

Engineered Nanoparticles

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create a better place

What is nanotechnology?

Nanotechnology: design and production of structures by controlling shape and size at the nanoscale ¹.

Nanoscale: having one or more dimensions $< 100\text{nm}$ ¹.

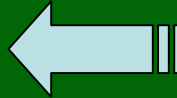
Development of materials that exhibit significantly changed physical, chemical or biological properties, phenomena due to their nanoscale size

There is nothing new about nanoparticles!

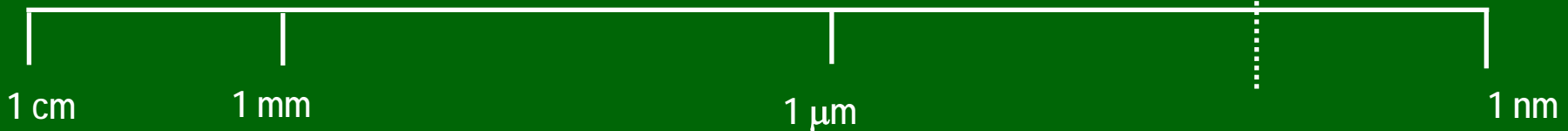
¹ www.bsiglobal.com/manufacturing/nano

Size really matters!

- chemical reactivity
- conductivity
- tensile strength
- optical, magnetic properties



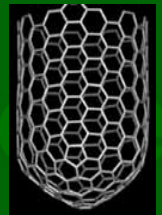
surfaces properties become important
quantum effects dominate behaviour



Ant
~ 5 mm



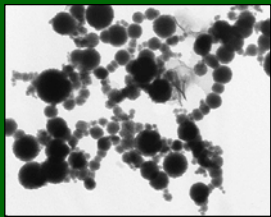
Human hair
~ 10-50 μ m wide



Carbon nanotube
~2 nm diameter

A new technology revolution?

Nanotechnologies offer the potential to bring large economic, health and environmental benefits



Iron nanoparticles

Fuel additives, Coatings, pigments, construction materials, cosmetics, electronic equipment, food processing, drug delivery, textiles, remediation etc.....



Carbon Buckyball

Investment in nanotechnologies is both global and exponential in scale, with a market value estimated at > \$1 trillion by 2013

A nano evening in Stresa

www.nanotechproject.org



'Nanodry'



Titanium Dioxide



Fullerenes



Nano Titanium/ Carbon



Nano- enhanced polymer



Ag



ZnO



Nanocare
Stain resistance



Memory Chip



Fullerenes

Nanoproducts are a) diverse and b) already here

Enhanced properties, enhanced risks?

If nanoparticles are intentionally manufactured to exploit enhanced properties, do they pose enhanced risks to environment and human health?

Increased mobility within organisms (toxicokinetics)?

Novel effects, or influences on dose response relationships due to particle size / number / shape?

Increased persistence or interaction with other substances, affecting their behaviour / toxicity?

New or existing substances?

Risk Assessments for bulk materials appropriate for nanomaterials?

Building confidence to realise the benefits



Building public confidence in nanotechnologies means:

Responsible innovation

Appropriate controls

Based on robust evidence

Communicated in an open and meaningful way

FINANCIAL TIMES FRIDAY JUNE 18 2004



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NANOTECHNOLOGY

Why scientists must dispel our 'grey goo' fears

Industries developing nanoproducts are worried that public hysteria could kill off a useful technology, writes Robert Service

Forget the futuristic visions of molecular-scale devices that seek out and destroy cancer cells and repair faulty heart valves. The truth is that nanotechnology is already here.

Intel and other computer chip companies already sell tens of billions of dollars worth of chips every year packed with electronic circuitry patterned down to the nanoscale. Computer hard drives, LED-based traffic signals, CD players and low-friction coatings account for billions more in sales.

als can change drastically as their size is whittled down from the bulk material to small clusters of atoms. Gold, for example, is inert in bulk but becomes highly reactive at the nanoscale, making it a potentially valuable catalyst. Electrical, optical, thermal and other properties of materials may undergo similar shifts.

That protean nature, coupled with new tools for studying small-scale materials, has transformed the kinds of questions scientists can ask, says John Marbur-

big businesses pursuing nano research includes General Electric, Lucent, Philips, Matsushita, Intel, Advanced Microdevices and Merck.

In April Merrill Lynch launched a nanotechnology index to track the stock performance of the emerging sector. According to David Rejeski, who directs the Foresight and Governance Project at the Woodrow Wilson International Center for Scholars in Washington, DC, 130 nano-based products have already been released on to the US market. And according to US government

What is the evidence?

July 2004: Royal Society and Royal Academy of Engineers report ¹ published, identifying large uncertainties with characterising risks to environment and human health.

1. Free engineered nanoparticles and nanotubes are the primary concern
2. Virtually no data on environmental hazard, sources, fate, exposure - almost no methods for measuring.
3. Evidence from ultrafines, coal dust ,atmospheric pollution,asbestos : potential issue :oxidative stress, genotoxicity, inflammatory responses
4. Proceed with caution; invest in risk research; encourage public engagement; review horizontal and sector specific legislation

¹ <http://www.nanotec.org.uk/finalReport.htm>

Developing the Evidence Base

- : in the UK : Nanotechnologies Research Co-ordination Group (NRCG) ¹
- : research report with 19 specific objectives published in November 2005
- : metrology and nomenclature, measurement, exposure, ecotoxicology, stakeholder dialogue

Responsible development of nanotechnologies with appropriate controls is central to UK ² and EU strategy ³, integrating societal, environmental and health considerations

¹ www.defra.gov.uk/environment/nanotech/nrcg

² www.ost.gov.uk/policy/issues/

³ <http://cordis.europa.eu/nanotechnology/>

Recent Publications

Zhu et al (2006) Toxicity of an engineered nanoparticle (fullerene, C₆₀) in two aquatic species, *Daphnia* and fathead minnow. In press Marine Environmental Research

Lovern S.B., Klaper, R. (2006) *Daphnia magna* mortality when exposed to titanium dioxide and fullerene (C₆₀) nanoparticles. Environmental Toxicology and Chemistry 25 (4) 1132 – 1137.

Oberdorster, E., 2004. Manufactured nanomaterials (fullerenes, C60) induce oxidative stress in the brain of juvenile Largemouth Bass. Environmental Health Perspectives 112 (10), 1058–1062.

Evaluation and development of methods for evaluating hazard; dosimetry and characterisation, standard reference materials for benchmarking toxicological tests

Environmental Nano Risk Research Programmes

Environmental Nanosciences Initiative: www.nerc.ac.uk/funding/thematics/eni/

Nanocare / INOS (Germany) www.nanopartikel.info-main.html

USEPA: [www.http://es.epa.gov/ncer/nano/](http://es.epa.gov/ncer/nano/)

EU Framework Programme :

NANOSAFE / NANOSAFE 2 (www.nanosafe.org)

IMPART / NANOTOX (www.impart-nanotox.org)

etter place

Getting More Information

web: www.defra.gov.uk/environment/nanotech

email: richard.owen@environment-agency.gov.uk

web: <http://cordis.europa.eu/nanotechnology/>

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