

Green Nanotechnology

It's easier than you think

**Project on Emerging Nanotechnologies
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**To paraphrase Ned Pepper
from “True Grit”**

**I call that bold talk from such a
new technology**



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Questions to Consider

(Industry View)

- **What is “green” nanotechnology and where are the present (and future) opportunities for industry?**

And

Since this is for The Wilson Center

- **What are the policy options that would be effective for advancing “green” concepts in this new technology?**



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“Green” Nano Opportunities

(Three broad categories)

1. New or improved products
2. Products directly affecting the environment
3. Inherently greener processes through catalysis or the nanomaterial process itself

How do we to achieve these benefits while guarding against the potential environmental hazards?



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1. New or Improved Products

- **Greatly improved photovoltaic devices, fuel cells, catalytic converters, etc.**
 - * **The “green” benefit is generally obvious**
 - * **These are already on the near term horizon**
- **New and improved existing products with equal or better performance for less weight, longer service life, or new performance, many (most?) of which have a “green” effect.**
 - * **These will frequently require a full LCA to quantify the “green” benefit.**
 - * **They are already in commerce**



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DuPont is Very Active in New or Improved Products

- Well aligned with our market facing Sustainability Goals of:

- ★* Environmentally Smart Market Opportunities from R&D Efforts

- ★* Products that Reduce Greenhouse Gas Emissions:

- * Revenues from Non-Depletable Resources:

- ★* Products that Protect People:



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2. Products Directly Affecting the Environment

- **New products with new performance such as zero valent iron for treating DNAPLs**
- **Additives to common products such as cerium compounds added to diesel fuel to reduce soot and unburned hydrocarbons⁽¹⁾**
- **All of these will require extensive analysis of reaction products, end points, toxicity, and environmental fate and effects**

(1) This may not be a nanomaterials issue, input or output



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3. Processes Involving Nanomaterials

- Processes to make nanomaterials will not necessarily be inherently “green”.
 - * LCAs incorporating the effect of the product may show them to be much “greener”
- Nanostructured catalysts and membranes continue to offer great promise.
 - * The increased emphasis on basic nano-science can only help and should be supported.



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Regulatory Issues

Working through the Nanotechnology Panel of the American Chemistry Council

- Significant opportunity for all society.
- Opportunity to work together.
- Existing regulatory EPA, OSHA & MSDS frameworks are sufficiently robust with evolutionary changes.⁽¹⁾
- Support intergovernmental harmonization.
- Support intergovernmental EHS research.

Some slides are updates or repeats from “Green Nanotechnology III; Industrial Perspectives” by John Carberry, April 19, 2006 to the Wilson Center



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(1) Based on experience, thus far, working with these groups



ACC Nanotechnology Panel

**Air Products and
Chemicals, Inc.
Arch Chemicals, Inc.
Arkema, Inc
BASF Corporation
Bayer Material Science
LLC
Cytec Industries, Inc
Degussa Corporation
Dow Chemical Company**

**DuPont
Elementis Specialties
Honeywell/UOP
Oxonica Ltd
PPG Industries Inc
Proctor & Gamble
Rohm and Haas
Chemicals
Sasol North America,
Inc.**



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Nanotechnology Panel Issues

- **Inventory of nanomaterials**
- **Human and environmental toxicology**
- **Laboratory and workplace safety**
- **Life cycle societal value of use and exposure assessment**

- **Working with Government, NGOs and SMEs**
- **International harmonization**
- **Financial equity**



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Inventory of Nanomaterials

- **Participate in developing the nomenclature and the definitions with OECD, ISO, US EPA, ASTM**
- **Participate in defining the basic information required to specify a unique nanomaterial**
- **Participate in the definition of "new" versus "existing"**
- **Develop an inventory of "existing" nanomaterials**



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Human and Environmental Tox

- Work internationally with others to develop tests, protocols, and tiered testing
- Support generation of information for common nanomaterials (e.g. cement dust, soot, volcanic ash) as a benchmark for comparison.
- Participate in developing environmental fate and effects protocols, tests and data

And, longer term

- Participate in demonstrating extension of acute tests to predict chronic effects
- Support emerging in-vitro developments
- Understand the unique toxicity mechanisms of nanomaterials, if any



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Lab and Workplace Safety

- **Development of a laboratory safety review and guideline handling practices**
- **Development of manufacturing workplace guideline practices**
- **Development of MSDS guidelines**
- **Interaction with, and standardization through, US-NIOSH, US-ASTM and UK-HSE**
- **Consortium to develop the technology for generation and characterization of particles, workplace air sample monitor, and testing to assess respirator HEPA filters**



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Nanoparticle Occupational Safety and Health Consortium

DuPont

Air Products & Chemicals

Degussa Corporation

Dow Chemical

Proctor & Gamble

PPG Industries

Rohm and Haas

United Kingdom

Health & Safety

Executive

**Plus other companies and organizations
for a total of 16**



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QUOTE FOR THE DAY

“Nanotechnology promises to dramatically change the products we manufacture and the way we do manufacturing in virtually every area — electronics, transportation, food, and consumer goods. It offers us the opportunity to make products and processes ‘green’ from the beginning. We simply cannot let this opportunity pass by.”

- Dr. Barbara Karn

How are we (industry) doing, thus far?



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The “Green” Fit of Present Nano

Most common present applications best fit with the Principles of Green Engineering of:

- Extended service life - **Polymer fills** with longer or higher thermal resistance
- Reduced materials consumption - **Light weight materials** and **protective coatings**
- Reduced energy demand - Improved performance of **electronics** and **green energy** devices



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Meeting Barbara Karn's Vision?

- For products, yes. Not yet for processes
- But, if subsequently, we can capture Maxwell's Demon...



- ...and engineer catalysts that operate specifically at the molecular level, then perhaps we can engineer processes that approach 100% yield.



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* = www.maxwellian.demon.co.uk/name.html



Take Home Thoughts for Nano

- **Nanomaterials are, thus far, an outstanding, albeit evolutionary opportunity**
- **Existing regulatory mechanisms in the OECD Nations are adequate for the task**
- **Society needs to generate considerable basic toxicity and EFE information to:**
 - + **assess the concept of “dramatically increased toxicity due to nano-size**
 - + **provide comparisons of new nanomaterials to common existing nanomaterials**
- **This is an outstanding opportunity to work together**



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Thank you for your time !!!



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