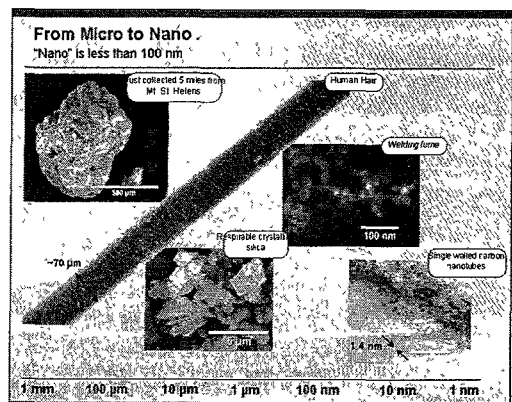
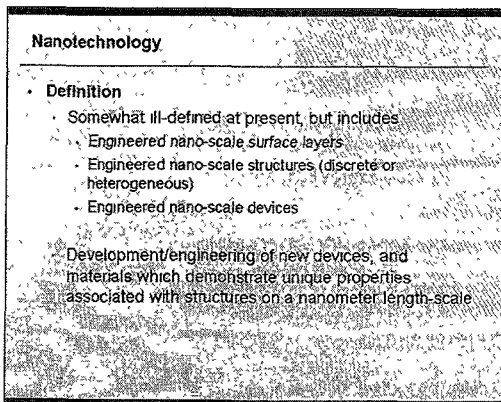
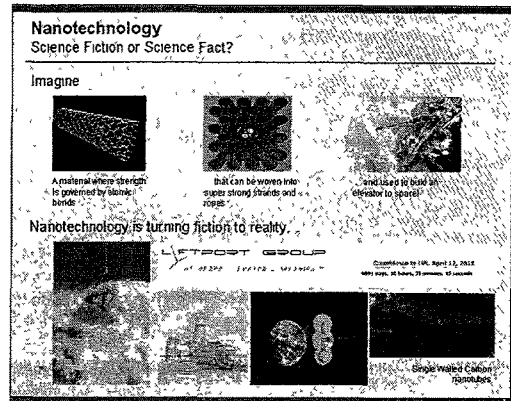
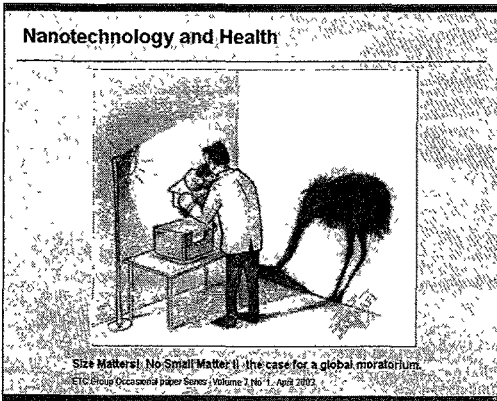


[S-1]

**Nanotechnology and Occupational Health
Addressing Potential Health Risks**

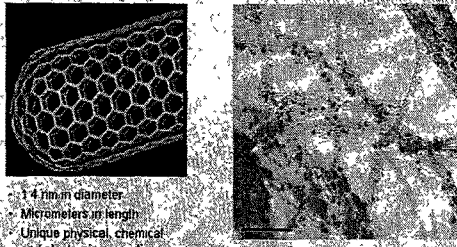
Andrew Maynard

National Institute for Occupational Safety and Health
Cincinnati, Ohio, USA



Unique Structures and Morphologies

Single Walled Carbon Nanotubes




1.4 nm in diameter
Micrometers in length
Unique physical, chemical and electronic properties

Transmission Electron Microscopy

Unique Quantum Properties

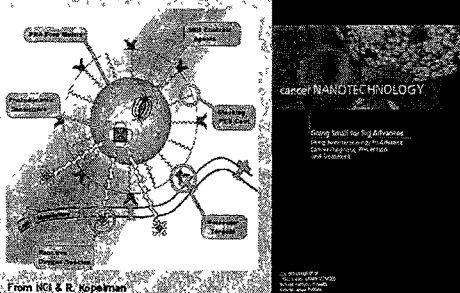
Quantum Dots - size-determined fluorescence



Smaller → Larger

Unique Devices

'Smart' multifunctional nanoparticles

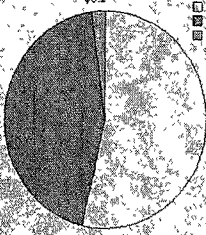


From HCl & R. Kopelman

Nanotechnology

Global nanotechnology R&D investment in 2004 (US\$, billions)

Total US\$8.6 billion

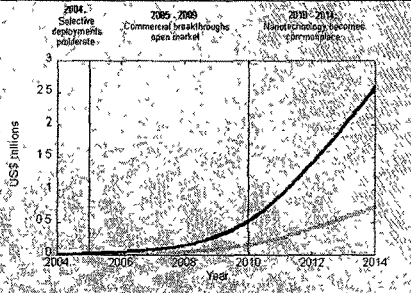


Investor Type	Investment (US\$, billions)
Corporate	5.8
Government	0.2
Venture Capital	2.6
Total	8.6

Source: 2004 Lux Research Reference Study - The Nanotechnology Report 2004

Nanotechnology

Global forecast of products incorporating nanotechnology




Year	Nanomaterials (US\$ millions)	Nanointerfaces (US\$ millions)	Nano-enabled products (US\$ millions)
2004	0.0	0.0	0.0
2006	0.0	0.0	0.0
2008	0.0	0.0	0.0
2010	0.0	0.0	0.0
2012	0.0	0.0	0.0
2014	0.0	0.0	0.0

Source: 2004 Lux Research Report - Seeing nanotechnology's value through

Nanotechnology is 'Now'

Selected consumer products



Easton CNT is Real Nanotechnology

Nanoclay Composite

Carbon Nanotube Composite

Nano fibers

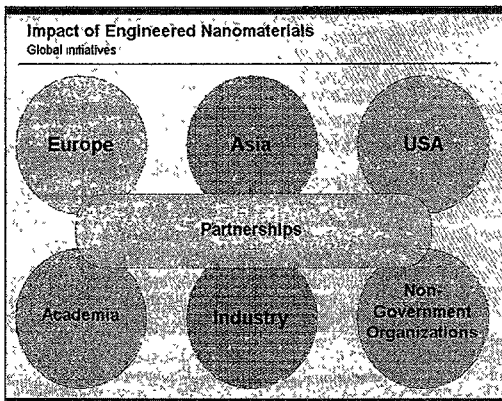
Defining the Issue

Nanotechnology and Occupational Health

- Nanotechnology - The Motivation**
 - Purposely engineered nanostructured materials and devices demonstrate new, unique and non-scalable properties and behavior
- Responsible Nanotechnology - The Challenge**
 - Does the nature of engineered nanostructured materials and devices present new safety and health risks?
 - How can the benefits of nanotechnology be realized while proactively minimizing the potential risk?

Concern over the Potential Impact of Nanotechnology

ETC Group 2003
 etc
 VDI (German), 2004
 SwissRe, 2004
 Environmental Health Perspectives 2004
 Royal Society, 2004



US National Nanotechnology Initiative Strategic Plan

- Goal 4: Support responsible development of nanotechnology**
 - Environmental, health and safety implications
 - Ethical, legal and all other societal issues
- Program Component Area 7: Societal Dimensions**
 - Environmental, health and safety research
 - Education
 - Broad societal implications

www.nano.gov

The NIOSH Nanotechnology Initiative

Addressing the implications and applications of nanotechnology in the workplace

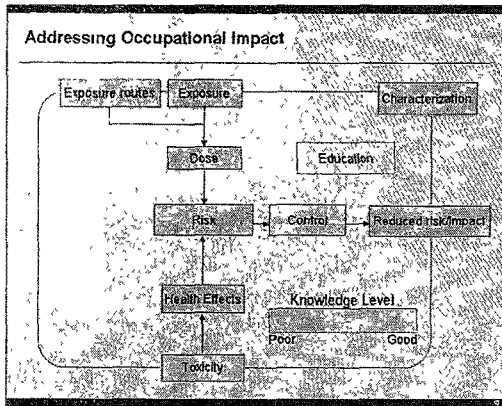
Toxicity, Health Effects, Exposure, Measurement, Control, Surveillance, Risk Assessment, Risk Management
 Government, Academia, Industry, Labor
 Information, Education, Recommendations
 Research, Education, Outreach
NIOSH
 www.cdc.gov/niosh/topics/nanotech

Potential Health Impact

What makes 'nano' different?

Influence of structure on potential health impact

High Physical Structure: Size, Shape, Surface Area, Nano-Structure → Unconventional Understanding → Nano-Materials & Devices
 Low Physical Structure: Macro-Materials, Liquids, Gases & Vapors → Conventional Understanding → Mass, Composition



Setting Boundaries

Engineered nanomaterials which potentially present new challenges

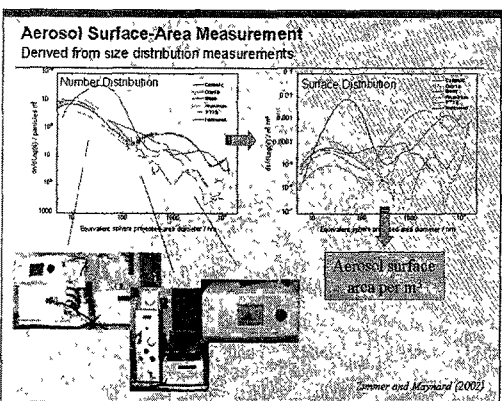
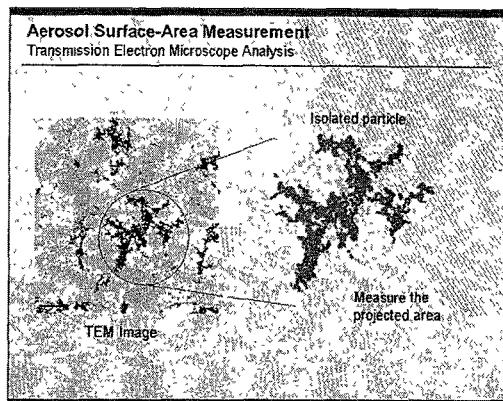
- Criteria
 - Nanomaterials capable of entering or interacting with the body
 - Nanomaterials which potentially exhibit nanostructure-dependent biological activity

	Nanoparticles Simple, complex, "smart" Aerosols, powders, suspensions, slurries		Agglomerates or aggregates of nanoparticles
	Aerosolized suspensions Including slurries and dispersions of nanomaterials		Combination Aerosols from grinding, cutting, machining, nanomaterials
	Degradation/Failure Aerosols and suspensions resulting from degradation and failure of nanomaterials		Unintentional use Potentially occurs from ultrafine dimensional control

Monitoring Nanoscale Aerosol Exposures

Options

- Adapt current mass-based approaches**
 - Continuity with the past
 - Sensitivity and relevance issues
- Measure size distribution**
 - Provides a lot of information
 - Impractical in many instances
- Monitor number concentration**
 - Relatively simple
 - Difficult to differentiate between process-related and background aerosols
 - Relevance?
- Monitor aerosol surface area concentration**
 - Relevant for some materials
 - Is this achievable?



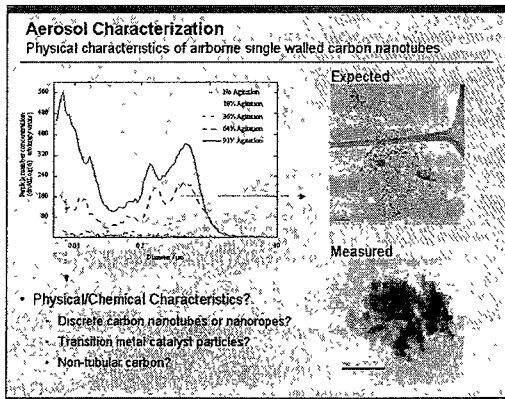
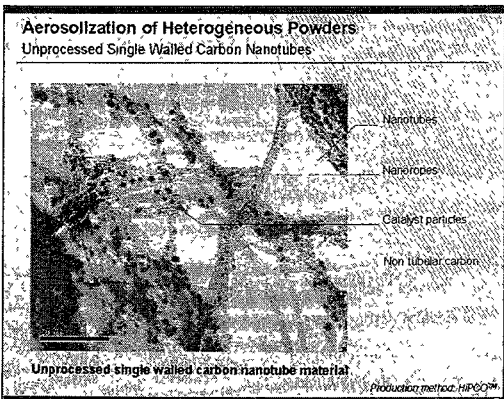
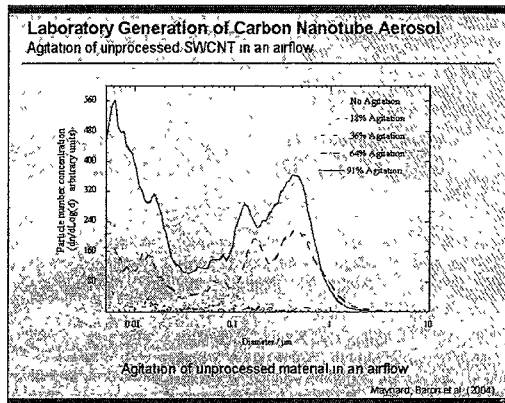
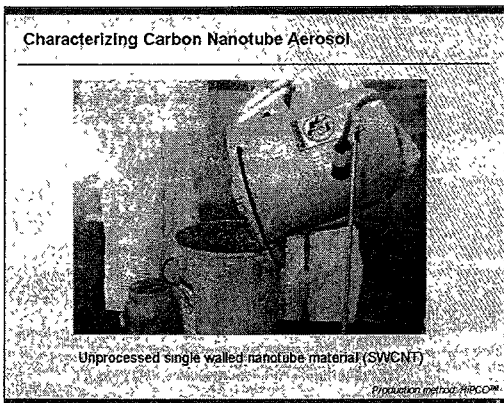
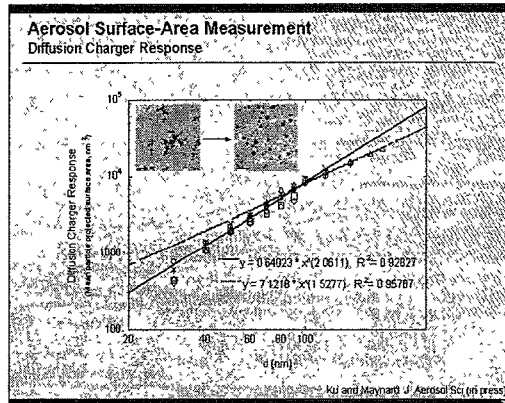
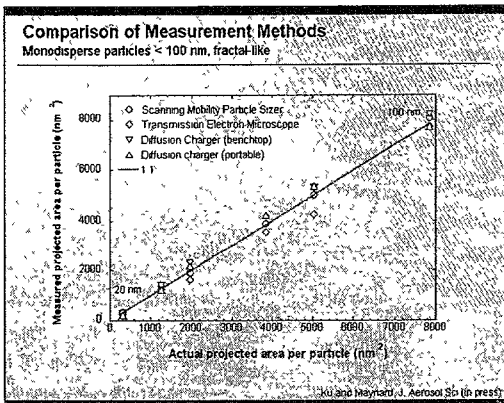
Aerosol Surface-Area Measurement

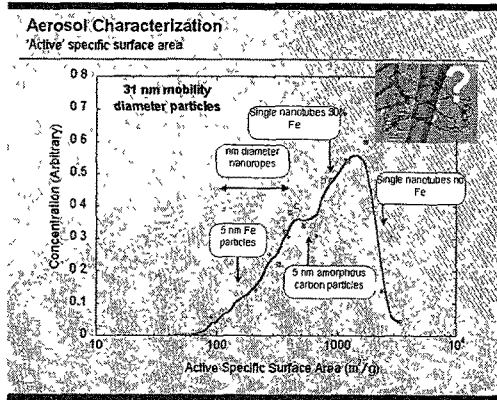
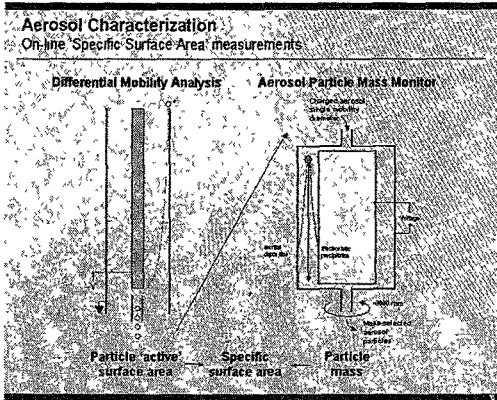
Using attachment rate

Charge on Surface Aerosol ∝ Area

DC2000 CE Diffusion Charger
EcoChem

Electrometer





- ### Summary
- Occupational safety and health is a key component of responsible nanotechnology
 - Nanotechnology challenges conventional approaches to addressing occupational safety and health risk
 - Nanomaterials and devices of concern include those capable of entering the body and causing harm as a result of their nanostructure
 - Proactive risk assessment and management requires extensive strategic research
 - Current knowledge provides a starting point for addressing risk

