NIBIO
NORSK INSTITUTT FOR BIOØKONOMI

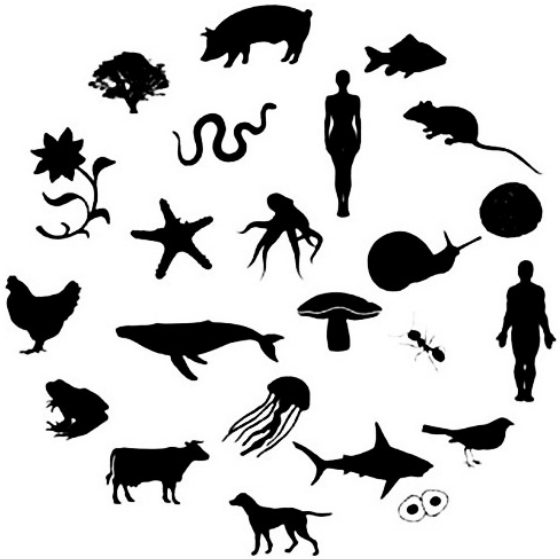
Nanoteknologi
Trusler for helse og miljø?

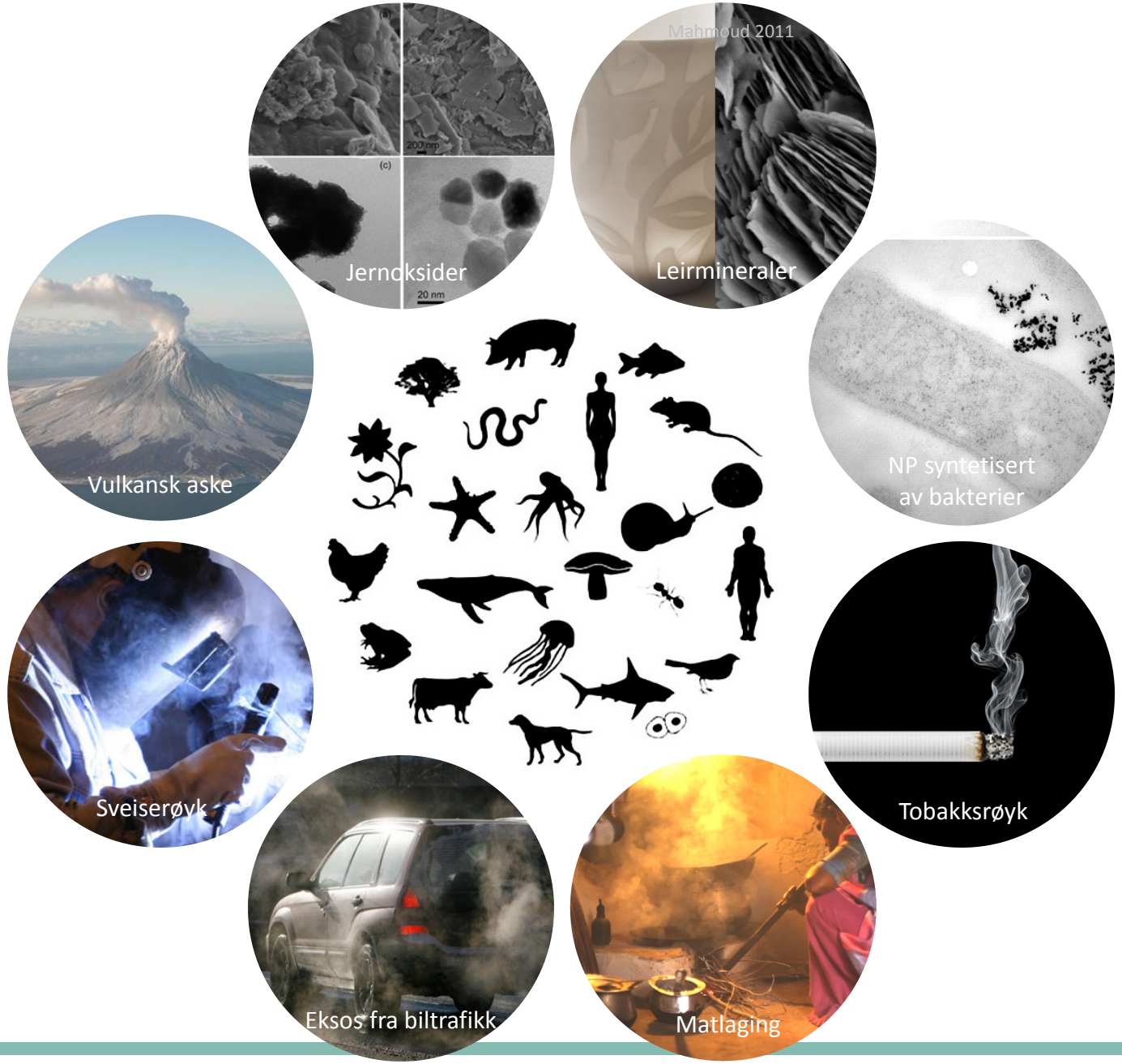
Claire Coutris

Stavanger 21. Oktober 2015, Seminar om nanoteknologi – muligheter og trusler

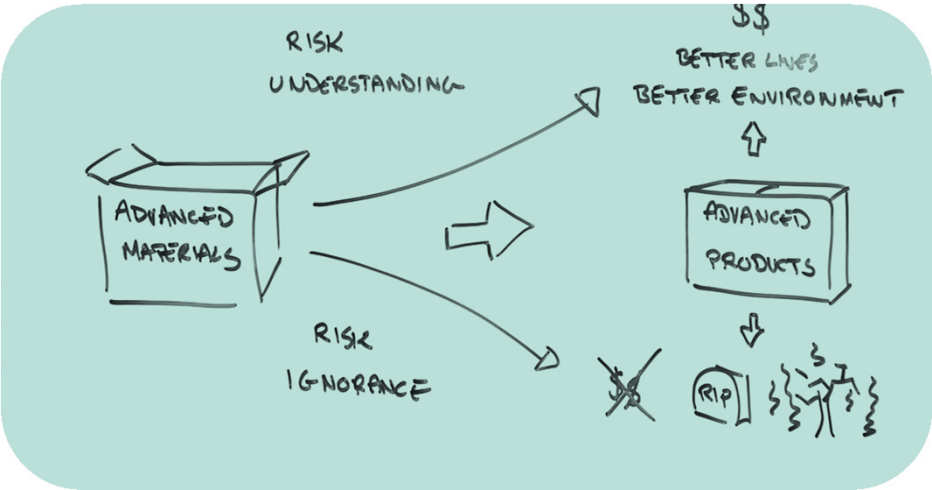
Norges Tekniske Vitenskapsakademi og Vitenskapsakademiet i Stavanger

OMGITT AV NATURLIGE OG TILFELDIGE NANOMATERIALER




Jernoksider
Mahmoud 2011
Leirmineraler
Vulkansk aske
NP syntetisert
av bakterier
Sveiserøyk
Tobakksrøyk
Eksos fra biltrafikk
Matlaging

ANSVARLIG TEKNOLOGISK UTVIKLING TAR HENSYN TIL RISIKO



HVA ER RISIKO?

+

= Ingen risiko

Fare Ingen eksponering

Fare + eksponering = Risiko

Fare = den **iboende evnen** til et kjemikalie til å ha **negative** effekter i miljøet

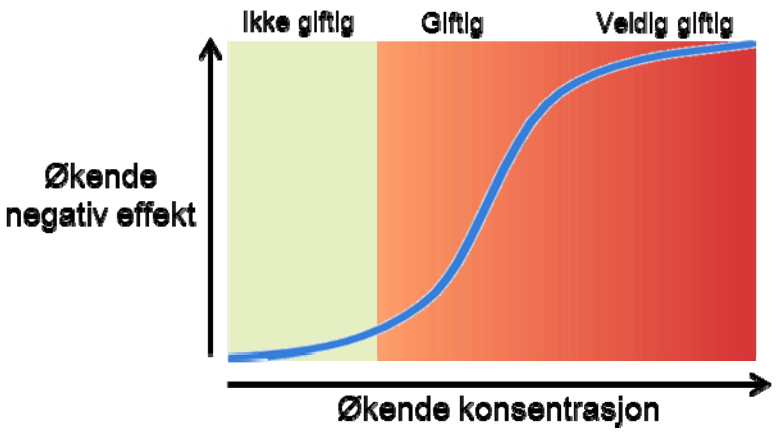
Risiko = sannsynligheten for at en skade **inntreffer** på mennesker eller økosystem ved en gitt **eksponering** til et kjemikalie

ØKOTOKSIKOLOGISK RISIKOVURDERING

Fare identifisering / Effektvurdering

↓

Forventet ingen effekt konsentrasjon (PNEC)



ØKOTOKSIKOLOGISK RISIKOVURDERING

Fare identifisering / Effektvurdering

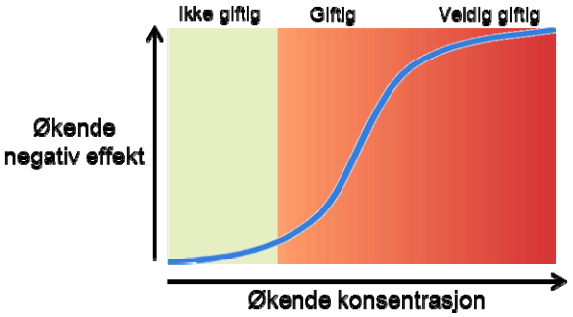
Eksponeringskarakterisering

Forventet ingen effekt konsentrasjon (PNEC)

Estimert konsentrasjon i miljøet (PEC)

Risikokarakterisering

PEC < PNEC

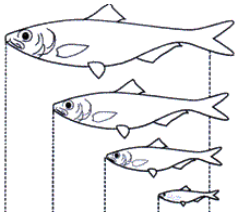


PEC > PNEC

Risikoforvaltning

STANDARD ØKOTOKS TESTER

- ✓ Standard (in vivo) tester utført i laboratoriet
- ✓ Overlevelse, vekst og reproduksjon



- ✓ Tester utført på et begrenset antall velkjente arter
  - ✓ Akutt/kronisk
  - ✓ Akvatisk/terrestrisk

OECD RETNINGSLINJER FOR ØKOTOKSIKOLOGISKE TESTER

OECD Guidelines for the Testing of Chemicals, Section 2

Effects on Biotic Systems

OECD Guidelines for the Testing of Chemicals

Subscribe to the feed

Hide / Show Abstract

The OECD *Guidelines for the Testing of Chemicals* is a collection of about 150 of the most relevant internationally agreed testing methods used by government, industry and independent laboratories to identify and characterise potential hazards of chemicals. They are a set of tools for professionals, used primarily in regulatory safety testing and subsequent chemical and chemical product notification, chemical registration and in chemical evaluation. They can also be used for the selection and ranking of candidate chemicals during the development of new chemicals and products and in toxicology research. This group of tests covers effects on biotic systems.

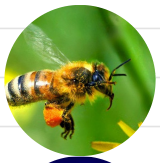
Also available in: French

ISSN : 2074-5761 (online)
DOI : 10.1787/20745761

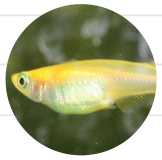
Hide / Show all Ab

Click to Ac

Mark	Date	Title
☐	28 July 2015	Test No. 240: Medaka Extended One Generation Reproduction Test (MEOGRT) OECD
☐	28 July 2015	Test No. 241: The Larval Amphibian Growth and Development Assay (LAGDA) OECD
☐	26 Sep 2014	Test No. 238: Sediment-Free Myriophyllum Spicatum Toxicity Test OECD
☐	26 Sep 2014	Test No. 239: Water-Sediment Myriophyllum Spicatum Toxicity Test OECD
☐	26 July 2013	Test No. 236: Fish Embryo Acute Toxicity (FET) Test OECD
☐	26 July 2013	Test No. 237: Honey Bee (Apis Mellifera) Larval Toxicity Test, Single Exposure OECD
☐	26 July 2013	Test No. 210: Fish, Early-life Stage Toxicity Test OECD
☐	02 Oct 2012	Test No. 211: Daphnia magna Reproduction Test OECD
☐	02 Oct 2012	Test No. 229: Fish Short Term Reproduction Assay OECD
☐	28 July 2011	Test No. 201: Freshwater Alga and Cyanobacteria, Growth Inhibition Test OECD
☐	28 July 2011	Test No. 234: Fish Sexual Development Test OECD
☐	28 July 2011	Test No. 235: Chironomus sp., Acute Immobilisation Test OECD
☐	23 July 2010	Test No. 209: Activated Sludge, Respiration Inhibition Test (Carbon and Ammonium Oxidation) OECD
☐	23 July 2010	Test No. 223: Avian Acute Oral Toxicity Test OECD
☐	23 July 2010	Test No. 233: Sediment-Water Chironomid Life-Cycle Toxicity Test Using Spiked Water or Spiked Sediment OECD
☐	08 Sep 2009	Test No. 229: Fish Short Term Reproduction Assay OECD
☐	08 Sep 2009	Test No. 230: 21-day Fish Assay OECD
☐	08 Sep 2009	Test No. 231: Amphibian Metamorphosis Assay OECD
☐	08 Sep 2009	Test No. 232: Collembolan Reproduction Test in Soil OECD
☐	16 Oct 2008	Test No. 226: Predatory mite (Hypoaspis (Geolaelaps) aculeifer) reproduction test in soil OECD
☐	16 Oct 2008	Test No. 228: Determination of Developmental Toxicity of a Test Chemical to Dipteran Dung Flies(Scathophaga stercoraria L. (Scathophagidae), Musca autumnalis De Geer (Muscidae)) OECD
☐	16 Oct 2008	Test No. 211: Daphnia magna Reproduction Test OECD



☐	15 Oct 2007	Test No. 225: Sediment-Water Lumbriculus Toxicity Test Using Spiked Sediment OECD
☐	25 Jan 2007	Test No. 224: Determination of the Inhibition of the Activity of Anaerobic Bacteria OECD
☐	11 Sep 2006	Summary of Considerations in the Report from the OECD Expert Group on Ecotoxicology OECD
☐	17 Aug 2006	Test No. 227: Terrestrial Plant Test: Vegetative Vigour Test OECD
☐	17 Aug 2006	Test No. 208: Terrestrial Plant Test: Seedling Emergence and Seedling Growth Test OECD
☐	11 July 2006	Test No. 221: Lemna sp. Growth Inhibition Test OECD
☐	23 Nov 2004	Test No. 202: Daphnia sp. Acute Immobilisation Test OECD
☐	23 Nov 2004	Test No. 218: Sediment-Water Chironomid Toxicity Using Spiked Sediment OECD
☐	23 Nov 2004	Test No. 219: Sediment-Water Chironomid Toxicity Using Spiked Water OECD
☐	23 Nov 2004	Test No. 220: Enchytraeid Reproduction Test OECD
☐	23 Nov 2004	Test No. 222: Earthworm Reproduction Test (Eisenia fetida/Eisenia andrei) OECD
☐	21 Jan 2000	Test No. 215: Fish, Juvenile Growth Test OECD
☐	21 Jan 2000	Test No. 216: Soil Microorganisms: Nitrogen Transformation Test OECD
☐	21 Jan 2000	Test No. 217: Soil Microorganisms: Carbon Transformation Test OECD
☐	21 Sep 1998	Test No. 212: Fish, Short-term Toxicity Test on Embryo and Sac-Fry Stages OECD
☐	21 Sep 1998	Test No. 213: Honeybees, Acute Oral Toxicity Test OECD
☐	21 Sep 1998	Test No. 214: Honeybees, Acute Contact Toxicity Test OECD
☐	17 July 1992	Test No. 203: Fish, Acute Toxicity Test OECD
☐	17 July 1992	Test No. 210: Fish, Early-Life Stage Toxicity Test OECD
☐	04 Apr 1984	Test No. 204: Fish, Prolonged Toxicity Test: 14-Day Study OECD
☐	04 Apr 1984	Test No. 205: Avian Dietary Toxicity Test OECD
☐	04 Apr 1984	Test No. 206: Avian Reproduction Test OECD
☐	04 Apr 1984	Test No. 207: Earthworm, Acute Toxicity Tests OECD



OECD RETNINGSLINJER FOR TOKSIKOLOGISKE TESTER

OECD Guidelines for the Testing of Chemicals, Section 4

Health Effects

OECD Guidelines for the Testing of Chemicals

Subscribe to the feed

Hide / Show Abstract

The OECD *Guidelines for the Testing of Chemicals* is a collection of about 150 of the most relevant internationally agreed testing methods used by government, industry and independent laboratories to identify and characterise potential hazards of chemicals. They are a set of tools for professionals, used primarily in regulatory safety testing and subsequent chemical and chemical product notification, chemical registration and in chemical evaluation. They can also be used for the selection and ranking of candidate chemicals during the development of new chemicals and products and in toxicology research. This group of tests covers health effects.

Also available in: French

ISSN : 2074-5788 (online)
DOI : 10.1787/20745788

Hide / Show all Abstracts

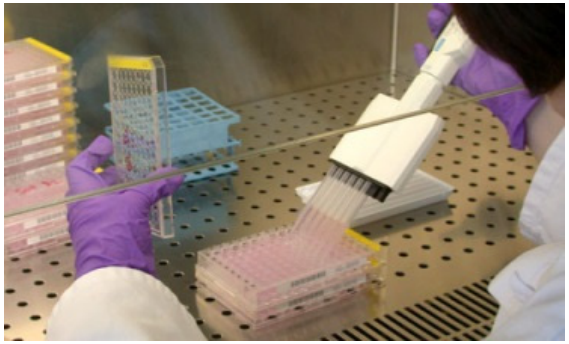
Mark	Date	Title	Click to Access
☐	28 July 2015	Test No. 490: In Vitro Mammalian Cell Gene Mutation Tests Using the Thymidine Kinase Gene OECD	PDF READ
☐	28 July 2015	Test No. 491: Short Time Exposure In Vitro Test Method for Identifying i) Chemicals Inducing Serious Eye Damage and ii) Chemicals Not Requiring Classification for Eye Irritation or Serious Eye Damage OECD	PDF READ
☐	28 July 2015	Test No. 492: Reconstructed human Cornea-like Epithelium (RhCE) test method for identifying chemicals not requiring classification and labelling for eye irritation or serious eye damage OECD	PDF READ
☐	28 July 2015	Test No. 493: Performance-Based Test Guideline for Human Recombinant Estrogen Receptor (hrER) In Vitro Assays to Detect Chemicals with ER Binding Affinity OECD	PDF READ
☐	28 July 2015	Test No. 404: Acute Dermal Irritation/Corrosion OECD	PDF READ
☐	28 July 2015	Test No. 421: Reproduction/Developmental Toxicity Screening Test OECD	
☐	28 July 2015	Test No. 422: Combined Repeated Dose Toxicity Study with the Reproduction/Developmental Toxicity Scree OECD	
☐	28 July 2015	Test No. 430: In Vitro Skin Corrosion: Transcutaneous Electrical Resistance Test Method (TER) OECD	
☐	28 July 2015	Test No. 431: In vitro skin corrosion: reconstructed human epidermis (RHE) test method OECD	
☐	28 July 2015	Test No. 435: In Vitro Membrane Barrier Test Method for Skin Corrosion OECD	
☐	28 July 2015	Test No. 439: In Vitro Skin Irritation: Reconstructed Human Epidermis Test Method OECD	
☐	28 July 2015	Test No. 455: Performance-Based Test Guideline for Stably Transfected Transactivation In Vitro Assays to D Agonists and Antagonists OECD	
☐	28 July 2015	Test No. 483: Mammalian Spermatogonial Chromosomal Aberration Test OECD	
☐	05 Feb 2015	Test No. 442C: In Chemico Skin Sensitisation OECD	PDF READ
☐	05 Feb 2015	Test No. 442D: In Vitro Skin Sensitisation OECD	PDF READ
☐	26 Sep 2014	Test No. 489: In Vivo Mammalian Alkaline Comet Assay OECD	PDF READ
☐	26 Sep 2014	Test No. 431: In Vitro Skin Corrosion: Reconstructed Human Epidermis (Rhe) Test Method OECD	
☐	26 Sep 2014	Test No. 473: In Vitro Mammalian Chromosomal Aberration Test OECD	PDF READ
☐	26 Sep 2014	Test No. 474: Mammalian Erythrocyte Micronucleus Test OECD	PDF READ
☐	26 Sep 2014	Test No. 475: Mammalian Bone Marrow Chromosomal Aberration Test OECD	PDF READ
☐	26 Sep 2014	Test No. 487: In Vitro Mammalian Cell Micronucleus Test OECD	PDF READ
☐	26 July 2013	Test No. 430: In Vitro Skin Corrosion: Transcutaneous Electrical Resistance Test Method (TER)	
☐	23 July 2010	Test No. 439: In Vitro Skin Irritation OECD	
☐	23 July 2010	Test No. 442A: Skin Sensitization OECD	PDF REA
☐	23 July 2010	Test No. 442B: Skin Sensitization OECD	PDF REA
☐	23 July 2010	Test No. 487: In Vitro Mammalian Cell Micronucleus Test OECD	
☐	08 Sep 2009	Test No. 403: Acute Inhalation Toxicity OECD	PDF REA
☐	08 Sep 2009	Test No. 412: Subacute Inhalation Toxicity: 28-Day Study OECD	PDF REA
☐	08 Sep 2009	Test No. 413: Subchronic Inhalation Toxicity: 90-day Study OECD	PDF REA
☐	08 Sep 2009	Test No. 451: Carcinogenicity Studies	PDF REA
		52: Chronic Toxicity Studies	PDF REA
		3: Combined Chronic Toxicity/Carcinogenicity Studies	PDF REA
		6: Acute Inhalation Toxicity – Acute Toxic Class Method	PDF REA
		7: Bovine Corneal Opacity and Permeability Test Method for Identifying Ocular Corrosives and Severe Irritants	
		8: Isolated Chicken Eye Test Method for Identifying Ocular Corrosives and Severe Irritants	
		1: Hershberger Bioassay in Rats	PDF REA
		55: The Stably Transfected Human Estrogen Receptor-alpha Transcriptional Activation Assay for Detection of Estrogenic Agonist-Activity of als	
☐	16 Oct 2008	Test No. 407: Repeated Dose 28-day Oral Toxicity Study in Rodents OECD	PDF REA
☐	16 Oct 2008	Test No. 425: Acute Oral Toxicity: Up-and-Down Procedure OECD	PDF REA
☐	15 Oct 2007	Test No. 426: Developmental Neurotoxicity Study OECD	PDF REA
☐	15 Oct 2007	Test No. 440: Uterotrophic Bioassay in Rodents OECD	PDF REA
☐	11 Sep 2006	Summary of Considerations in the Report from the OECD Expert Groups on Short Term and Long Term Toxicology OECD	PDF REA
☐	17 Aug 2006	Test No. 435: In Vitro Membrane Barrier Test Method for Skin Corrosion OECD	
☐	23 Nov 2004	Test No. 427: Skin Absorption: In Vivo Method OECD	PDF REA
☐	23 Nov 2004	Test No. 428: Skin Absorption: In Vitro Method OECD	PDF REA
☐	23 Nov 2004	Test No. 430: In Vitro Skin Corrosion: Transcutaneous Electrical Resistance Test (TER) OECD	

Akutt toksisitet
Hud- og øyeirritasjon
Gentoksisitet
Karsinogen effekt
Reprotoksisitet
Nevrotoksisitet

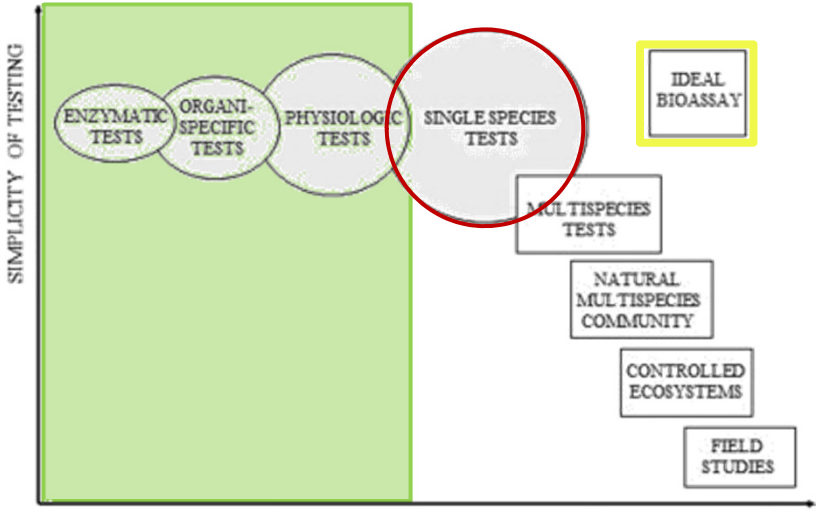
ANDRE ØKOTOKSIKOLOGISKE TESTER

- ✓ *In vitro* testing, organer, cellekulturer, …
- ✓ Forklarer giftstoffers virkemåte

  f.eks. gentoksisitet, immuntoksisitet, oksidativt stress
- ✓ Alternativ til dyreforsøk, etisk grunnlag
- ✓ HIGH THROUGHPUT



Høy kontroll
Enkel
Rask

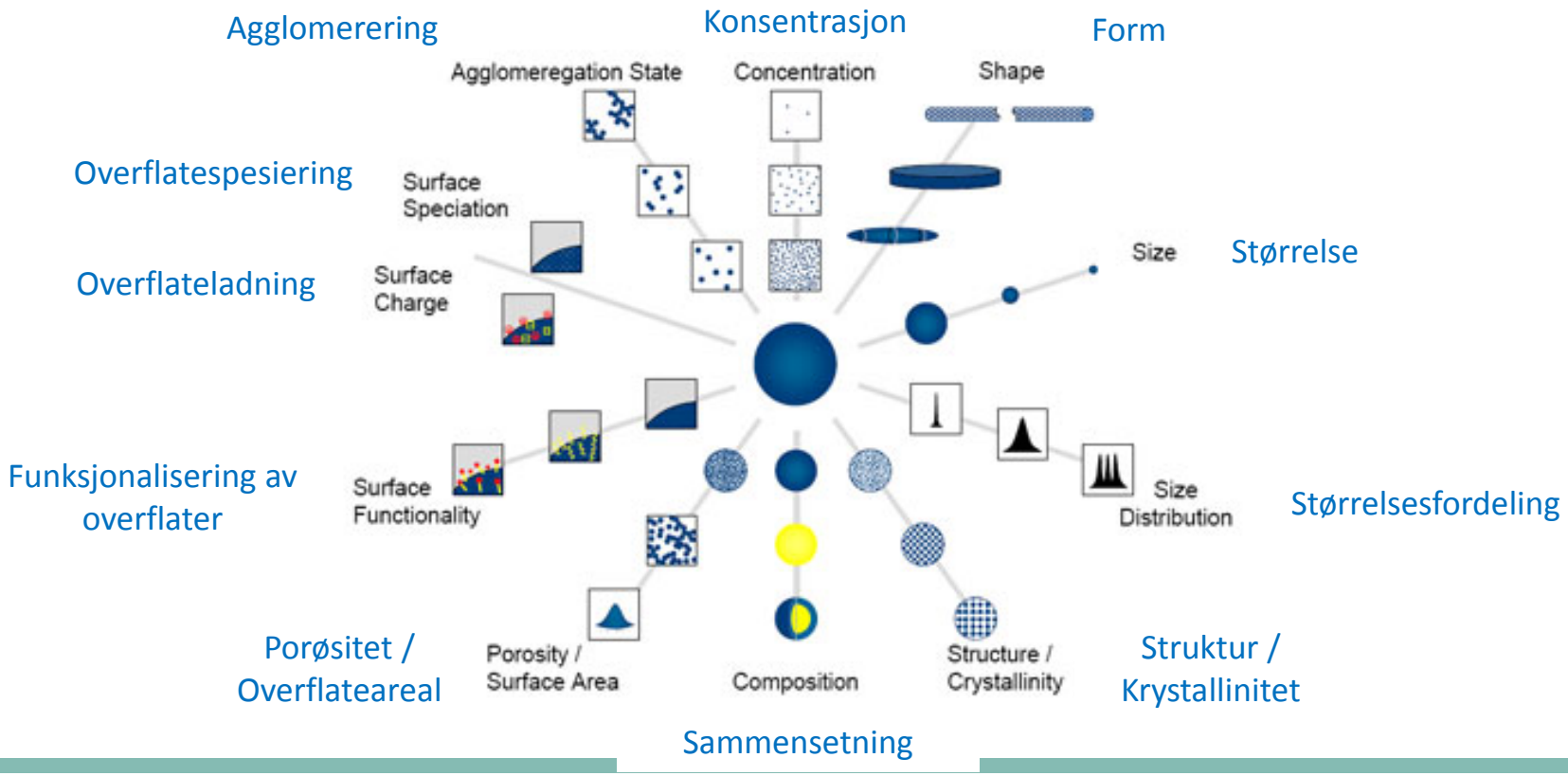


Lav økologisk relevans

PARACELSUS REVISITED

«Alt er gift og ingenting er uten gift; bare dosen avgjør om noe er en gift»

Stemmer ikke for nanomaterialer!

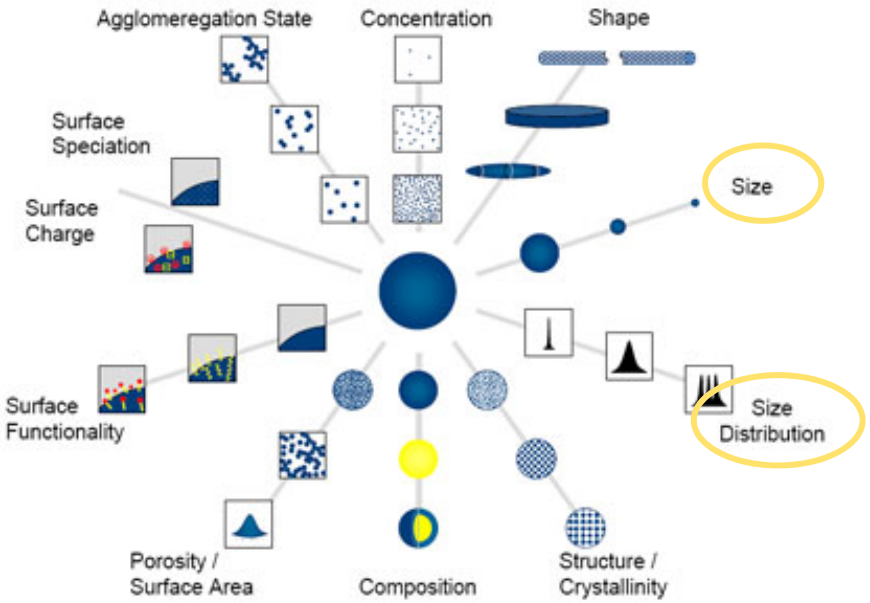


KARAKTERISERING AV TEST MATERIALER ER VIKTIG …OG VANSKELIG

Characterization (as on the shelf)		Characterization (in respective media)
Appearance (IA)	Dissociation constant (IA)	Composition/purity
Melting point (IA)	pH (IA)	Size, size distribution
Density (IA)	Agglomeration or aggregation	Agglomeration/aggregation
Size, size distribution	Crystalline phase	Zeta-potential
N-octanol–water partition coefficient (WR)	Crystallite and grain size	Biophysical properties (AA) (protein binding/corona characterization, residence times, adsorption enthalpy, conformation changes on binding)
Water solubility/dispersibility, hydrophilicity	Aspect ratio, shape	Dissolution (WR)
Solubility/dispersibility in organic solvents, oleophilicity	Specific surface area	
Auto flammability (IA)	Zeta potential	Test item preparation protocol, conditioning, homogeneity and short term stability
Flammability (IA)	Surface chemistry (WA)	
Stability in solvents and identity of relevant degradation products	Stability and homogeneity (on the shelf, in water and organic solvents)	
Oxidizing properties (IA)	Dustiness	
Oxidation reduction potential	Porosity, pore and pour density	
Explosiveness (IA)	Photocatalytic activity	
Storage stability and reactivity towards container material	Catalytic activity	
Stability towards thermal, sunlight, metals	Radical formation potential	

WR, where relevant; IA, if applicable; WA, where available; AA, as appropriate.

PARTIKKELSTØRRELSE OG STØRRELSESFORDELING



PARTIKKELSTØRRELSE OG STØRRELSESFORDELING

- ✓ Flere studier* viser at giftigheten øker med avtagende partikkelstørrelse
  - ✓ Større oksidativ skade ble indusert av TiO_2 NP med mindre partikkelstørrelse
  - ✓ Av 20, 80, og 113 nm Ag NP, viste de minste NP høyere gentoksisitet, cytotoksisitet og utviklingstoksisitet
- ✓ Forskjellige måter å måle størrelse på, hver med sine fordeler, ulemper og anvendbarhet grenser
- ✓ Anbefalt å kombinere ulike metoder, og å oppgi størrelsesfordelingen framfor kun den gjennomsnittlige størrelsen.

* Men ikke alle

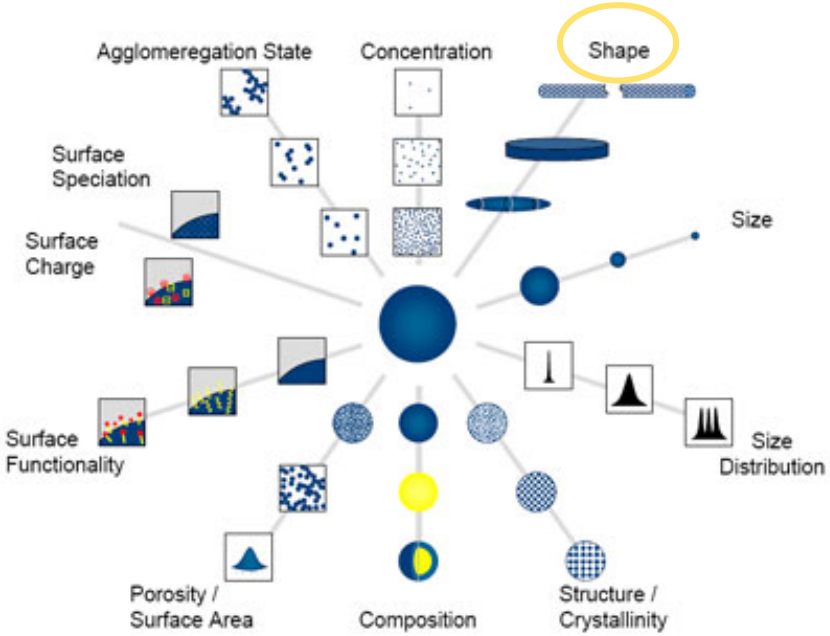
Gurr et al 2005, Oksel et al 2015, Park et al 2011

PARTIKKELSTØRRELSE OG STØRRELSEFORDELING

Method	Parameters measured	Sample required	Particle size range	Additional information
Electron microscopy	Particle size Size distribution Particle shape Agglomeration	Dry	0.3 nm–μm	(+) High resolution (–) Expensive and complex (–) Vacuum is needed (Dhawan & Sharma, 2010)
Atomic force microscopy	Particle size Size distribution Morphology Surface structure Agglomeration	Wet/dry	1 nm–μm	(+) 3D images (+) Works well in ambient air (–) Particles should be on the surface. (Powers et al., 2006)
Dynamic light scattering (DLS)	Particle size Size distribution Agglomeration Zeta potential	Wet	1 nm–6 μm	(+) Cheap and fast (–) Sample polydispersity may distort the results. (Tomaszewska et al., 2013)
NP tracking analysis (NPTA)	Particle size Size distribution Agglomeration	Wet	10 nm–2 μm	(+) Particle-by-particle basis (–) Dependence on the settings (Hassellöv & Kaegi, 2009)
Centrifugal sedimentation	Particle size Size distribution	Wet	5 nm–10 μm	(+) Accurate and repeatable results (–) Takes long time for small particles to sediment (Laidlaw & Steinmetz, 2005)
BET surface area analysis	Particle size Surface area	Dry	5 nm–1 μm	(–) Size distribution is not provided. (Dhawan & Sharma, 2010)
Laser diffraction	Particle size Size distribution	Wet/dry	40 nm–3 mm	(+) Fast and flexible (–) Dependent on optical parameters (Kübart & Keck, 2013)
Mobility analysis	Particle size Size distribution	Dry	2 nm–2 μm	(+) Commonly used for aerosols (–) Interpretation of results may require additional information. (Oberdorster et al., 2005)
Acoustic methods	Particle size Size distribution Zeta potential	Wet	20 nm–10 μm	(+) Effective in concentrated suspensions (–) Difficult to interpret the data (Powers et al., 2006)

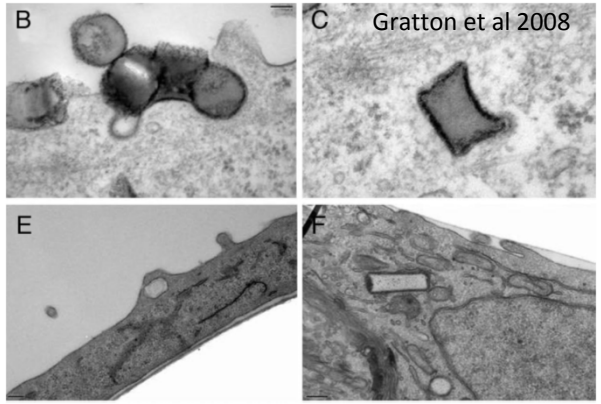
+, Represents advantageous; –, means disadvantageous.

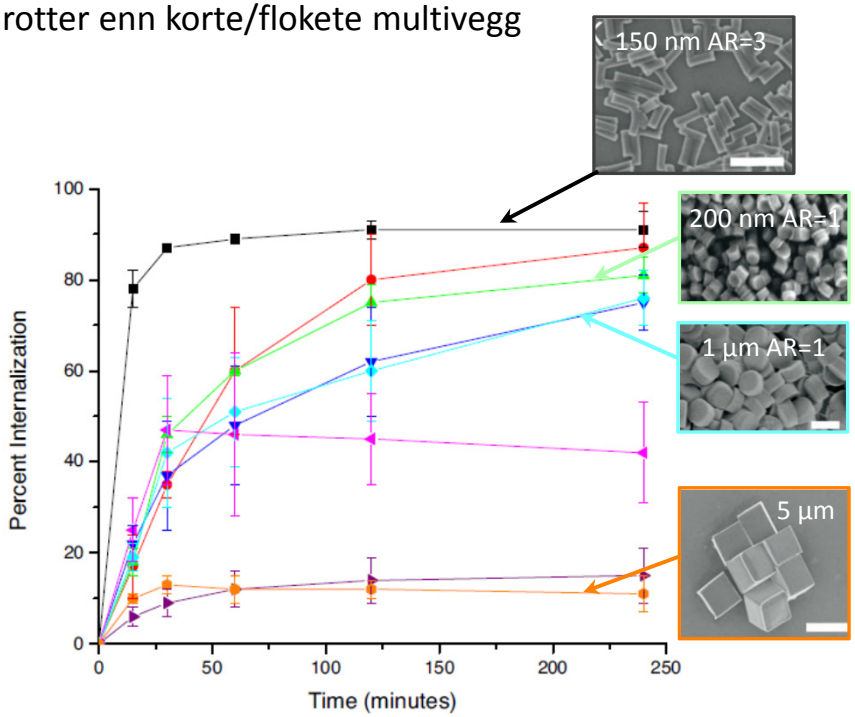
PARTIKKELFORM



PARTIKKELFORM

- ✓ Partikkelform påvirker hydrodynamisk diameter, og dermed mobilitet i væsker, samt avsetning- og absorpsjonskinetikk i et biologisk miljø.
- ✓ Hvor viktig partikkelform er for toksisitet har blitt vist i flere studier
  - ✓ Lange multivegg karbon nanorør var mer gifitg for rotter enn korte/flokete multivegg karbon nanorør
  - ✓ Sølv NP antibakterielle aktivitet var formavhengig
  - ✓ Partikler med sideforhold 3 ble lettere tatt opp i celler enn partikler med mindre sideforhold





Opptak i HeLa celler

Gratton et al 2008, Oksel et al 2015, Poland et al 2008, Powers et al 2007

PARTIKKELFORM

Scanning elektronmikroskopi bilde av celler som gjennomgår frustrert fagocytose, indusert av:

Multivegg karbon nanorør

Amositt asbestfiber

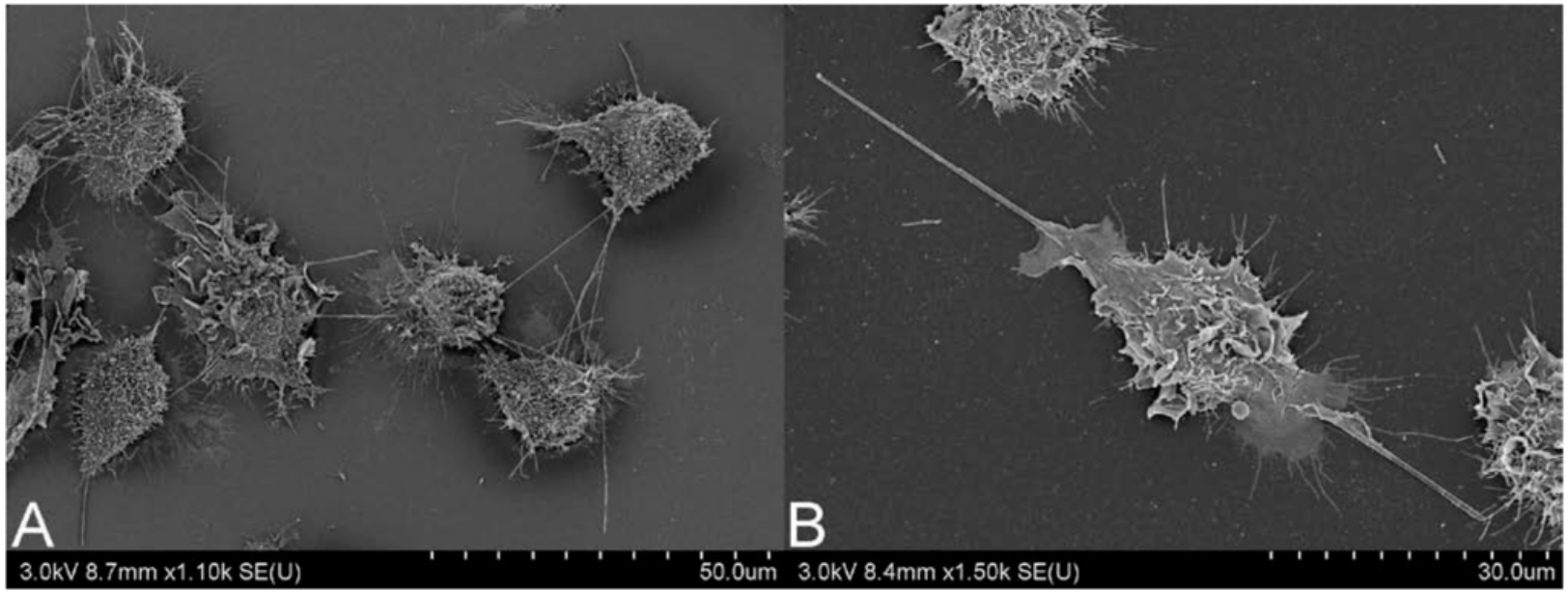
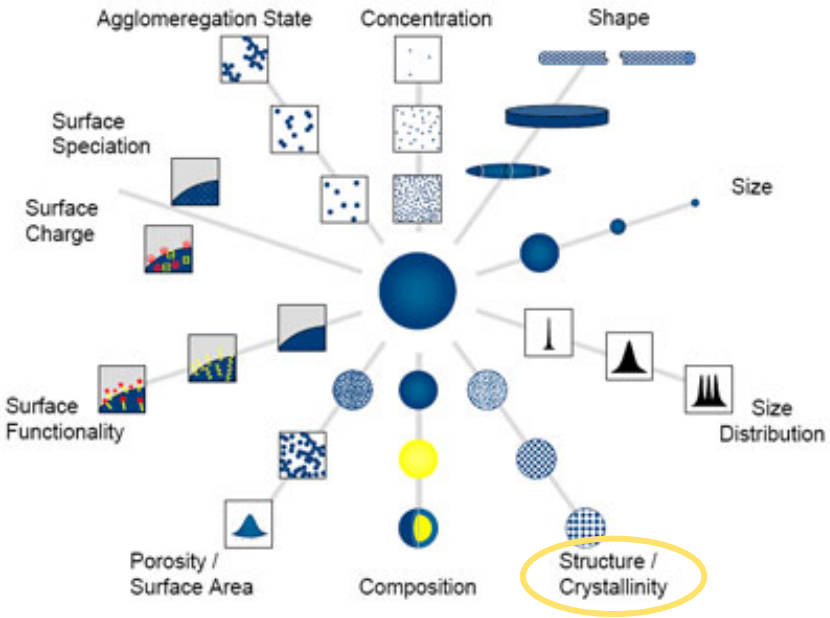


Image: Matthew Boyles, Lesley Young and Vicki Stone

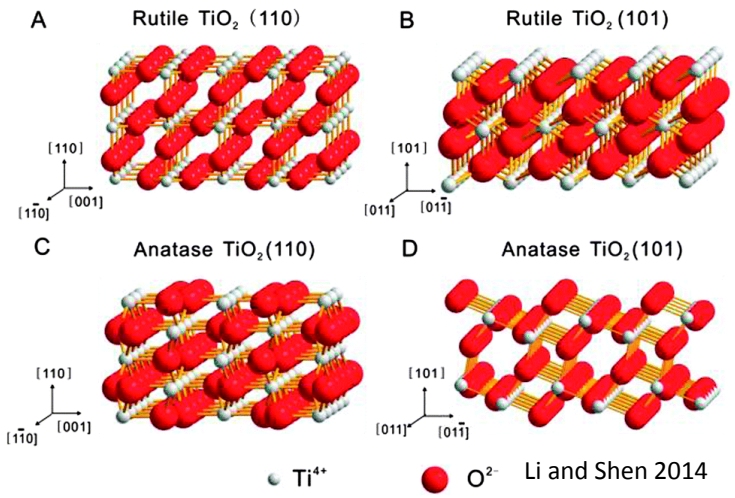
KRYSTALLINITET



KRYSTALLINITET

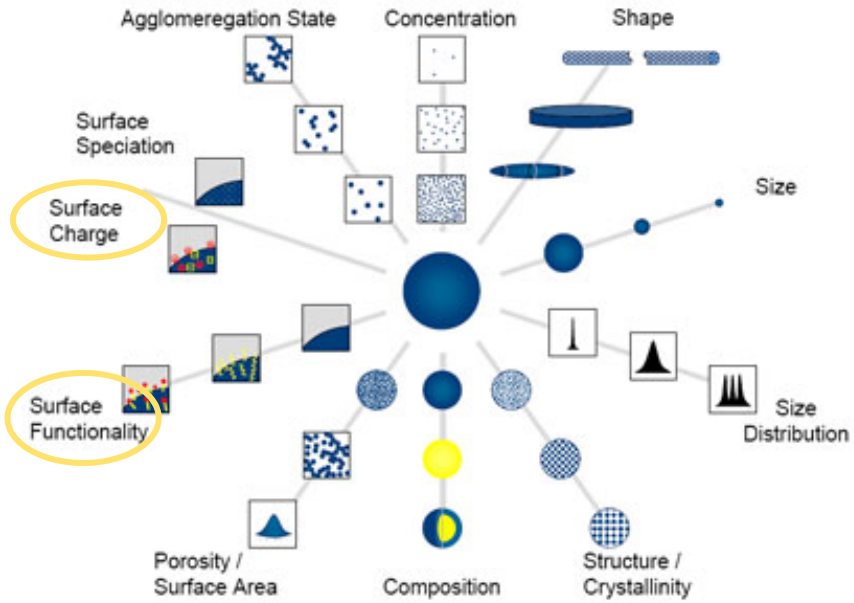
- ✓ Nanomaterialer av samme kjemiske sammensetning kan ha forskjellige toksikologiske effekter på grunn av forskjeller i atomordninger og krystallstruktur
- ✓ TiO_2 NP av samme størrelse men ulike krystallinitet ble undersøkte for produksjon av frie radikaler:

  Amorfe partikler viste den høyeste fri radikalaktivitet, fulgt av ren anatase og anatase/rutil blanding. Ren rutil ga det laveste produksjon av frie radikaler



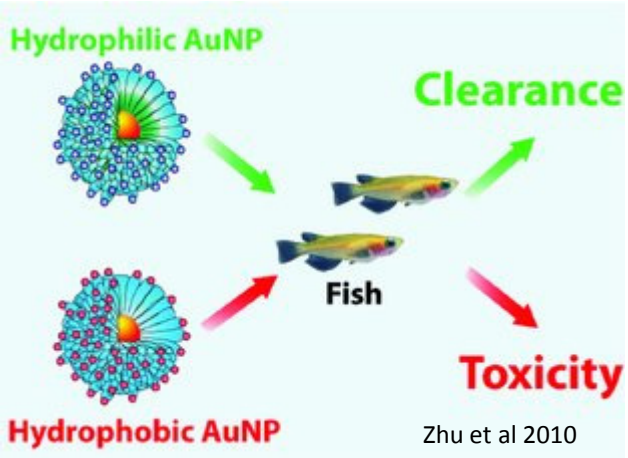
Li and Shen 2014

OVERFLATELADNING OG FUNKSJONALISERING

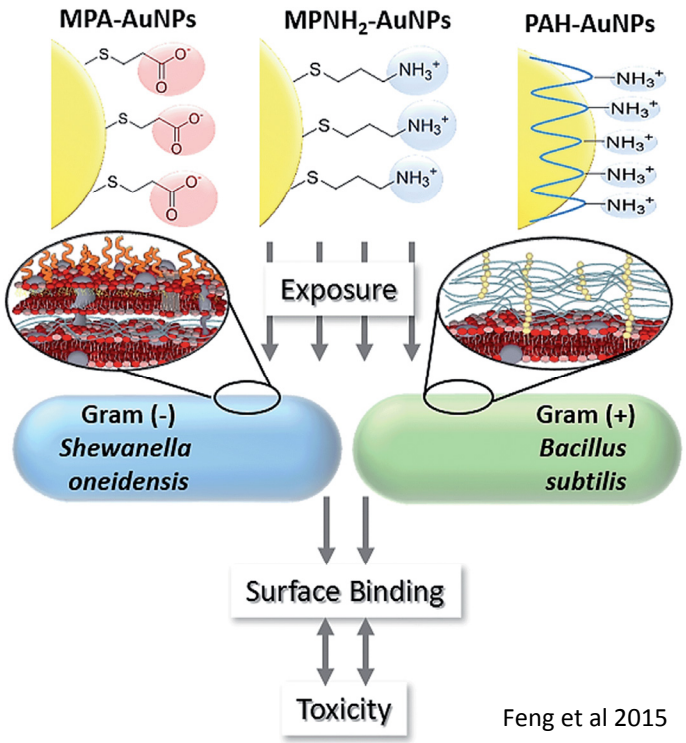


OVERFLATELADNING OG FUNKSJONALISERING

- ✓ Overflateegenskaper spiller en veldig viktig rolle for
  - ✓ interaksjoner mellom nanopartikler og deres omkringliggende miljø (biotisk og abiotisk)
  - ✓ Agglomerering



Zhu et al 2010

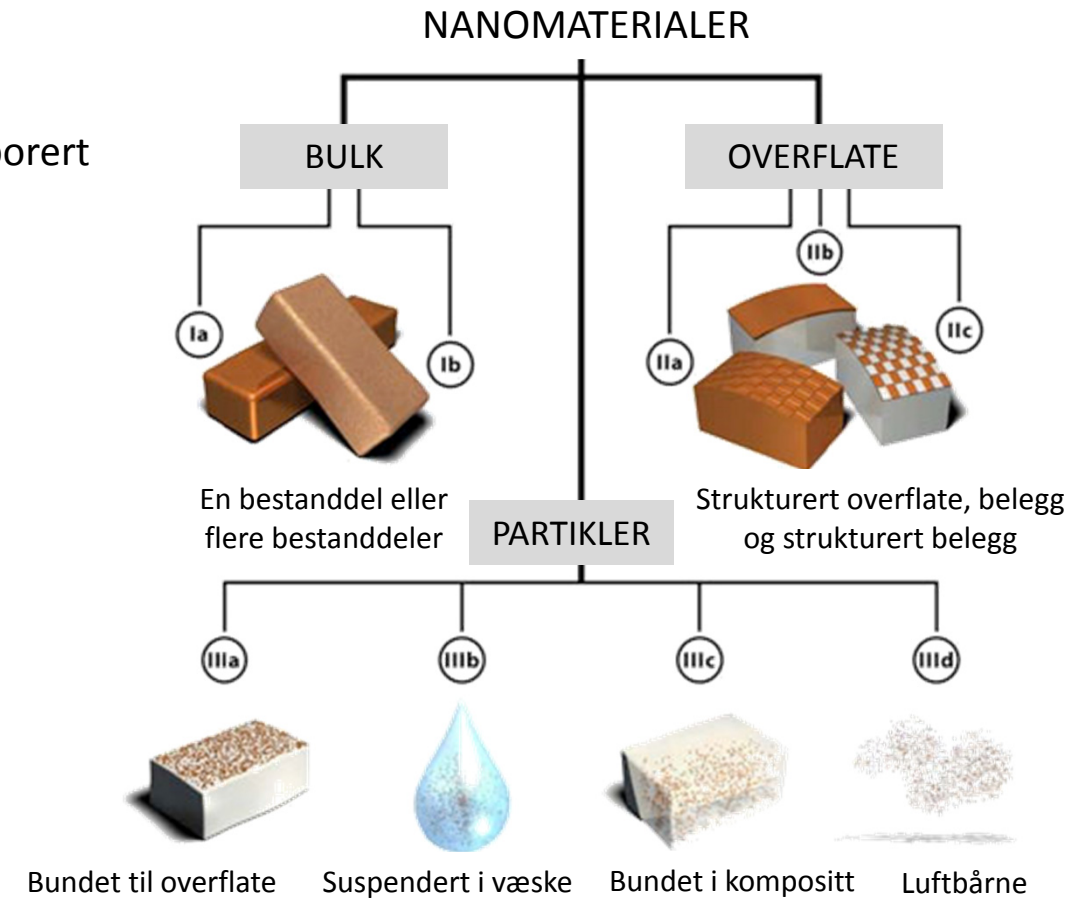


Feng et al 2015

HVA MED EKSPONERING?

Den varierer mye avhengig av

- ✓ Måten nanomaterialer blir inkorporert i forbruksvarer
- ✓ Måten disse produkter blir brukt av forbrukere



Hansen et al 2007

DATABASER FOR PRODUKTER SOM INNEHOLDER NANOMATERIALER

USA: Woodrow Wilson Center for Scholars' Project on Emerging Nanotechnologies

http://www.nanotechproject.org/cpi/

DK: The Nanodatabase (snart på norsk også)

http://nanodb.dk/da/

LOGIN DANISH

The Nanodatabase

SØG I DATABASEN HVAD ER NANO? TIP OS OM ET PRODUKT NYHEDER ANALYSIS WASTE TREATMENT ANALYSIS OM OS

SØG I DATABASEN

Forside / Søg i databasen

http://nanodb.dk/da

Keyword

FILTERS

- Year
- Categories
- Nanomaterials
- Nano Element Locations
- Wastematerials
- Country Of Origin
- Country Of Production
- Manufacturers
- Potential Exposure Pathways
- Added On Or After Date

FOUND **2181 PRODUCTS** ON 110 PAGES

Albertsons Chocolate Syrup

Manufacturer Albertsons
Nanomaterial Titandioxid
Category Food and Beverage, Supplements

Nano Risk Category

Kraft Jet Puffed Marshmallow

Manufacturer Kraft
Nanomaterial Titandioxid
Category Food and Beverage, Food

Nano Risk Category

Hershey's Chocolate Syrup

Manufacturer The Hershey Company
Nanomaterial Titandioxid
Category Food and Beverage, Food

Nano Risk Category

M&Ms with peanuts

Manufacturer Mars
Nanomaterial Titandioxid
Category Food and Beverage, Food

Nano Risk Category

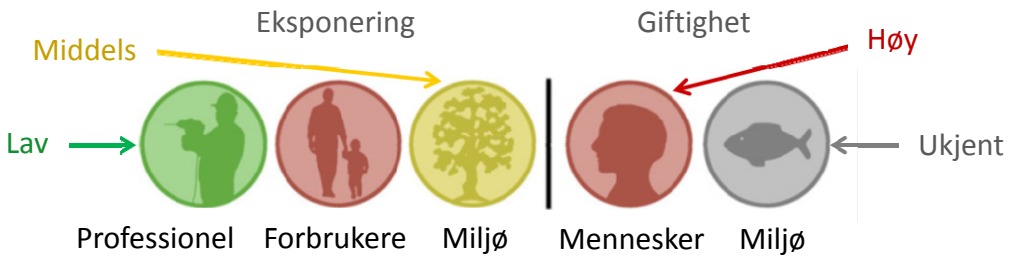


Image Reference

Data: Exposure Profile NANOVERTM Cleansing Soap _ 6908

Data: Safety Profile Silver

NANOVERTM Cleansing Soap

Nanogist Health and Fitness, Personal Care / Korea, Republic of

NanoRiskCat

Exposure			Effects	
Professional	Consumers	Environment	Humans	Environment

Nanomaterial
Silver

Evaluation and Location of the Nanoelement
Suspended in solid

Available in
Denmark, European Union

Image Reference

Data: Exposure Profile Chantecaille Nano Gold Energizing Cream _ 4671

Data: Safety Profile Gold

Chantecaille Nano Gold Energizing Cream

Chantecaille Health and Fitness, Cosmetics / United States

NanoRiskCat

Exposure			Effects	
Professional	Consumers	Environment	Humans	Environment

Nanomaterial
Gold

Evaluation and Location of the Nanoelement
Airborne, Suspended in liquid

Available in
Denmark, European Union
Link to webshop
Shop

Waste Material
Glass

Image Reference

Data: Exposure Profile BaByliss PRO Sleek Expert Nano Straightener _ 4497

Data: Safety Profile Titanium

BaByliss PRO Sleek Expert Nano Straightener

BaByliss Health and Fitness, Personal Care / France

NanoRiskCat

Exposure			Effects	
Professional	Consumers	Environment	Humans	Environment

Nanomaterial
Titanium

Evaluation and Location of the Nanoelement
Surface bound

Available in
Denmark, European Union
Link to webshop
Shop

Waste Material
Electronics, Small household appliances

Image Reference

Data: Exposure Profile Babolat NS Drive Tennis Racket _ 4492

Data: Safety Profile Carbon Nanotubes

Babolat NS Drive Tennis Racket

Babolat Health and Fitness, Sporting Goods / France

NanoRiskCat

Exposure			Effects	
Professional	Consumers	Environment	Humans	Environment

Nanomaterial
Carbon nanotubes

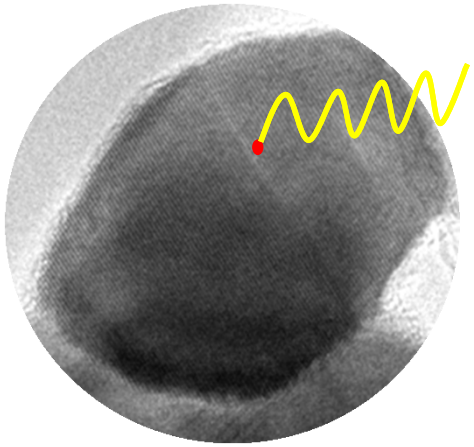
Evaluation and Location of the Nanoelement
Suspended in solid

Available in
Denmark, European Union
Link to webshop
Shop

Waste Material
Multi material waste, Combined metal and plastic

NORSK BIDRAG TIL EKSPONERINGSKARAKTERISERING

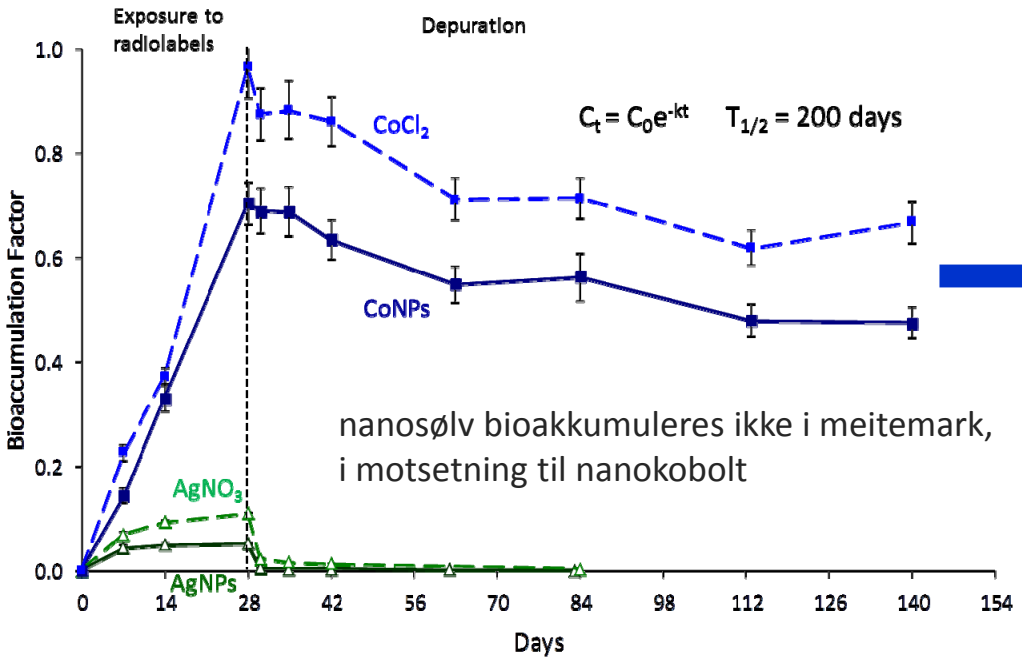
Bruk av radioaktivitet for å spore NP i forsøksdyr og jordsmonn



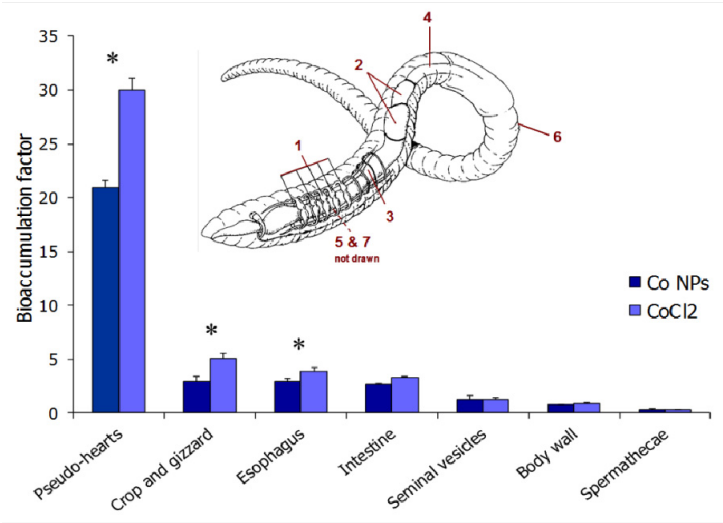
Oughton et al 2008, Coutris et al 2012

NORSK BIDRAG TIL EKSPONERINGSKARAKTERISERING

Bruk av radioaktivitet for å spore NP i forsøksdyr og jordsmonn

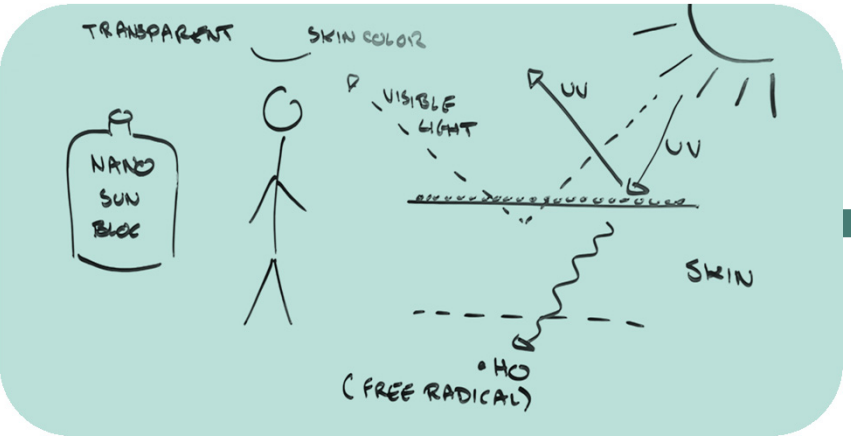


nanosølv bioakkumuleres ikke i meitemark, i motsetning til nanokobolt

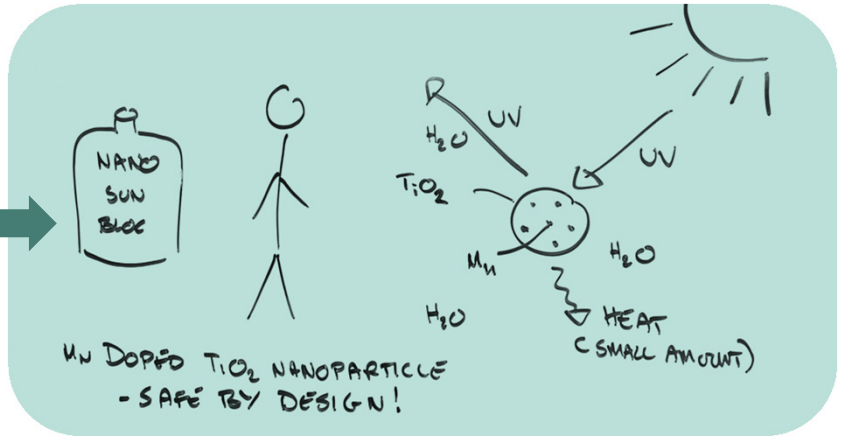


Oughton et al 2008, Coutris et al 2012

SAFE BY DESIGN



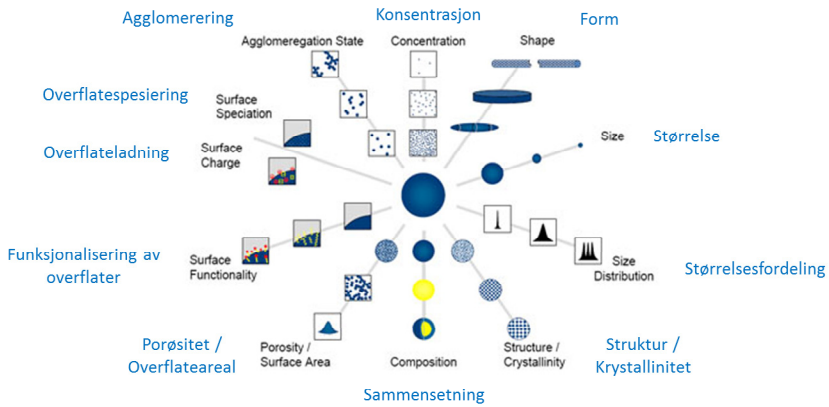
Solkrem med 20 nm TiO_2 NP



Solkrem med 20 nm TiO_2 NP tilsatt små mengder mangan

TAKE HOME MESSAGES

1. Risiko er fare (toksisitet) + eksponering, og det er ikke tilstrekkelig å bare forholde seg til fare.
2. Toksisitet måles mha retningslinjer som ble lagt for vanlige kjemikalier, og justeringer trenges i noen tilfeller.
3. Omfattende karakterisering av nanomaterialer i testforhold må til for å kunne gi brukbare resultater.
4. Mange faktorer påvirker nanomaterialenes risikoprofil.
5. Kunnskap om disse faktorer kan brukes til utviklingen av tryggere og mer bærekraftige materialer.



TAKE HOME MESSAGES

1. Risiko er fare (toksisitet) + eksponering, og det er ikke tilstrekkelig å bare forholde seg til fare.
2. Toksisitet måles mha retningslinjer som ble lagt for vanlige kjemikalier, og justeringer trenges i noen tilfeller.
3. Omfattende karakterisering av nanomaterialer i testforhold må til for å kunne gi brukbare resultater.
4. Mange faktorer påvirker nanomaterialenes risikoprofil.
5. Kunnskap om disse faktorer kan brukes til utviklingen av tryggere og mer bærekraftige materialer.

Det er sannelig på tid å ikke skjære alle [nanomaterialer] over én kam, og ikke omtale dem som en enhet. Det gjør vi ikke med resten av kjemikalier.

NIBIO

NORSK INSTITUTT FOR
BIOØKONOMI