

# Background Introduction To Nanotechnology

Commercial interest in nanotechnology is growing exponentially across a range of industries. Many potential new users have little or no experience of handling nano materials, which can have very different physical and chemical properties from traditional chemicals. Small and medium enterprises who wish to use nano technology may not have extensive Health Safety and Environment (HS&E) resources available in house.

Separate but related to the above, there is a high level of interest in nanotechnology in both the popular and scientific press. The general tenor is that nanotechnology offers major potential benefits but there is a lot we do not yet know from a human and environmental safety standpoint.

In net, it is very important that those wishing to deploy nanotechnology develop HS&E capability before moving ahead. Not only do they need to develop capability to ensure worker and environmental safety, they also need to be able to demonstrate capability to internal and external stakeholders including workers, shareholders and public interest groups. This is an important aspect of Product Stewardship and miss-steps by a few companies could jeopardize the wider community's right to practice.

## **The ORC Compendium of HS&E tools**

The ORC Compendium of HS&E tools is an attempt to collect best practices and reference materials in a single place that is easy to search. Everything submitted is subjected to peer review and the reviewer comments are sited next to each tool.

Non ORC practitioners are invited to submit additional HS&E related materials. These will be reviewed and posted in the compendium together with reviewer comments.



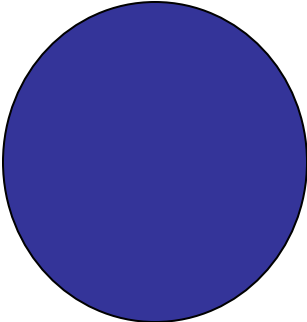
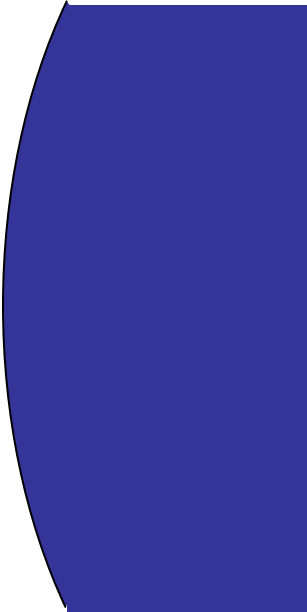
The intent is that the compendium will be continuously updated as new knowledge is developed. It is being made widely available and will serve as a “one stop” reference source for nano practitioners.

This power point presentation gives some basic background information:

- What are nanoparticles?
- What are the current industrial applications?
- What are the potential health hazards?
- What are the main workplace HS&E risks?
- How does good HS&E practice help the business?

# What are Nanoparticles?

- Very Small particles, usually  $< 100\text{nm}$  in diameter.
- Poorly soluble.

Nanoparticle	Pigments	Pollen, Mist	Table Salt Table Salt
			
(0.001 – 0.1 $\mu\text{m}$ ) 1 – 100 nm	(1 – 10 $\mu\text{m}$ )	(10 – 100 $\mu\text{m}$ )	(100 – 1000 $\mu\text{m}$ )

❖ The diameter of a human hair is  $\approx 500,000\text{ nm}$

# What is different about engineered nanoparticles?

Although there is still not universal agreement, the essence of nanotechnology is manipulating matter at microscopically small levels, usually between 1 – 100 nm, enabling materials and products to be developed with new and diverse properties.

**Also nano sized particles are not new:**

**Volcanoes:**



**Fires:**



**Car Exhausts:**

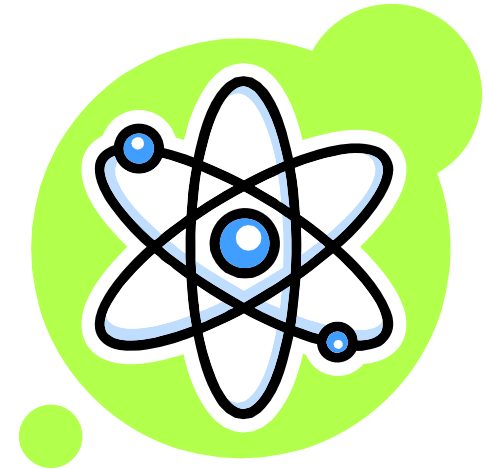


**What is new is that we can now make nano sized particles in industrial Processes – these are termed engineered nano particles**



## Current / Near Term Uses Of Nano

- The unprecedented control that nanotechnology is giving us to place groups of atoms exactly where we want them offers great promise in many areas:
  - Medical diagnostic tools and sensors
  - Solar energy collection (photovoltaics)
  - Direct hydrogen production
  - Flexible display technologies and e-paper
  - Composites containing nanotubes
  - Glues, paints and lubricants
  - New forms of computer memory
  - Printable electronic circuits
  - Various optical components



*Source: Inst of Nanotechnology*

## Potential Health Effects

However, balanced against the real promise of this technology are concerns over whether these new materials and products also present new health risks. Early research has indicated that insoluble nanometer-diameter particles in the lungs behave differently to larger particles – possibly entering cells and even translocating to other organs in the body. Nanostructured agglomerates of insoluble nanoparticles seem to elicit a response in the lungs that is associated with surface chemistry and surface area – not the more traditionally measured mass and chemical composition. Carbon nanotubes – an unusual configuration of carbon atoms into long, thin tubes – have been shown to lead to unusual responses in rat and mouse lungs.

Do these toxicity studies indicate that engineered nanomaterials present a greater risk than conventional materials? It's too early to say, and hazard alone is not informative about risk without information on exposure, control and exposure measurement. However, the current state of science does raise a number of critical questions – it shows that nanostructured materials can present a unique health hazard, and that care needs to be taken to ensure that new risks are identified and managed to the best of our ability. This means using all available information to develop appropriate risk management strategies, while ensuring that timely and targeted research is carried out to answer some of the more critical outstanding questions.

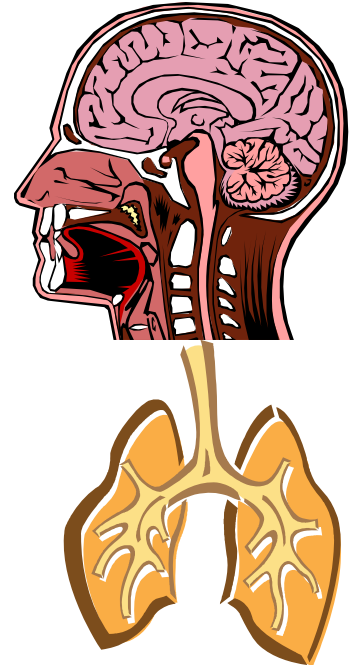
# Potential Health Effects

1. Health effects can not always be extrapolated from regular sized parent material. Nano sized materials have unique properties.
2. For individual nano receipts health effects will depend on things like:
  - Size
  - Shape
  - Solubility
  - Chemical properties
  - Charge
  - Surface porosity
3. To assure safety, it is important to assess health effects on a case by case basis for each individual material.



# Potential Health Effects

- **Whilst hazard needs to be decided on a case by case basis, here are some generalizations we can share:**
  1. There is potential for high deposition efficiency throughout the respiratory tract.
  2. Nanoparticles, because of increased surface area, tend to cause greater lung inflammation than regular sized parent material.
  3. At least some nanoparticles can pass through the lining of the respiratory tract (particularly the lungs) and relocate to other organs e.g.
    - Heart.
    - Liver
    - Central Nervous System



## Potential Health Effects

- Based on the previous 2 slides some possible health effects are likely to be:
  - Lung inflammation.
  - Illness due to relocation of particles to other organs.
- When assessing risk its important to consider all potential exposure routes:
  - Inhalation
  - Skin absorption
  - Oral ingestion
- **Never assume that the hazards are the same as for regular size parent materials.**

# What are the main workplace HS&E risks?

## 1. Health risks due to employee exposure

(discussed in the preceding three slides)



## 2. Fire / explosion risks

This applies to metals and organic materials. The risk is likely to be highest if nano dusts are formed during the production process (e.g. if when spray drying a Suspension of nano particles, the solvent evaporates during the process and a nano aerosol is created.



## 3. Environmental release

It is important to control environmental emissions. For any emissions that do occur it is important to understand the environmental fate. This involves emissions to air water and solid waste.



# How does good HS&E practice help the business?

- Commercial interest in nanotechnology is growing exponentially across a range of industries. Many potential new users have little or no experience of handling nano materials.
- There is a high level of interest in nano technology in both the popular and scientific press.
- The general tenor is that nano technology offers major potential benefits but there is a lot we do not yet know from a human and environmental safety standpoint.
- In net, it is very important that those wishing to deploy nanotechnology develop HS&E capability before moving ahead.
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