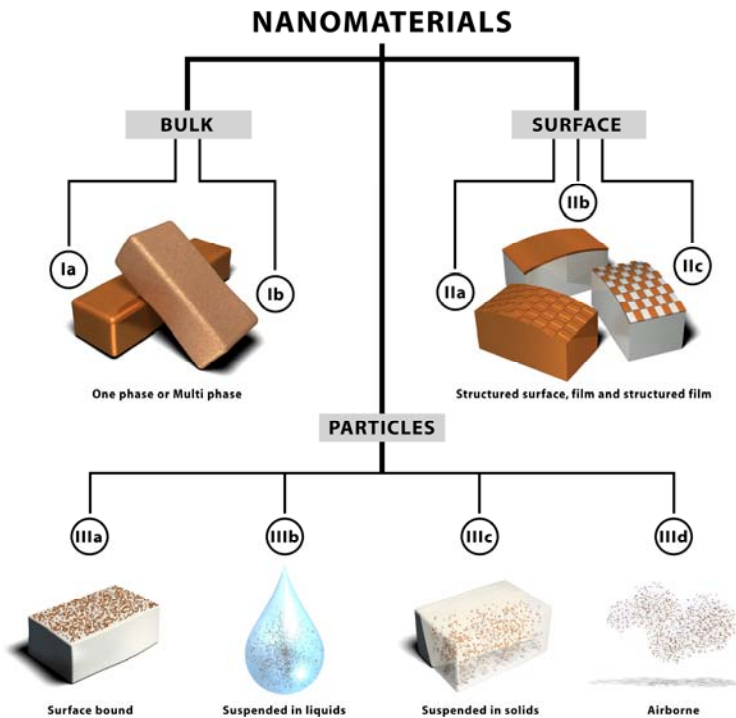
Surface bound

Suspended in liquids

Suspended in solids

Airborne

# Workability



Research Inventories

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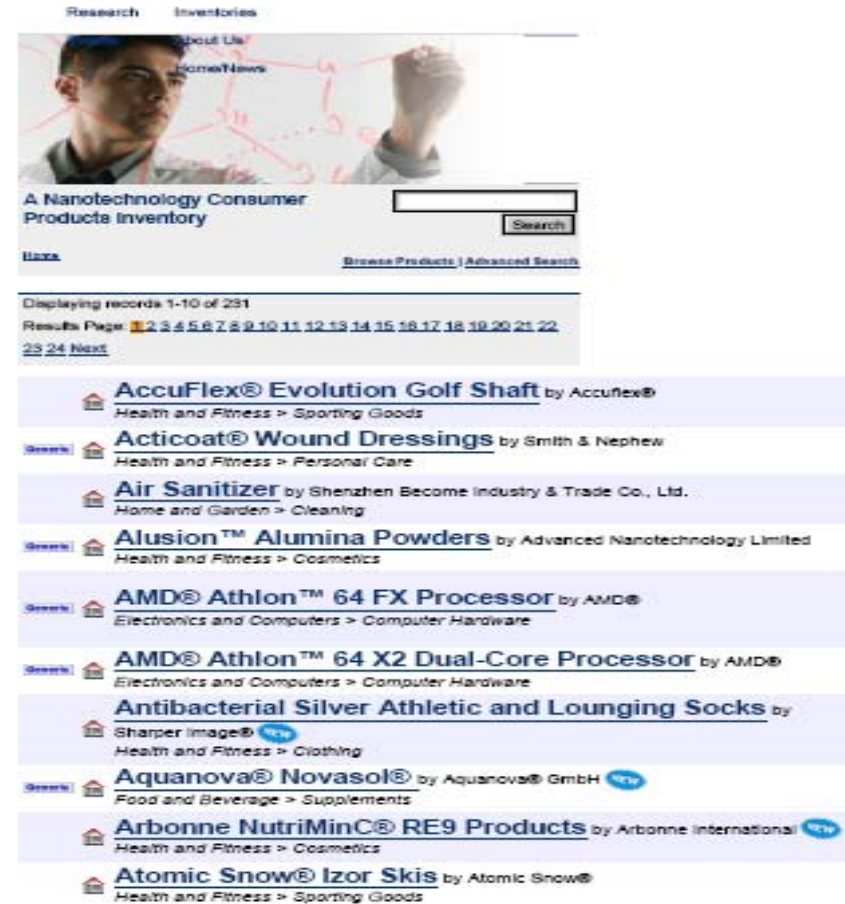
Results Page: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 Next

- AccuFlex® Evolution Golf Shaft** by Accuflex®  
Health and Fitness > Sporting Goods
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Health and Fitness > Personal Care
- Air Sanitizer** by Shenzhen Become Industry & Trade Co., Ltd.  
Home and Garden > Cleaning
- Alusion™ Alumina Powders** by Advanced Nanotechnology Limited  
Health and Fitness > Cosmetics
- AMD® Athlon™ 64 FX Processor** by AMD®  
Electronics and Computers > Computer Hardware
- AMD® Athlon™ 64 X2 Dual-Core Processor** by AMD®  
Electronics and Computers > Computer Hardware
- Antibacterial Silver Athletic and Lounging Socks** by Sharper Image®  
Health and Fitness > Clothing
- Aquanova® Novasol®** by Aquanova® GmbH  
Food and Beverage > Supplements
- Arbonne NutriMinC® RE9 Products** by Arbonne International  
Health and Fitness > Cosmetics
- Atomic Snow® Izor Skis** by Atomic Snow®  
Health and Fitness > Sporting Goods

<http://www.nanotechproject.org/index.php?id=44&action=view>

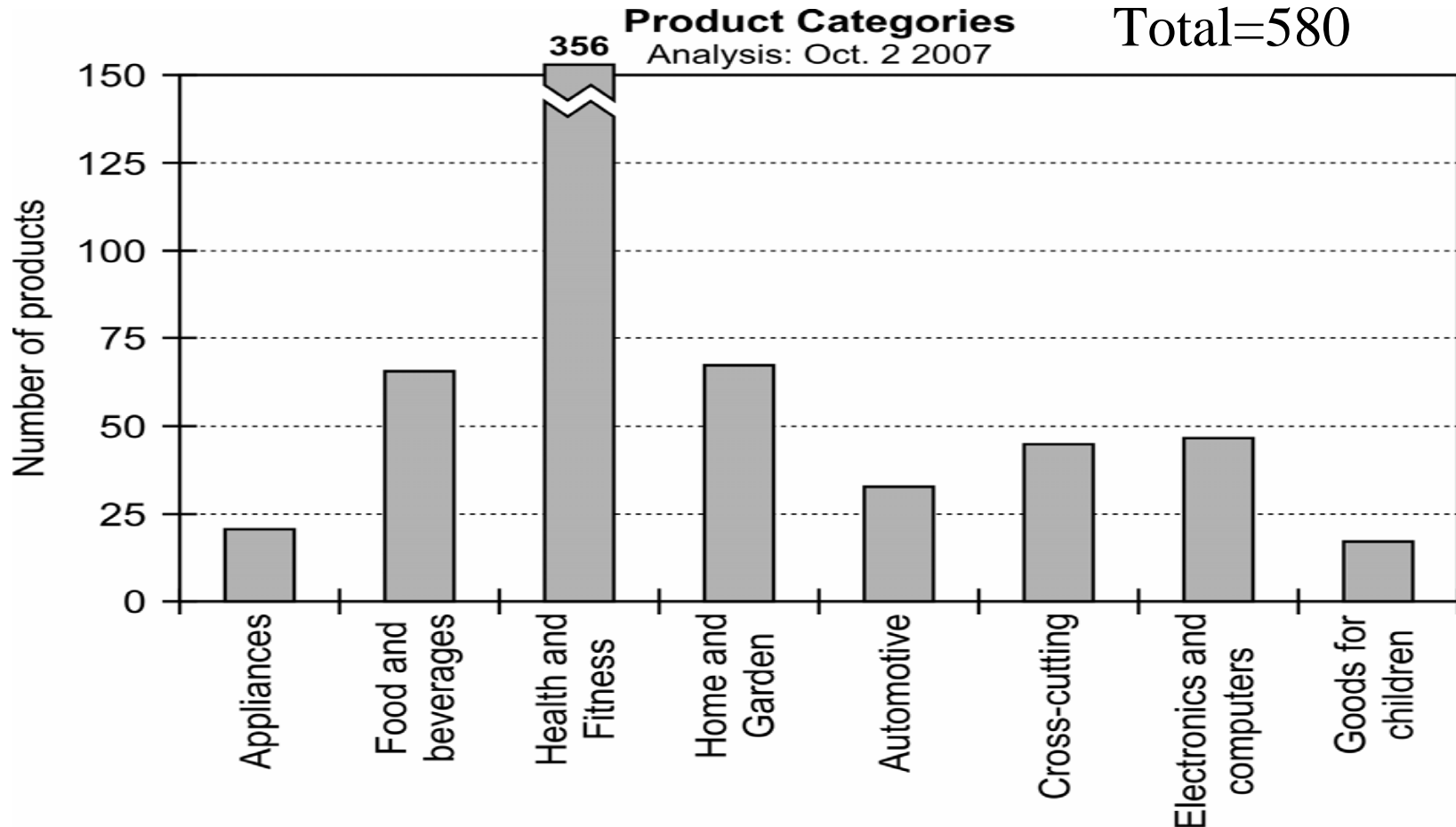
# W. Wilson Center Product Inventory

- 580 products
  - Product name, Company, manufacturer or supplier, Country of origin, Product description
  
- Limitations
  - Only products advertised online
  - Based on reporting from manufacturers
  - Language barrier
  - T-shirt:
    - 3 sizes, 3 colors = 1 product

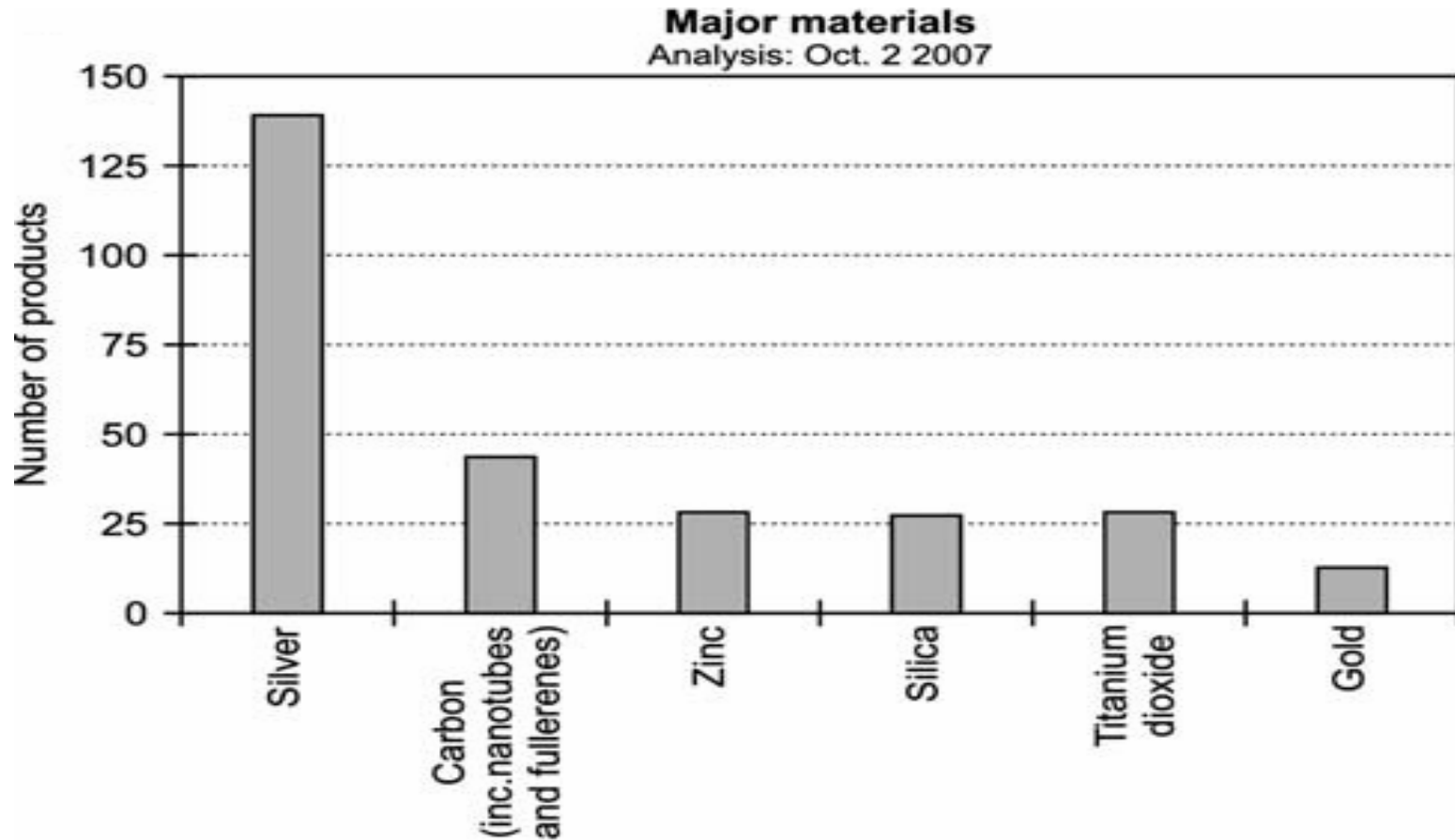


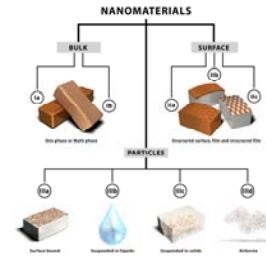
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# W. Wilson Center Product Inventory

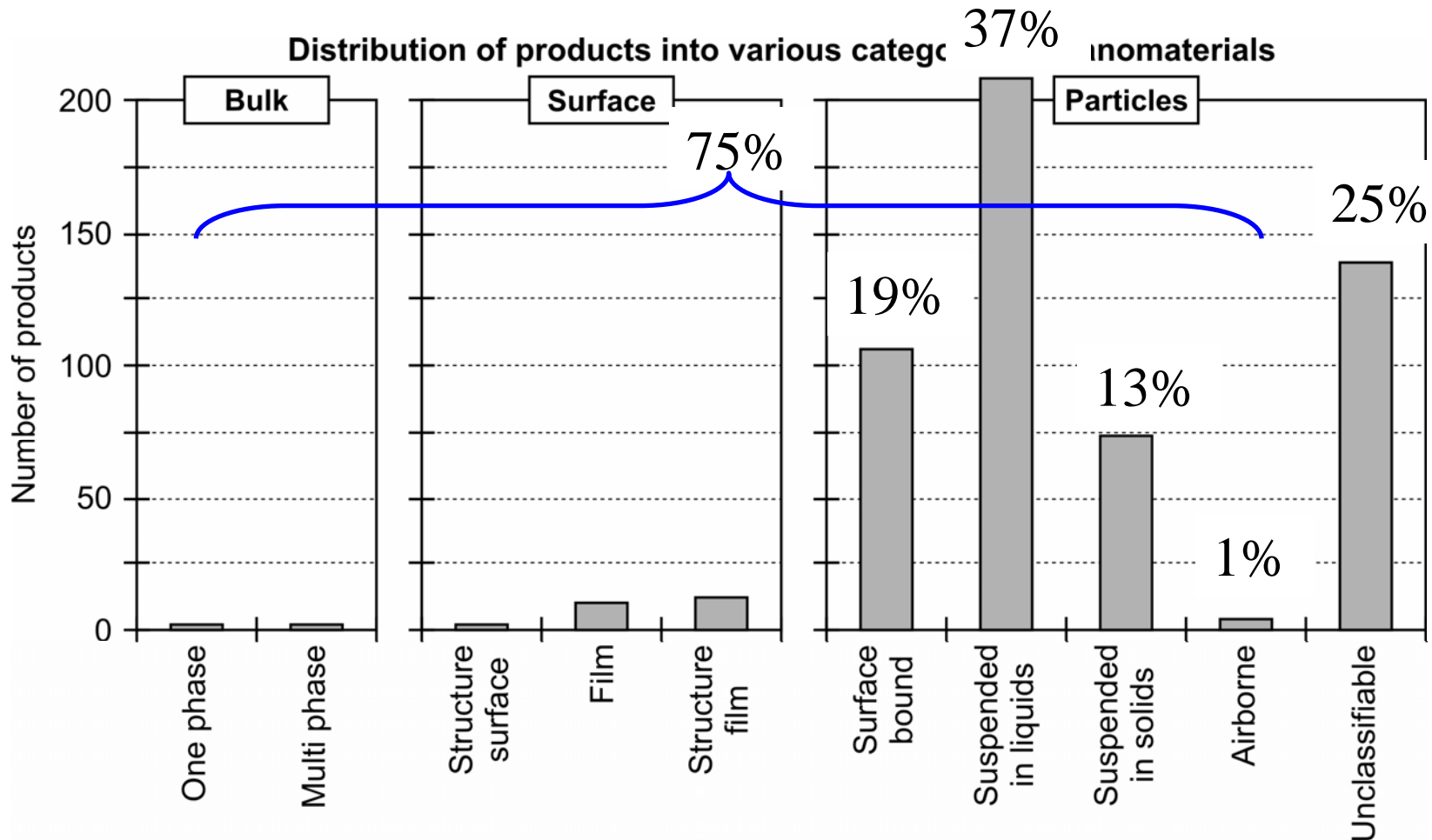
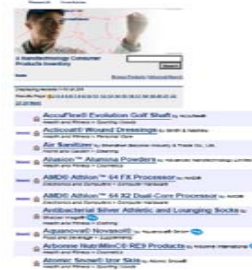


# W. Wilson Center Product Inventory

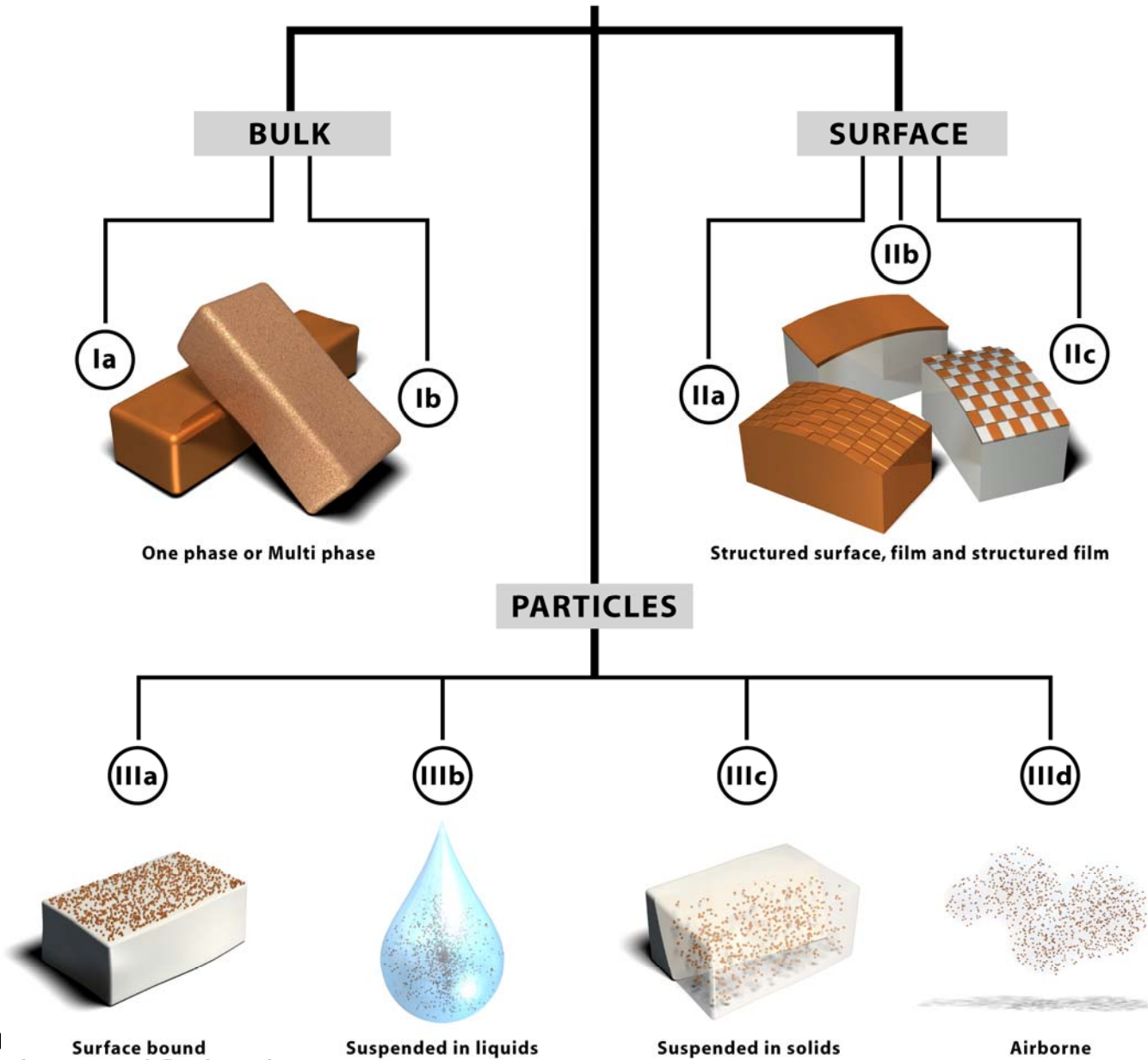




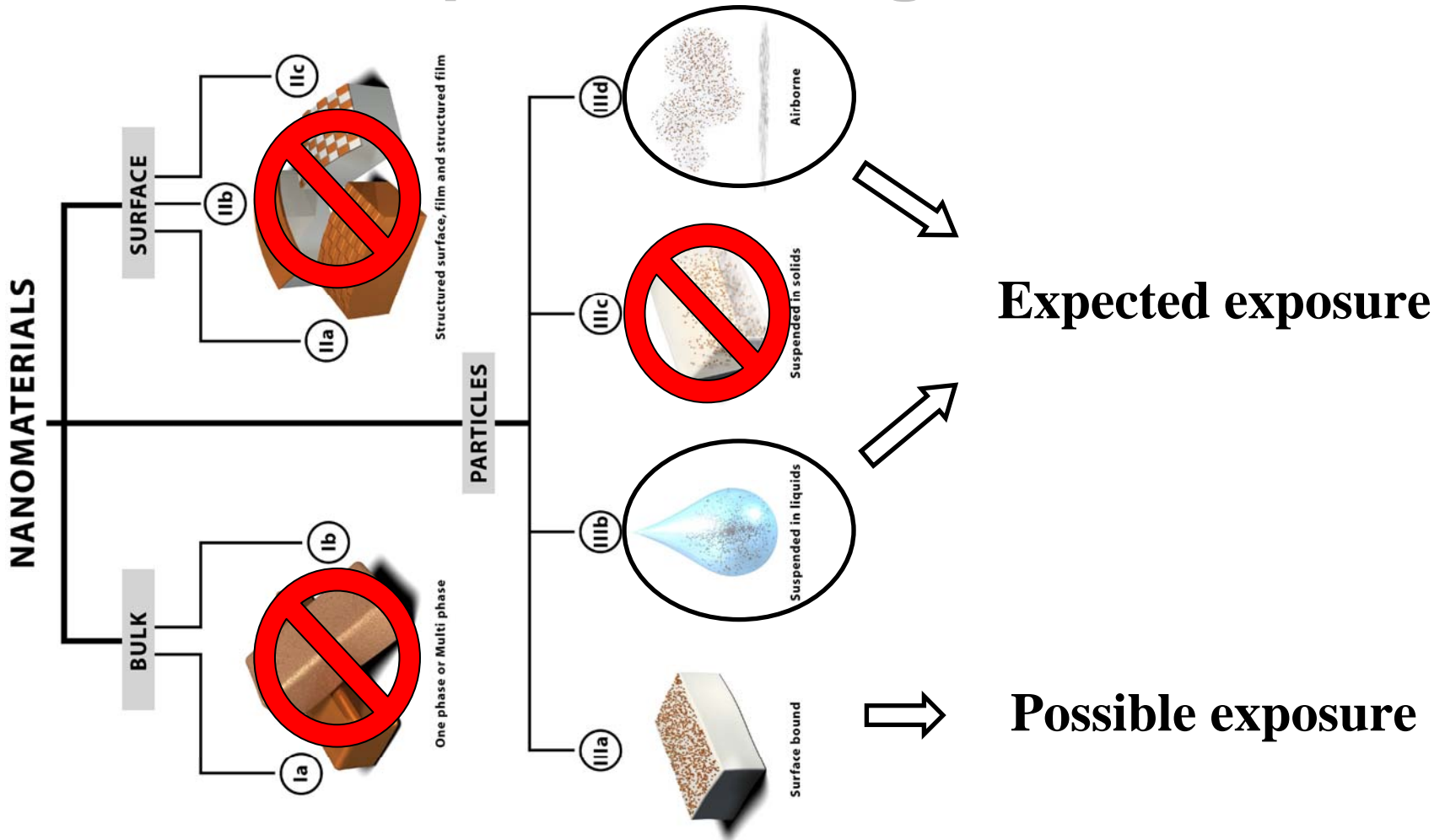
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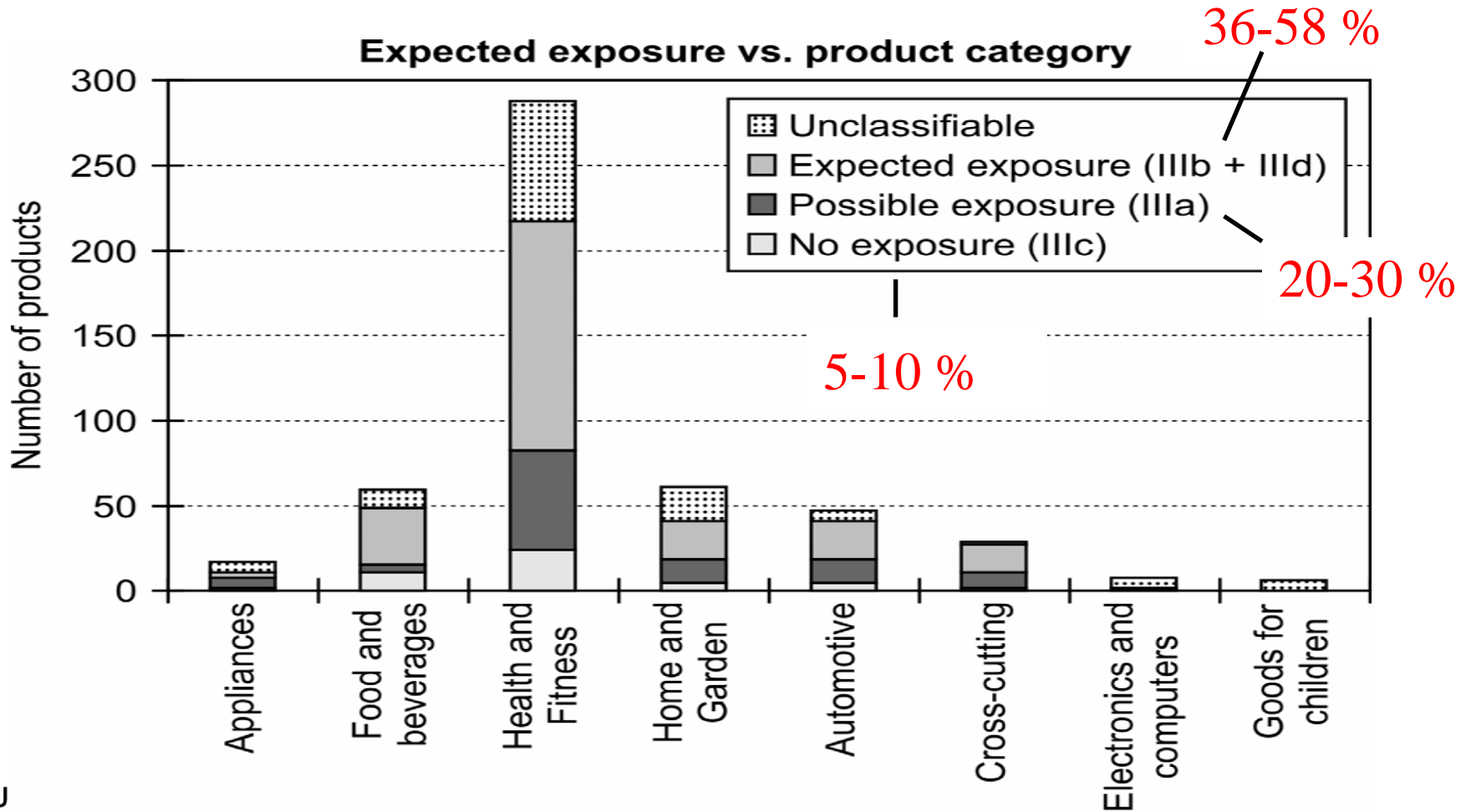
# NANOMATERIALS



# Exposure Categories

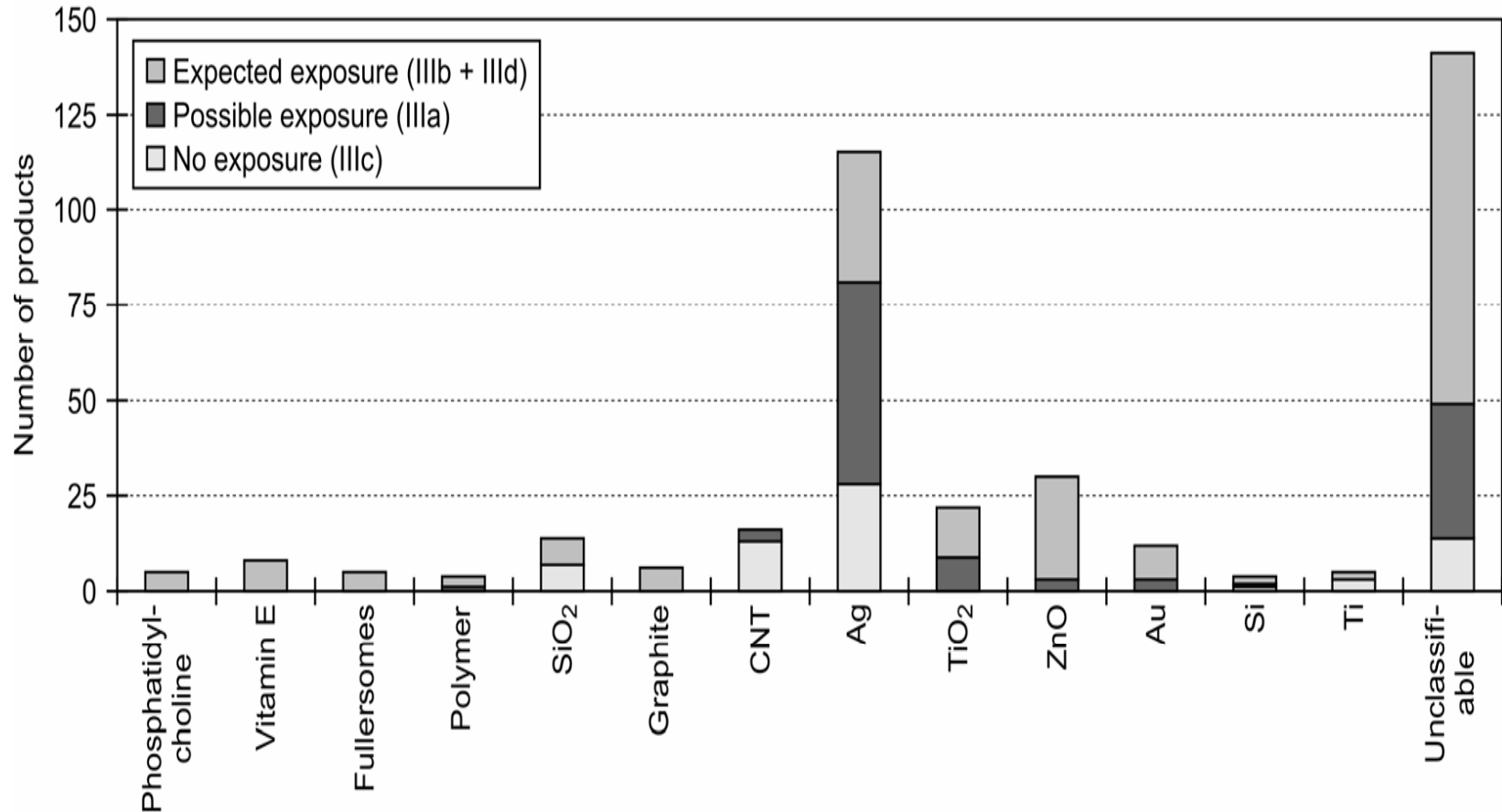


# W. Wilson Center Product Inventory



# W. Wilson Center Product Inventory

Expected exposure vs. material



# Conclusion # 1

- Able to categorize 75% of 580 products
- Mainly NPs "suspended in liquids" (37%) and "surface bound" (19%) – Airborne = 1%
- Expected exposure to NPs = 45 %
- No exposure < 10 %
- Ag is predominant; exposure potential is high
- Unknown material used = Expected exposure is high

# Exposure scenario

- Sun lotion
- Adult ♀/♂ & 2 yr old
- 3 application/day
- Assuming 10 % TiO<sub>2</sub> nanoparticles
  - Realistic worst-case scenario (???)
- 100 % skin penetration
  - Obviously controverisal
  - Can always be refined
- TGD – 8000 mg/application
- EU Sci Com recommendations – 36 000 mg/application



**Table 1** Equations, explanations, and default values for dermal exposure assessment of TiO<sub>2</sub> applied in sunscreen lotion

Symbol	Explanation	Equation	Scenario
F <sub>prod</sub>	Concentration of active substance in the product		10 % <sup>ii</sup>
Bw	Body weight (adult ♀/♂/2 yr old)		60/70 <sup>i</sup> /12.34 <sup>iv</sup> kg
N	Number of applications		3 per day <sup>i</sup>
A <sub>der</sub>	The quantity of active substance on the skin per application (mg) <sup>iii</sup>	$Q_{prod} * F_{prod}$ (1)	
U <sub>der pot</sub>	Potential daily uptake of quantity of active substance (mg/kg bw/day)	$(A_{der} * n) / bw$ (2)	
Q <sub>prod child</sub>	The quantity of product per application for a child	$(k_{child} * Q_{prod, adult}) / k_{adult}$ (3)	
Q <sub>prod</sub>	The quantity of product per application for an adult		
Q <sub>prod adult</sub>	The quantity of product per application for an adult		8000 mg <sup>iii</sup>
Q <sub>prod adult</sub>	The quantity of recommended product per application for an adult		36000 mg <sup>iv</sup>
k <sub>child</sub>	Body area of a 2 yr old child, weighting 12.34 kg and measuring 86.8 cm (m <sup>2</sup> )		0.55 <sup>v</sup>
k <sub>adult</sub>	Body area of an adult woman (m <sup>2</sup> )		1.69 <sup>iii</sup>

i) European Commission JRC 2003, ii) (Tønning and Poulsen 2007); iii) European Commission JRC 2003, iv) European Commission 2006, v) Lentner 1981

# Exposure estimates

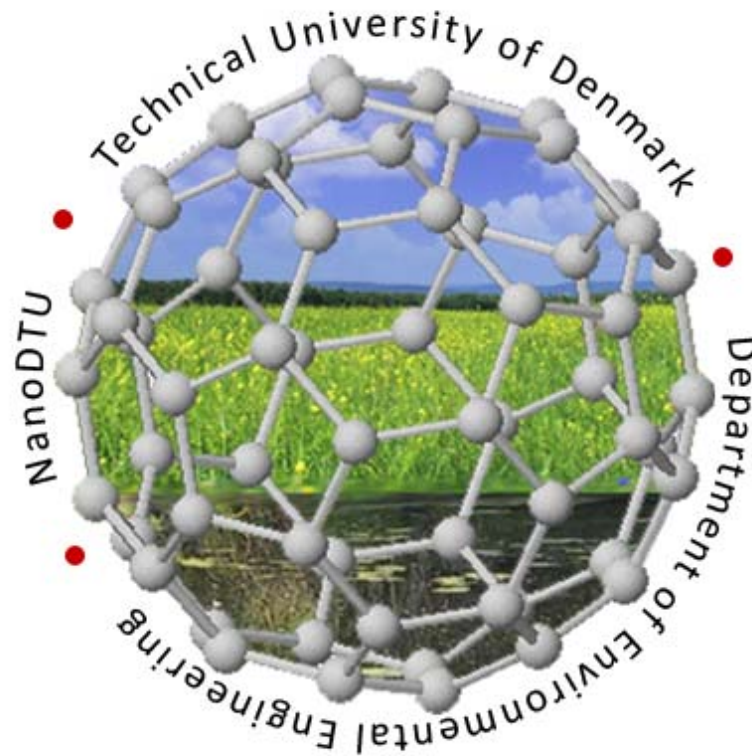
		$F_{\text{prod}}$ (%)	$Q_{\text{prod}}$ (mg)	$A_{\text{der}}$ (mg)	$U_{\text{der pot}}$ (mg kg <sup>-1</sup> bw d <sup>-1</sup> )
TGD	Adult	10	8000	800	♂34.29/40♀
	Child		2603,55	260,36	63,30
Commission Recommendation	Adult	10	36000	3600	♂154.29/♀180
	Child		11715,98	1171,60	284,83

- For a child  $A_{\text{der}}$  is 1/3 whereas  $U_{\text{der}}$  is twice that compared to an adult

## Conclusion # 2

- TDG equations can be used to estimate NP exposure
- But should they be used?
  - Equations for  $A_{\text{der}}$  and  $U_{\text{der}}$  not developed for particles
  - Each particle type is different – something TGD ignores
- Lack of access to product information inhibits realistic exposure assessments
- Regulatory agencies have limited authority to obtain product information

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[sfh@env.dtu.dk](mailto:sfh@env.dtu.dk)

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