Nanotechnology Research Infrastructure: A Collaborative Platform for Innovation

Lisa E. Friedersdorf, PhD

Director, National Nanotechnology Coordination Office

October 24, 2019

National Nanotechnology Coordinated Infrastructure

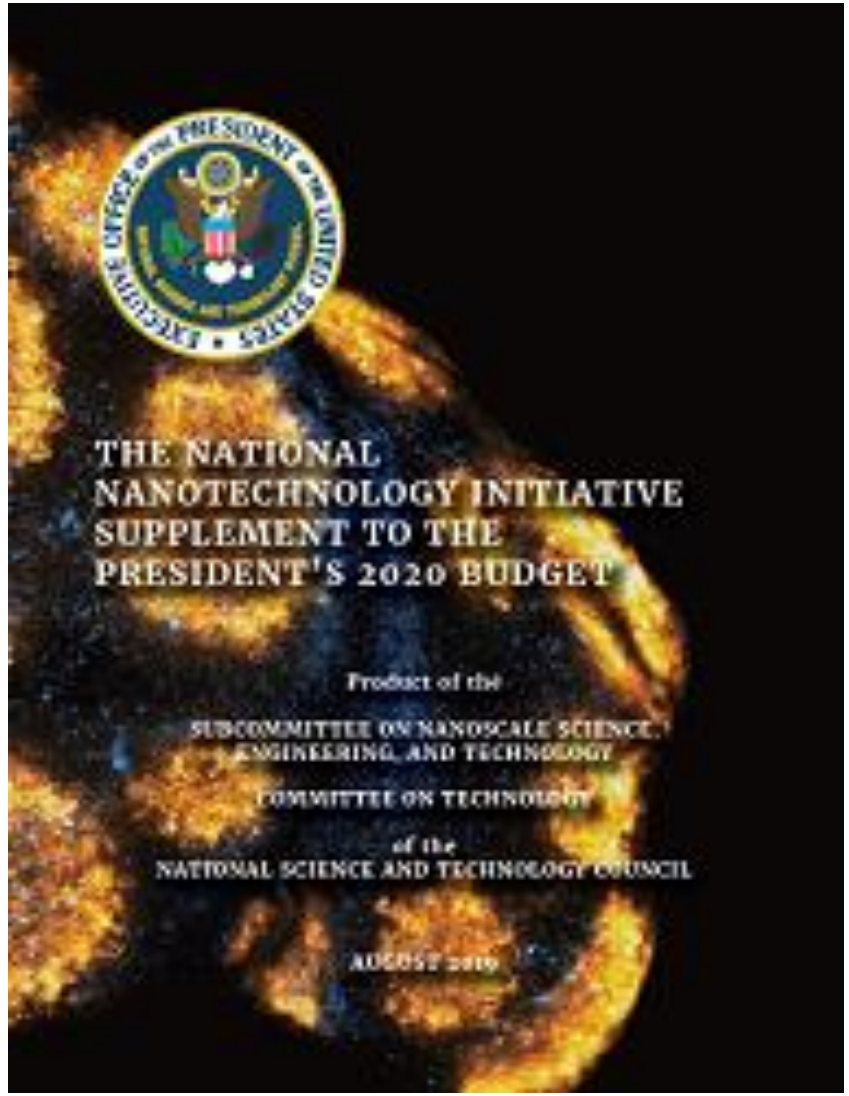
Harvard University, Boston

U.S. National Nanotechnology Initiative (NNI)

- Collaborative R&D to advance understanding and control of matter at the nanoscale for:
  - National economic benefit
  - National security
  - Improved quality of life

- 20 Federal Departments and Independent Agencies

- 2020 budget request: over $1.4 billion
  - Cumulative ~$29 billion investment since 2001
  - EHS investment ~$1.26 billion since 2005



A coordinated initiative, not a distinct funding program.

National Nanotechnology Initiative

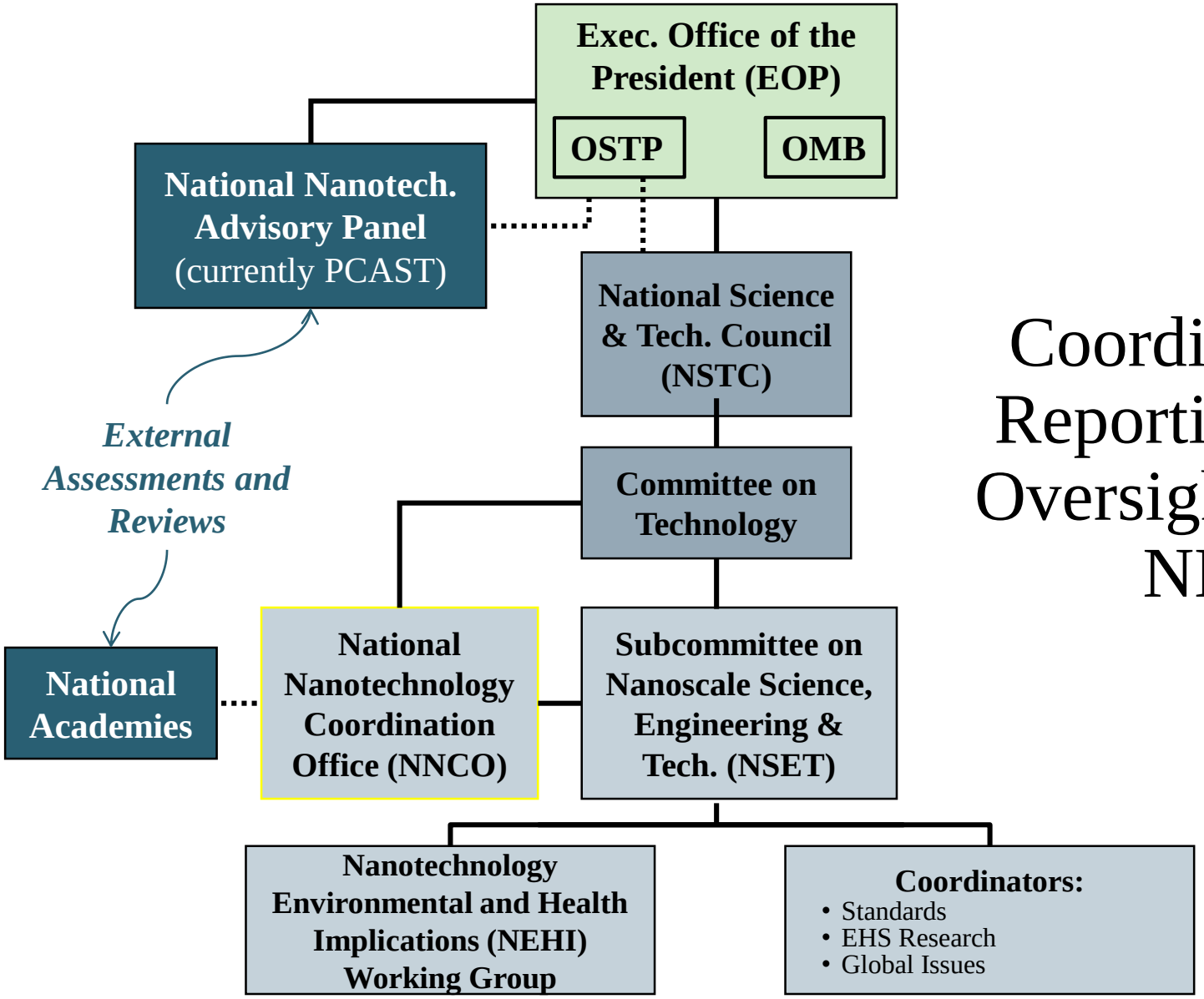
Vision: A future in which the ability to understand and control matter at the nanoscale leads to a revolution in technology and industry that benefits society.

Goals:

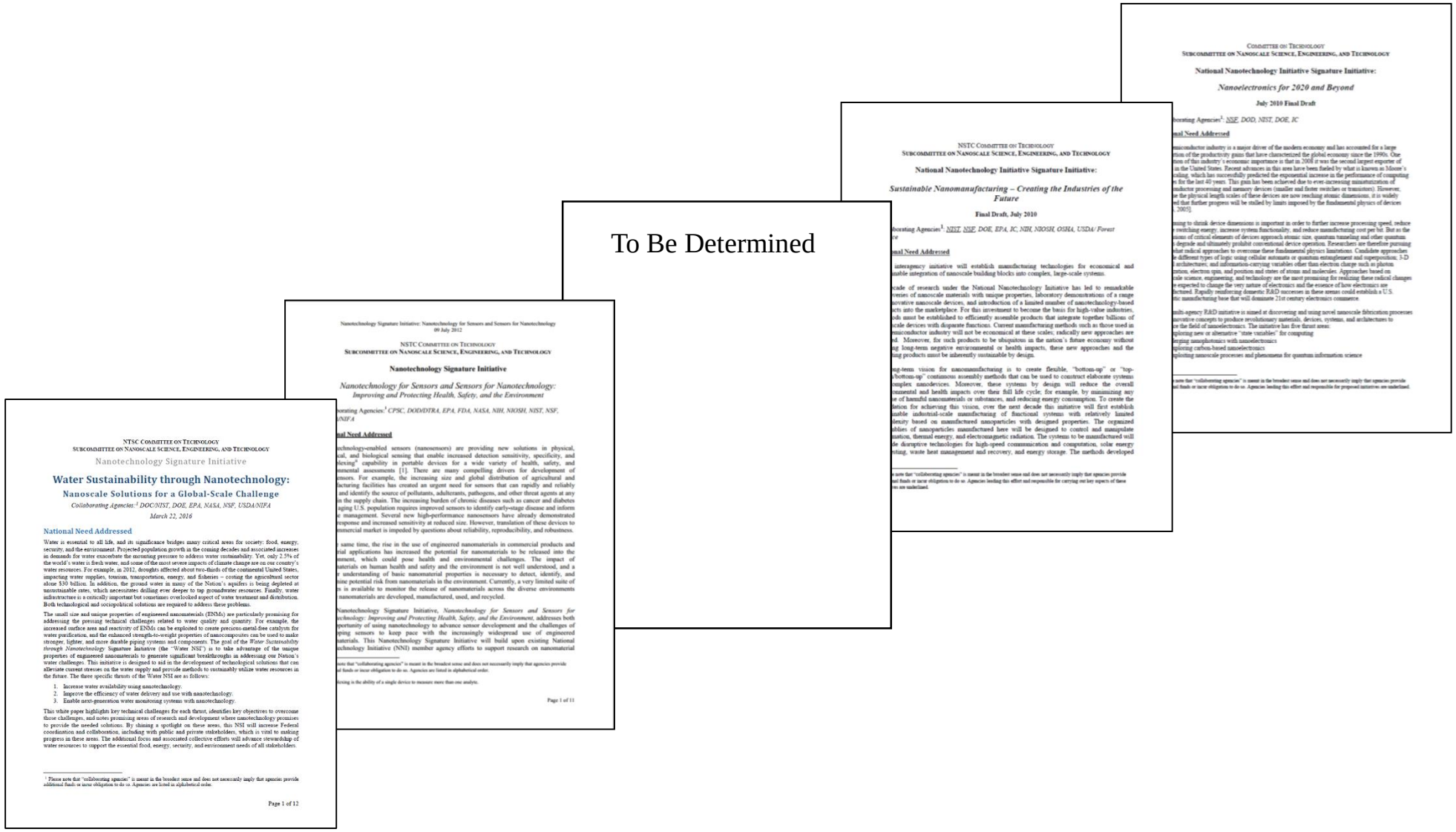
- Advance a world-class nanotechnology research and development program.
- Foster the transfer of new technologies into products for commercial and public benefit.
- Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology.
- Support responsible development of nanotechnology.

DOE
HHS/NIH
OSTP
OMB
NSF
DOD
HHS/FDA
NASA
DOS
USDA/NIFA
USDA/ARS
DOTr
USDA/FS
DOT/FHWA
EPA
IC/DNI
NRC
DOC/NIST
DOI/USBR
DOC/USPTO
DOI/USGS
HHS/CDC/ATSDR
HHS/CDC/NCEH
DOC/ITA
HHS/CDC/NIOSH
DOC/EDA
DOL/OSHA
DOC/BIS
DOJ/NIJ
DOEd
DHS
CPSC
ITC

Coordination, Reporting, and Oversight of the NNI



The NNI's Nanotechnology Signature Initiatives



NTSC COMMITTEE ON TECHNOLOGY
SUBCOMMITTEE ON NANOSCALE SCIENCE, ENGINEERING, AND TECHNOLOGY

Nanotechnology Signature Initiative

Water Sustainability through Nanotechnology:

Nanoscale Solutions for a Global-Scale Challenge

Collaborating Agencies:[1] DOC/NIST, DOE, EPA, NASA, NSF, USDA/NIFA

March 22, 2016

National Need Addressed

Water is essential to all life, and its significance bridges many critical areas for society: food, energy, security, and the environment. Projected population growth in the coming decades and associated increases in demands for water exacerbate the mounting pressure to address water sustainability. Yet, only 2.5% of the world's water is fresh water, and some of the most severe impacts of climate change are on our country's water resources. For example, in 2012, droughts affected about two-thirds of the continental United States, impacting water supplies, tourism, transportation, energy, and fisheries – costing the agricultural sector alone $30 billion. In addition, the ground water in many of the Nation's aquifers is being depleted at unsustainable rates, which necessitates drilling ever deeper to tap groundwater resources. Finally, water infrastructure is a critically important but sometimes overlooked aspect of water treatment and distribution. Both technological and sociopolitical solutions are required to address these problems.

The small size and unique properties of engineered nanomaterials (ENMs) are particularly promising for addressing the pressing technical challenges related to water quality and quantity. For example, the increased surface area and reactivity of ENMs can be exploited to create precious-metal-free catalysts for water purification, and the enhanced strength-to-weight properties of nanocomposites can be used to make stronger, lighter, and more durable piping systems and components. The goal of the *Water Sustainability through Nanotechnology* Signature Initiative (the "Water NSI") is to take advantage of the unique properties of engineered nanomaterials to generate significant breakthroughs in addressing our Nation's water challenges. This initiative is designed to aid in the development of technological solutions that can alleviate current stresses on the water supply and provide methods to sustainably utilize water resources in the future. The three specific thrusts of the Water NSI are as follows:

1. Increase water availability using nanotechnology.
2. Improve the efficiency of water delivery and use with nanotechnology.
3. Enable next-generation water monitoring systems with nanotechnology.

This white paper highlights key technical challenges for each thrust, identifies key objectives to overcome those challenges, and notes promising areas of research and development where nanotechnology promises to provide the needed solutions. By shining a spotlight on these areas, this NSI will increase Federal coordination and collaboration, including with public and private stakeholders, which is vital to making progress in these areas. The additional focus and associated collective efforts will advance stewardship of water resources to support the essential food, energy, security, and environment needs of all stakeholders.

[1] Please note that "collaborating agencies" is meant in the broadest sense and does not necessarily imply that agencies provide additional funds or incur obligation to do so. Agencies are listed in alphabetical order.

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To Be Determined

Nanotechnology Signature Initiative: Nanotechnology for Sensors and Sensors for Nanotechnology
09 July 2012

NSTC COMMITTEE ON TECHNOLOGY
SUBCOMMITTEE ON NANOSCALE SCIENCE, ENGINEERING, AND TECHNOLOGY

Nanotechnology Signature Initiative

Nanotechnology for Sensors and Sensors for Nanotechnology: Improving and Protecting Health, Safety, and the Environment

...borating Agencies:[1] CPSC, DOD/DTRA, EPA, FDA, NASA, NIH, NIOSH, NIST, NSF, ...NIFA

...nal Need Addressed

...chnology-enabled sensors (nanosensors) are providing new solutions in physical, ...cal, and biological sensing that enable increased detection sensitivity, specificity, and ...flexing[a] capability in portable devices for a wide variety of health, safety, and ...nmental assessments [1]. There are many compelling drivers for development of ...sensors. For example, the increasing size and global distribution of agricultural and ...facturing facilities has created an urgent need for sensors that can rapidly and reliably ... and identify the source of pollutants, adulterants, pathogens, and other threat agents at any ...in the supply chain. The increasing burden of chronic diseases such as cancer and diabetes ...aging U.S. population requires improved sensors to identify early-stage disease and inform ...e management. Several new high-performance nanosensors have already demonstrated ...response and increased sensitivity at reduced size. However, translation of these devices to ...commercial market is impeded by questions about reliability, reproducibility, and robustness.

...same time, the rise in the use of engineered nanomaterials in commercial products and ...rial applications has increased the potential for nanomaterials to be released into the ...nment, which could pose health and environmental challenges. The impact of ...aterials on human health and safety and the environment is not well understood, and a ...e understanding of basic nanomaterial properties is necessary to detect, identify, and ...ine potential risk from nanomaterials in the environment. Currently, a very limited suite of ...s is available to monitor the release of nanomaterials across the diverse environments ... nanomaterials are developed, manufactured, used, and recycled.

...Nanotechnology Signature Initiative, *Nanotechnology for Sensors and Sensors for ...chnology: Improving and Protecting Health, Safety, and the Environment*, addresses both ...portunity of using nanotechnology to advance sensor development and the challenges of ...ping sensors to keep pace with the increasingly widespread use of engineered ...aterials. This Nanotechnology Signature Initiative will build upon existing National ...chnology Initiative (NNI) member agency efforts to support research on nanomaterial

...note that "collaborating agencies" is meant in the broadest sense and does not necessarily imply that agencies provide ...al funds or incur obligation to do so. Agencies are listed in alphabetical order.

...lexing is the ability of a single device to measure more than one analyte.

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NSTC COMMITTEE ON TECHNOLOGY
SUBCOMMITTEE ON NANOSCALE SCIENCE, ENGINEERING, AND TECHNOLOGY

National Nanotechnology Initiative Signature Initiative:

Sustainable Nanomanufacturing – Creating the Industries of the Future

Final Draft, July 2010

...borating Agencies[1]: *NIST, NSF, DOE, EPA, IC, NIH, NIOSH, OSHA, USDA/ Forest ...ce*

...nal Need Addressed

...interagency initiative will establish manufacturing technologies for economical and ...mable integration of nanoscale building blocks into complex, large-scale systems.

...cade of research under the National Nanotechnology Initiative has led to remarkable ...ersies of nanoscale materials with unique properties, laboratory demonstrations of a range ...novative nanoscale devices, and introduction of a limited number of nanotechnology-based ...cts into the marketplace. For this investment to become the basis for high-value industries, ...ods must be established to efficiently assemble products that integrate together billions of ...scale devices with disparate functions. Current manufacturing methods such as those used in ...emiconductor industry will not be economical at these scales; radically new approaches are ...ed. Moreover, for such products to be ubiquitous in the nation's future economy without ...ng long-term negative environmental or health impacts, these new approaches and the ...ting products must be inherently sustainable by design.

...ng-term vision for nanomanufacturing is to create flexible, "bottom-up" or "top-...-bottom-up" continuous assembly methods that can be used to construct elaborate systems ...omplex nanodevices. Moreover, these systems by design will reduce the overall ...nmental and health impacts over their full life cycle; for example, by minimizing any ...se of harmful nanomaterials or substances, and reducing energy consumption. To create the ...dation for achieving this vision, over the next decade this initiative will first establish ...mable industrial-scale manufacturing of functional systems with relatively limited ...density based on manufactured nanoparticles with designed properties. The organized ...mblies of nanoparticles manufactured here will be designed to control and manipulate ...mation, thermal energy, and electromagnetic radiation. The systems to be manufactured will ...de disruptive technologies for high-speed communication and computation, solar energy ...sting, waste heat management and recovery, and energy storage. The methods developed

...note that "collaborating agencies" is meant in the broadest sense and does not necessarily imply that agencies provide ...al funds or incur obligation to do so. Agencies leading this effort and responsible for carrying out key aspects of these ...ves are underlined.

COMMITTEE ON TECHNOLOGY
SUBCOMMITTEE ON NANOSCALE SCIENCE, ENGINEERING, AND TECHNOLOGY

National Nanotechnology Initiative Signature Initiative:

Nanoelectronics for 2020 and Beyond

July 2010 Final Draft

...borating Agencies[1]: *NSF, DOD, NIST, DOE, IC*

...nal Need Addressed

...miconductor industry is a major driver of the modern economy and has accounted for a large ...tion of the productivity gains that have characterized the global economy since the 1990s. One ...ion of this industry's economic importance is that in 2008 it was the second largest exporter of ... in the United States. Recent advances in this area have been fueled by what is known as Moore's ...aling, which has successfully predicted the exponential increase in the performance of computing ...s for the last 40 years. This gain has been achieved due to ever-increasing miniaturization of ...nductor processing and memory devices (smaller and faster switches or transistors). However, ...se the physical length scales of these devices are now reaching atomic dimensions, it is widely ...ed that further progress will be stalled by limits imposed by the fundamental physics of devices ... 2005].

...sing to shrink device dimensions is important in order to further increase processing speed, reduce ...r switching energy, increase system functionality, and reduce manufacturing cost per bit. But as the ...ions of critical elements of devices approach atomic size, quantum tunneling and other quantum ...s degrade and ultimately prohibit conventional device operation. Researchers are therefore pursuing ...what radical approaches to overcome these fundamental physics limitations. Candidate approaches ...de different types of logic using cellular automata or quantum entanglement and superposition; 3-D ... architectures; and information-carrying variables other than electron charge such as photon ...ization, electron spin, and position and states of atoms and molecules. Approaches based on ...scale science, engineering, and technology are the most promising for realizing these radical changes ...e expected to change the very nature of electronics and the essence of how electronics are ...factured. Rapidly reinforcing domestic R&D successes in these areas could establish a U.S. ...stic manufacturing base that will dominate 21st century electronics commerce.

...multi-agency R&D initiative is aimed at discovering and using novel nanoscale fabrication processes ...novative concepts to produce revolutionary materials, devices, systems, and architectures to ...se the field of nanoelectronics. The initiative has five thrust areas:

...xploring new or alternative "state variables" for computing
...ercoupling nanophotonics with nanoelectronics
...xploring carbon-based nanoelectronics
...xploiting nanoscale processes and phenomena for quantum information science

...note that "collaborating agencies" is meant in the broadest sense and does not necessarily imply that agencies provide ...al funds or incur obligation to do so. Agencies leading this effort and responsible for proposed initiatives are underlined.

Stories from the NNI

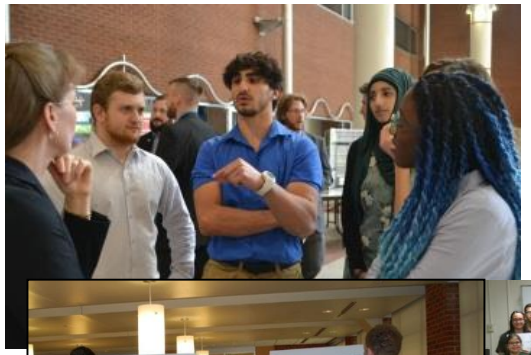
Engaging with the NNI

The promise of nanotechnology can only be achieved through community involvement.

How to engage?

- Webinars
- Workshops
- Respond to RFIs
- Share news and highlights
- Podcasts
- Communities of Research
- Contact the NNCO!

U.S. Nano and Emerging Technologies Student Network








NEXT TECH

Student Leaders Conference



Collaboration to Address Emerging Contaminants

Nanoplastics Interest Group

- Leveraging advances in nanotechnology
- Building on relationships and mechanisms for collaboration
- Focus on addressing current concerns and preventing future contamination

Opportunities to Leverage International Collaboration

Collaborative Platforms for Converging Technologies

U.S. Advanced Materials Case Study

National Nanotechnology Coordinated Infrastructure

Project 1: Collaborative Platforms for Converging Technologies
Advanced Materials U.S. Case Study: NNCI

This case study will use the following framework:

1. Platform Name and Description
2. Parent policy initiative
3. Stated Aim or Mission
4. Funding
5. Access
6. Intellectual Property Terms
7. Data (ownership and sharing)
8. Public Private Collaboration
9. Education
10. Standardization
11. Measures of activity
12. Stage of research, development, or commercialization
13. Safety/ regulation
14. Role of digitalization in the convergence enabled by the platform (if pertinent to the case)
15. Other

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THANK YOU.

Lisa E. Friedersdorf, PhD
Director, National Nanotechnology Coordination Office

http://www.nano.gov/
lfriedersdorf@nnco.nano.gov