Metrology and the challenges in relation to nanotechnology

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Definition of Nanotechnology

.....The *purposeful engineering* of matter at scales of *less than 100 nanometres (nm)* to achieve *size dependent* properties and functions

**I.e:**

......A spectrum of technologies defined by their metrologies!
Our Ability to Visualise & Measure Structures at the Nanoscale

10 nm Gold nanoparticles

Heat 670 Deg C

Single Crystal

Can see individual atoms

Scanning Transmission Electron Microscope
Aerosol reactor for manufacturing Inorganic core-shell nanoparticles for energy applications.

Electro-spinning device for making nanowires & fibres (e.g. bone regeneration scaffolds)
Global Competition in Investment

US NNI Funding by Agency, 2001-2015

EU Funding (US $)

Fiscal Year

$ millions


DOE

DHHS / NIH

NSF

DOC / NIST

DOD

USDA / ARS

DOJ

DOT

CPSC

USDA / FS

DHS

USDA / NIFA

DHHS / FDA

DHHS / NIOSH

EPA

NASA

FP5  FP6  FP7  H2020
Research Competences Needed

Nanosafety RISK = F[Hazard] x F[Exposure]

- Captures real knowledge
- Accelerates rate & quality of risk assessment
- Allows us to engineer “Safe by design “products
- Reduces overall costs longer term

TAW Presentations: 1) ENF2009 & 2) NSC 2010 Prague
Analysis of FP7 Nano EHS Projects in Relation to EU Strategy for REACH

Key:
- Yellow: Nanomaterials hazard and risk research and Innovation projects
- Blue: Nanomaterials hazard and risk infrastructure development projects
- Red: Quantitative Structure Activity Analysis (QSAR)
- Green: NanoFutures European Technology Platform (11 Industry Sectors Input into nanosafety research needs)

REACH & CLP
Regulation, Classification, Labelling, & Packaging of Nanomaterials

New ENPs Submitted For regulatory testing
REACH & CLP Approval

European Industry
Development & Scale up of novel nanomaterials

"Safe-by-design" Products & processes

SUN
MODENA
QSAR & Safe by design Modelling project

Research Infrastructure
Regulatory Testing Infrastructure
Potential roadblock ahead?

- Nanotechnology potential downgraded in US
- €160M invested in FP7 nanosafety research...
  ......*but clear conclusions still in the future*
- Some Member States worried about risks (e.g. Cosmetics directive in France and EU*)
- CEFIC’s big industry members believe some nanotechnology markets will be denied to Europe’s chemical industry
- Bayer AG pulling out of CNT sector

*The Cosmetics Directive 76/768/EEC, EU Regulation No 1223/2009*
## NanoSafetyCluster Road Map

<table>
<thead>
<tr>
<th>Time</th>
<th>Material</th>
<th>Exposure</th>
<th>Hazard</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>Reference methods and nano-bio-interactions</td>
<td>Laboratory and computer simulations</td>
<td>Systems biology approaches available for hazard research</td>
<td>Improved risk communication and tools for risk assessment</td>
</tr>
<tr>
<td>2020</td>
<td>Data sets on reference ENM</td>
<td>Database on release</td>
<td>Understanding the association between material characteristics and hazard</td>
<td>Models and standards available</td>
</tr>
<tr>
<td>2025</td>
<td>Key metrics for harmful impact</td>
<td>Laboratory tests and models available for exposure assessment</td>
<td>A tool for safety assessment</td>
<td>A tool for the integration of safety by design strategies</td>
</tr>
</tbody>
</table>

- Horizon 2020 budget = €30Mn/year for 7 years
- Industry cannot wait 10 years for results.
EMRP – Big thank you!

Chemical and Optical Characterisation of Nanomaterials in Biological Systems – NanoChOp (http://nanochop.lgcgroup.com)
Nanoparticle Dispersion - Metrology Problem

1. Only 1 of the FP7 and US NP dispersion protocols worked in our hands!

2. Does this explain why only 5/22 toxicology labs in the Qnano project “Round Robins” had usable results?

3. How much of the €160M portfolio of excellent projects are affected?

4. What other areas of the FP7 and H2020 portfolios would benefit from greater involvement of EURAMET?

(NPL & Leeds U PCA collaboration (in press)
Funded by EU FP7 MARINA & NANoREG projects)
Nanotechnology, Metrology & Safety.....
.....a personal viewpoint!

Jan 2009

ReSTOR®

Cataract

Aug 2009

Diffraction Lens Cross-section (~100 nm steps)
Completing the Bigger Picture….
Concluding Thoughts

● Europe invests €2 billion/year in nanotechnology R&I
● Potential global markets are huge ~ € trillions
● Major socioeconomic potential impact for healthcare, energy and nanoelectronics
● Significant opportunities near-term in transport, construction & consumer products
● Europe has a €160M portfolio of Environment, Health & Safety research into risks and hazards for engineered nanoparticles
● Open and continuous debate on risks & benefits with all stakeholders will be essential as findings emerge from this research portfolio over the next few years
● Without greater involvement of Europe’s NMI’s in this research, evidence-based regulation may be delayed or lost and economic benefits and jobs exported overseas
Thank you for your attention

…..Any Questions