NANO MATERIALS

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OVERVIEW

- Nano materials used across many sectors: consumer products, energy, food, medicine, industrial etc.
- Analytical methods being adapted for nano-scale materials
- Governments using existing laws for nano-scale materials and products

Disclaimer: Information and opinions presented today are not the position or policy of the State of California.

NANO SILVER

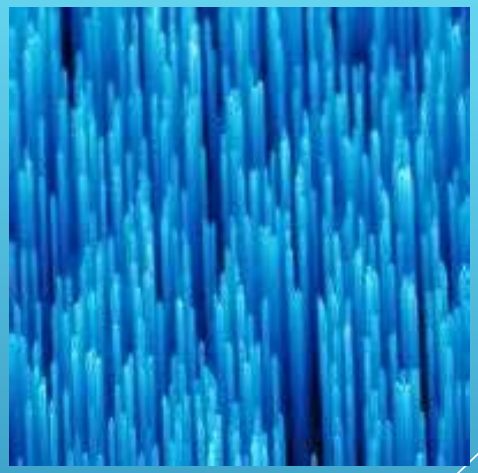
- Used as anti bacterial agent in consumer products
- example: Clothing-HeiQ “AGS-20”

UPDATE ON NANO SILVER REGULATED AS PESTICIDAL PRODUCT

HeiQ "AGS-20,"

- USEPA conditionally registered it under Federal Insecticide, Fungicide and Rodenticide Act(FIFRA)
- Natural Resources Defense Council (NRDC) filed suit against USEPA; oral arguments were heard on Jan 16, 2013
- HeiQ required to submit more data for full registration

- **Silver** – Coating material with high optical transparent conductive layer (Example: ClearOhm™ by Cambrios)
- **Indium phosphide*** - antennae that absorb sunlight and generate power
- **Nano wire solar cell** can produce an effect per active surface unit several times greater than silicon cells



NANOWIRES

*National Nano Manufacturing Network, University of Massachusetts, MA

- **Black silicon-** ‘Nano’ holes on surface-the light is absorbed rather than reflected
- **"Nano Sandwich“** nanostructured "sandwich" of metal and plastic- nearly triples the efficiency of solar cells

Example: Indium-Tin-oxide (ITO)

CAN SOLAR ENERGY GET BIGGER BY THINKING SMALL*?

*PATRICK J. KIGER, FOR NATIONAL GEOGRAPHIC NEWS, APRIL 28, 2013

- **Iron Oxide-** super paramagnetic, inexpensive, and environmentally benign
- Particles injected into a well with tiny nooks and crannies of rock
- Electro magnetic imaging equipment used
- If 10% more oil is recovered
- Yield would be up to 5 million extra barrels of oil per day

NANOTECH STRIKES OIL?*

*Bethany Halford, CEN, 2012

- 9nm diameter gold coated with sodium citrate reduces mercury ions to elemental mercury*
- Laboratory results meet WHO (World Health Organization) safety guidelines
- Can be used to clean water

WATER TREATMENT

*Katherine Sanderson, C&EN, 2012

- Microbes accumulate on filters and secrete polymeric slime- Gums water filtration
- **Carbon Nano tubes (CNT**) based filters hold electric charge
- Bacteria do not form clogging films

WASTE WATER TREATMENT

NANO TECHNOLOGY IN FOOD PRODUCTION

- As an anti-bacterial agent or to alter flavor or color

- Measure the temperature of tissue
- Pinpoint infections or cancer
- Fluorescent nanoparticles detect hot spots by **emitting** light from one wave length to other
- Examples:
- 1. Neodymium-doped lanthanum fluoride emit photons in the infrared range
- 2. **Gold (Au_{102})– used in thermal cancer treatment

NANO THERMOMETERS*

*Tim Wogan, C&EN, 2013

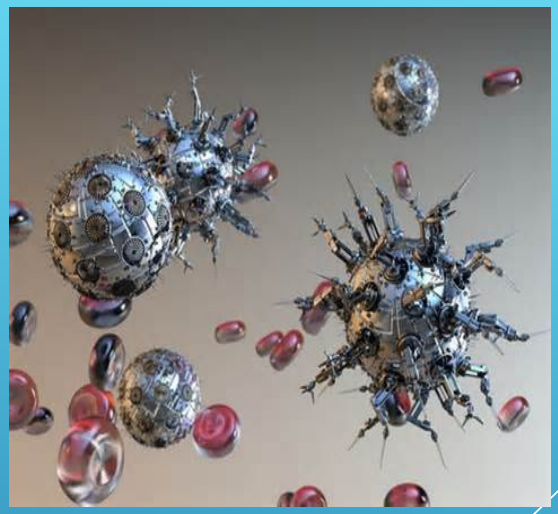
** Mitch Jacoby

- Zinc Oxide: **used in cosmetics ends up** as **component of solid waste** and **used as organic fertilizer**
- After initial improved crop growth, Zinc accumulated in leaves and beans of the soy plant
- May be toxic to mammalian cells; unknown for humans

DO NANO MATERIALS HARM CROPS?*

* Hayley Dunning, THE SCIENTIST, 2012

- Nano materials: High surface to volume ratio and reactivity
- Highly dynamic in environmental systems
- Transformations affect fate, transport, and toxic properties



NANO MATERIALS: TRANSFORMATIONS IN THE ENVIRONMENT*

*Gregory v. Lowry et al Environ. Sci. Technol. 2012, 46

CHEMICAL INFORMATION CALL-IN

- California law authorizes state departments to request information on **analytical test methods**, fate and transport in the environment and other relevant information about specified chemicals
- DTSC has conducted two nano material call-ins:
  - Carbon Nanotubes
  - Nano metals, oxides and quantum dots

DTSC NANO MATERIAL CALL-IN RESPONSES

- Roughly half of manufacturers and importers identified provided responses
- The others did not make or sell in California or were not in business any longer
- DTSC posted the responses on website

http://www.dtsc.ca.gov/PollutionPrevention/Round_Two.cfm

CHEMICAL CALL–IN INFORMATION

- Environmental Matrices: water and cells
- Instrumental techniques:
  - Electron and fluorescence microscopy
  - Spectrophotometry
  - Inductively coupled plasma optical emission spectrometry
  - Dynamic Light scattering

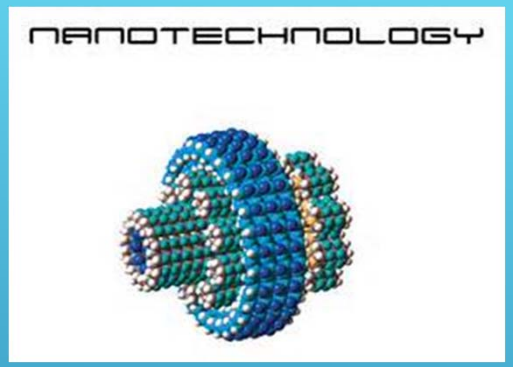
ANALYSIS OF NANO MATERIALS

- NMR and MRI: provide chemical and three-dimensional structural information

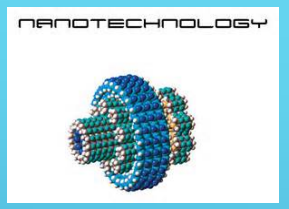
NANOMATERIALS AND PROPOSED REGULATIONS

Proposed “Safer Consumer Product”(SCP) regulations:

- Nano materials are not defined
- Characteristics used to described them are listed under the definition of “molecular identity”



Agglomeration state	Particle size, size distribution, and surface area
Bulk density	Physical form and shape, at room temperature and pressure
Chemical composition, including surface coating	Physiochemical properties
Crystal structure	Porosity
Dispersability	Solubility in water and biologically relevant to fluids
Molecular structure	Surface charge
Particle density	Surface reactivity



NANO MATERIALS AND THE PROPOSED SCP REGULATIONS

- Science provides information on the benefits and drawbacks of a technology or a product of that technology
- Significant limitations in the environmental, health and safety (EHS) data available for nano materials
- Test methods need modification before being applicable to nano materials.

AGENCIES ON NANO MATERIALS

- **FDA: proposed voluntary guidance for industry**
- **OSHA's** fact sheet-Working safely with nano materials:
- Exposure routes are inhalation, skin contact or ingestion
- Basic information to workers and employers
  - understand potential hazard and
  - measures to control exposure to nano materials in work places

INTERNATIONAL DEVELOPMENTS

- European Chemicals Agency (ECHA): preparing a guidance update on information requirements and chemical safety assessment
- Based on EU REACH project on nano materials ("RIP-oN")
- Consensus organizations (ISO, etc.) working on definitions, labeling, etc.

- EU- Registration, Evaluation, Authorization and Restriction of Chemicals(REACH)
- EU- Food Regulation (EC 258/97-1997)
- EU-Cosmetics Regulation (EC 1223/2009)
- French code de l'environnement, Livre V, Titre II, Chapitre III, (articles l523-1 to l523-5

EXISTING TOOLS OF MANDATORY NANOTECHNOLOGY GOVERNANCE*

*Michael Berger, NANOWERK

- US- Toxic Substances Control Act (TSCA) (carbon nanotubes)
- US- Federal Insecticide, Fungicide, and Rodenticide Act(FIFRA)

  (anti-microbial uses of nano materials)
- NIOSH Current Intelligence Bulletin (CIB) 63
- Berkeley City Council Ordinance Section 15.12.040

EXISTING TOOLS OF MANDATORY NANOTECHNOLOGY GOVERNANCE

- EU resolution called for legislation to be drafted to protect workers from health risks of nano materials in the workplace
- Japan's Ministry of Economy, Trade and Industry (**METI**) established committee on safety management for nano materials

IS NANO LEGISLATION COMING ?

- Suzanne Davis
- Hai- Yong Kang
- Donald Owen

ACKNOWLEDGEMENTS
DTSC COLLEAGUES

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THANK YOU