Federally-funded Nanotechnology Research in the United States

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NNI was established in 2001 (The 21st Century Nanotechnology Research and Development Act, PL 108-153)

- Focused on Precompetitive Science & Technology
- Currently: 25 federal agencies
- FY10 NNI budget: €1.34 billion
- FY11 NNI Budget: €1.36 billion (proposed)
- Cumulative budget since NNI inception: €9 billion
NNI Federal Participation

- NNI participating Departments & Agencies have grown to 25
# Federal Departments & Agencies with Nanotechnology R&D

<table>
<thead>
<tr>
<th>Department/Agency</th>
<th>FY2010 Nanotechnology R&amp;D Budget (Euros in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Science Foundation</td>
<td>319</td>
</tr>
<tr>
<td>Dept. of Energy</td>
<td>351</td>
</tr>
<tr>
<td>Dept. of Defense</td>
<td>286</td>
</tr>
<tr>
<td>Dept. Health &amp; Human Services (NIH)</td>
<td>265</td>
</tr>
<tr>
<td>Dept. of Commerce (NIST)</td>
<td>69</td>
</tr>
<tr>
<td>Environmental Protection Agency</td>
<td>14</td>
</tr>
<tr>
<td>Nat. Aero. &amp; Space Administration</td>
<td>13</td>
</tr>
<tr>
<td>Dept. of Health &amp; Human Services (NIOSH)</td>
<td>9</td>
</tr>
<tr>
<td>USDA Forest Service</td>
<td>4</td>
</tr>
<tr>
<td>USDA Res, Education &amp; Extension</td>
<td>2</td>
</tr>
<tr>
<td>Dept. of Transportation (FHWA)</td>
<td>2</td>
</tr>
</tbody>
</table>
**Vision**: a future in which the ability to understand and control matter on the nanoscale leads to a revolution in technology and industry that benefits society

- **Goal 1**: Advance a world-class nanotechnology research and development program.
- **Goal 2**: Foster the transfer of new technologies into products for commercial and public benefit.
- Develop and sustain educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology.
- **Goal 4**: Support responsible development of nanotechnology.
Investments by Component Area

Proposed 2011 federal funding = €1.36 billion

Eight Component Areas
A Sampling of NNI Publications

Supplement to the President's FY 2011 Budget

Environmental, Health, and Safety Research Strategy
Federal NNI Nanotechnology R&D

- 4-D image of atomic motion
  Air Force, NIH, NSF

- Nano Lithograph
  NSF

- Chitosan nanofibers
  EPA

- Highly ordered polymer layers
  DOD/ONR/ORL

- Fate of nanomaterial in living cells
  EPA

- Carbon nanotubes in electronics
  NSF

- Human toxicity
  EPA

- Nanobatteries
  DEO and NSF

- Tumor detection
  NIH

- Nanomaterials
  NIH and DOE

- Wood Cellulose Nanomaterials
  USDA FS
NNI Industry Collaborations for Development of Nanotechnology

- **Electronic Industry (Semiconductor Research Corporation lead), October/2003** - Collaborative activities in key R&D areas; 5 working groups, Periodical joint actions and reports; NSF-SRC agreement for joint funding; other joint funding

- **Chemical Industry (Council for Chemical Research lead) - Joint road map for nanomaterials R&D; Report in 2004; 2 working groups, including one EHS Use of NNI R&D results, and one to identify R&D opportunities**

- **Organizations and business (Industrial Research Institute lead) - Joint activities in R&D technology management; 2 working groups (nanotech in industry, EHS) Exchange information, use NNI results, support new topics**

- **Forest Products Industry (AF&PA Agenda 2020 Technology Alliance lead), April 2007** – Facilitate forest products industry input to and communication with NSET
Priority Applications for Nanotechnology

- Extending the Capabilities of Information Technology
- Health Care in the 21st Century
- Energy and the Environment
- National Security
- Beyond Steel: High Strength Materials
Federal programs have had a catalytic and substantial impact on the field of nanotechnology.

Increase NNI funding for nanomanufacturing research while maintaining support for basic research.

Commercial activities have gained momentum.

Metrics need to be developed to track the benefits of nanotechnology (e.g. job creation, contributions to GDP, etc.).

The scarcity of standardized commercialization data challenges the tracking of benefits.

Global economic competition has dramatically increased.
PCAST NNI Recommendations

- Increase focus on integration of components and processes that lead to commercialization
- Develop a cross industry strategy that links environment, health and safety research with knowledge gaps and decision-making needs
- Strengthen NNI coordination with additional funds and a broader mandate
- The lack of a skilled workforce presents a significant challenge to the nanotechnology-related business community--expedite the citizen review process for those receiving advanced degrees in science and engineering
NNI Signature Initiatives—2010

- Nanoelectronics for 2020 and Beyond
- Solar Energy Collection and Conversion
- Sustainable Nanomanufacturing – Creating the Industries of the Future
... if you want to know more about the NNI

The National Nanotechnology Initiative (NNI) provides a multi-agency framework to ensure U.S. leadership in nanotechnology that will be essential to improved human health, economic well-being and national security. The NNI invests in fundamental research to further understanding of nanoscale phenomena and facilitates technology transfer.

Leading to a Revolution in Technology and Industry

$34 Million Awarded to Inform Public and Explore Implications of Nanotechnology

The National Science Foundation (NSF) has announced a series of initiatives that will greatly expand efforts to inform the general public about nanotechnology, and to explore the implications of this fast-moving field for society as a whole.

The largest research grant ever awarded to NSF has provided $20 million for the National Nanoscale Informatics Training Program (NNITP). The new NSF program will fund a national network of training sites that will provide education and training in nanoscale research to graduate students, postdoctoral fellows, and professional researchers for nanotechnology.

NSF has also made four grants totaling $14.3 million in research on the societal implications of nanotechnology. The University of California at Santa Barbara, and Arizona State University in Tempe, have been selected to create two Centers for Nanotechnology in Society. These centers will support research and education on nanotechnology and social change, as well as educational and public outreach efforts, and international collaborations. In addition, building on previously successful efforts, NSF has funded nanotechnology-in-society projects at the University of South Carolina and at Harvard University. Read more.

NCI Announces Awards of $26.3 million for Centers of Cancer Nanotechnology Excellence

The National Cancer Institute (NCI), part of the National Institutes of Health (NIH), announced the implementation of a major component of its $144 million five-year initiative for nanotechnology in cancer research. First year awards totaling $26.3 million will help establish seven Centers of Cancer Nanotechnology Excellence (CCNE). Each of the CCNE awards is associated with one or more NCI-designated cancer centers, affiliated with schools of engineering and physical sciences, and partnered with not-for-profit organizations and/or private sector firms, with the specific intent of advancing the technologies being developed. Read more.

Nano Coalition Unveils EndWait

The International Council on Nanotechnology (ICON) announced nanomaterials findings related to the benefits and risks of nanomaterials. The environmental be
Current Federal funding is largely directed at non-biological nano-materials.

Nano-scale science, technology and engineering is not publicly available for business leadership to determine economic returns.

- Research drives business models and economy

Nanotechnology/Cellulose Nanotechnology Research is extremely expensive.

- Universities and Government Labs have much of the needed equipment and research capacity

- Industry cannot afford to invest in the basic research equipment but has the know-how and infrastructure to develop it commercially
Industry Focus on Product Platform Value Chain

The nanotechnology value chain

**Nanomaterials**
- Nanoscale structures in unprocessed form
- Nanoparticles, nanotubes, quantum dots, fullerenes, dendrimers, nanoporous materials, etc.

**Nanointermediates**
- Intermediate products with nanoscale features
- Coatings, fabrics, memory and logic chips, contrast media, optical components, orthopedic materials, superconducting wire, etc.

**Nano-enabled products**
- Finished goods incorporating nanotechnology
- Cars, clothing, airplanes, computers, consumer electronics devices, pharmaceuticals, processed food, plastic containers, appliances, etc.

Source: October 2004 Lux Research report “Sizing Nanotechnology's Value Chain”
Federal Forest Products Nanotechnology R&D

- USDA Forest Service lead Federal Agency
- Collaborating Federal Entities—NIST, NSF, DOD, EPA, NIH
- Form Public-Private Partnership with Forest Products industry & Academia
  - Develop a common vision and priorities for nanotechnology
  - Focus on research, development & deployment
  - Define roles and expectations
  - Strategies
    - Produce nanomaterials from wood
    - Incorporate a variety of nanomaterials into forest products to improve performance and multifunctionality
  - Develop a program implementation plan
Federal & Forest Products Industry Cooperation

- 2005 FPI Nanotechnology Roadmap
- 2006 & 2010 AF&PA Agenda 2020 FPI Technology Roadmaps
- 2007-2009 NNI Forest Products Industry Liaison
  - Conversion of industry goals using industry jargon to underlying fundamental science needs
  - Link with other industry sectors to explore commonalities in fundamental science needed
- 2009/2010 Engaged to seek increased funding

www.nanotechforest.org
US FPI Priority Nanotechnology Applications

- Improve strength/weight performance ratio of paper, paperboard, and wood-based structural materials
- Develop new value-added features for paper, paperboard, and forest products (e.g. photonic properties, piezoelectric properties, etc.)
- Create new revenue streams based on innovative forest-derived nanomaterials
Opportunities for International Cooperation in a Competitive World

Technology-element model. Source: Tassey (2007a)
International Cooperation

• Focus on precompetitive R&D avoids issues of intellectual property
• Permits findings to be freely shared (open communication)
• Creates the underlying science and technology for new innovations
• Allows for creative higher risk/higher reward research to be undertaken
• Achieves critical mass and speeds up research progress
• Reduces cost and unnecessary duplication of effort
• Allows industry within each nation to use the research
Potential Areas of International Collaboration

**Nanotechnology**
- Develop standard nomenclature for wood-derived nanomaterials and get it adopted by ISO.
- Develop methodologies for the manufacture, characterization, modification of nanocellulosic materials.
- Develop methodologies for incorporating nanomaterials into multifunctional hyper-performance wood-based products.
- EHS/ELSI studies on wood-derived nanomaterials
- Characterize the photonic effects achievable from wood-derived nanomaterials for light scattering, light absorption, light transmission and wavelength shifting.
- Characterize the wood-derived nanomaterial piezoelectric effects
- Develop methodologies to manipulate cell wall nano-scale architecture in growing trees
Thank you

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