Technology Innovation Program

Government Support for Innovations In Nano-Technology

Applied Power Electronics Conference 2010

National Institute of Standards and Technology

U.S. Department of Commerce

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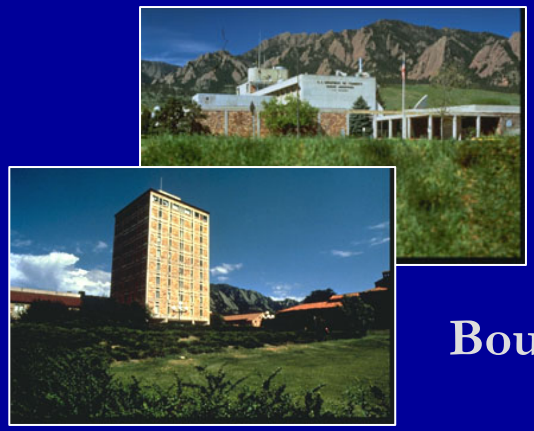
National Institute of Standards and Technoloy
U.S. Department of Commerce

NIST Mission …

Gaithersburg, MD



Boulder, CO

To promote U.S. innovation and industrial competitiveness by advancing

measurement science, standards,
and **technology**

in ways that enhance economic security and improve the quality of life for all Americans.

NIST: Promoting U.S. Innovation and Industrial Competitiveness

NIST Nanotechnology Mission: *To promote U.S. innovation and industrial competitiveness by advancing nanoscale measurement science, standards, and nanotechnology in ways that enhance economic security and improve our quality of life.*

Lloyd Whitman
Deputy Director
Center for Nanoscale Science and Technology

Call me any time.

TIP Technology Innovation Program

The NIST Center for Nanoscale Science and Technology

- Established in 2007
- Operates a national shared-use facility, including the Nano-Fab
- Conducts multidisciplinary research to create the next generation of nanoscale measurement instruments
- Link the external nanotech to the vast measurement expertise of the NIST Laboratories

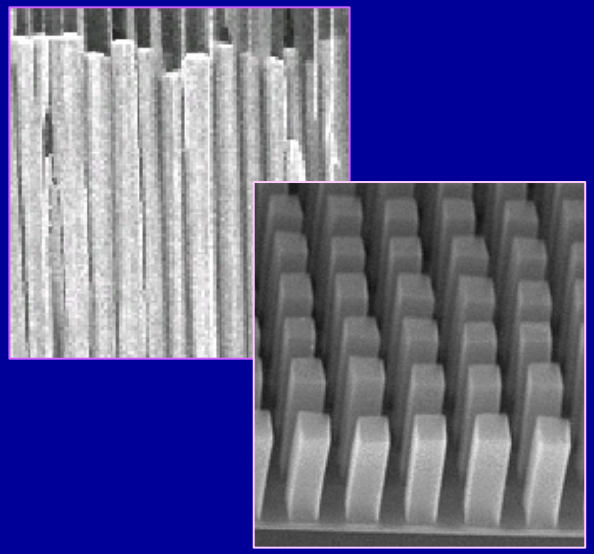
Participants in NIST Nanotechnology Center

- NIST provides leadership and technical expertise to standards development
  - International Organization for Standardization (ISO) Technical Committee 229 (TC 229)—Nanotechnologies
  - International Electrotechnical Commission (IEC) Technical Committee 113 (TC 113)—Nanotechnology standardization for electrical and electronic products and systems
  - ASTM Committee E56 on Nanotechnology
  - IEEE Nanotechnology Council Standards Committee
  - Organization for Economic Cooperation and Development
    - Working Party on Nanotechnology
    - Working Party for Manufactured Nanomaterials

  US National Nanotechnology Initiative Working Groups

Nano-structured Materials by Design

- ***Template Synthesis Platform for Nano-structured Materials***
- **GE Global Research, Niskayuna, NY**
- Other Participant: Molecular Nano-systems, Inc. Palo Alto, CA



November 2002 to October 2005
Total Project Budget: $5,784k
ATP Cost Share: $2,834k

Project

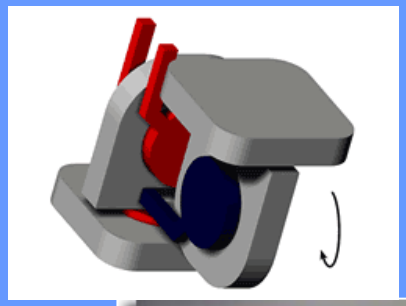
Develop and demonstrate the use of a technology platform for precisely-controlled growth of large arrays of aligned nano-rods, made from a broad spectrum of materials, and designed for applications in medical imaging systems, fluorescent lamps and flat-panel displays.

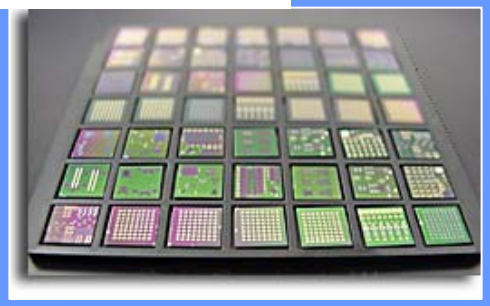
Potential Impacts

- Scalable process, leading to low-cost manufacturing
- Enable earlier detection of disease, e.g., cardiovascular disease and breast cancer
- Increase the efficiency of fluorescent lamps, resulting in large annual savings in energy costs and reduced greenhouse gas emissions
- Flat-panel displays with improved viewing attributes

Nano-scale Instrumentation

- ***Assemblers for Nanotechnology Applications and Manufacturing:***
- ***Enabling the Nanotechnology Era***
- **Zyvex Corporation, Richardson, TX**
- Other Participants: Honeywell International, Redmond, WA; Rensselaer Polytechnic Institute, Troy, NY; University of Texas at Dallas, Richardson, TX; University of North Texas, Denton, TX





October 2001 – September 2006
Total project budget: $24,416k (est.)
ATP Cost Share: $12,170k (est.)

Project

Develop low-cost, computer-controlled, micro-scale assemblers that operate in parallel to assemble three-dimensional micro-scale components, with extension of the technology to nano-scale assemblers for the commercialization of nanotechnology.

Potential Impact

- Provide competitive advantage to U.S. companies that manufacture optical network subsystems, multifunction chip assemblies, and devices for manipulating micro-samples in the biotech and pharmaceutical industries.
- Create automated micro-scale assembly capable of dramatically reducing costs and bringing MEMS assembly to the U.S.

TIP is Part of NIST

Funding

- $70 million FY 2010 including management of ongoing Advanced Technology Program awards

TIP draws upon NIST scientific and technical expertise

- Identifying and selecting critical national need areas for TIP funding
- Peer review of proposals

NIST benefits from collaborating with TIP

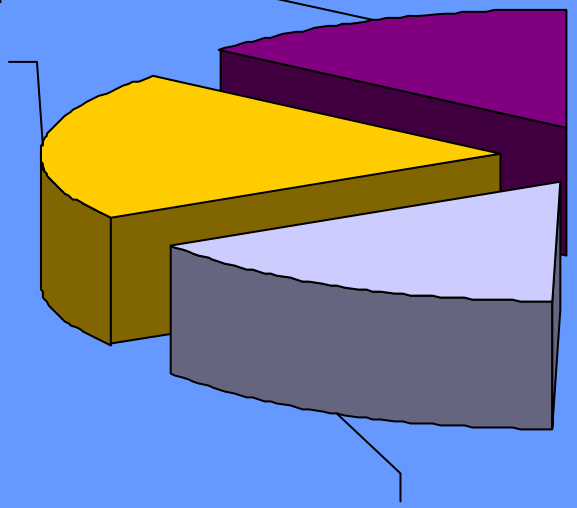
- Learning about critical national needs as applied to NIST research
- Enhancing knowledge through proposal review

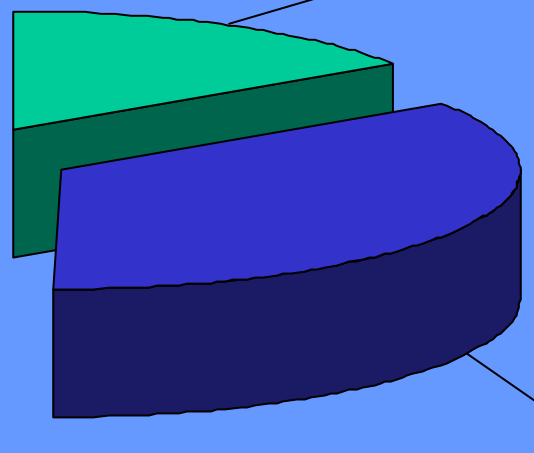
TIP Purpose …

"Assisting United States businesses and institutions of higher education or other organizations, such as national laboratories and nonprofit research institutions, to support, promote, and accelerate innovation in the United States through high-risk, high-reward research in areas of critical national need."

America COMPETES Act
(PL 110-69)
August 9, 2007

ATP Awards–Nanotechnology

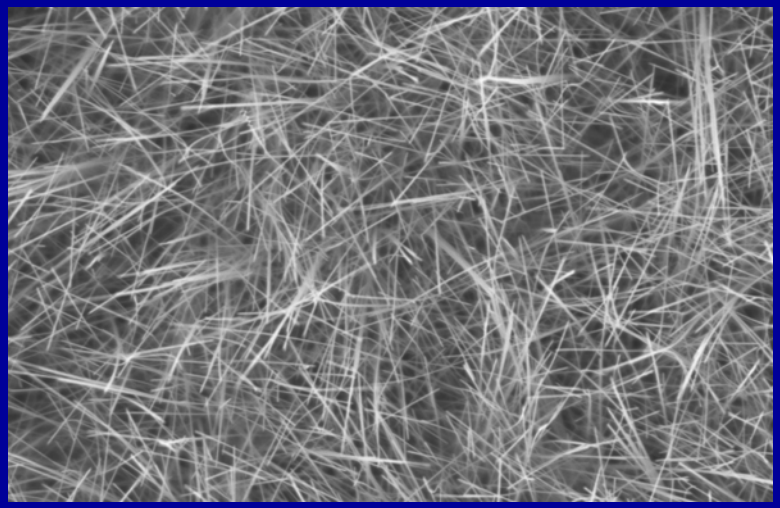




Total Cost Sharing:
- ATP: $170.1 M
- Industry: $159.5 M

TIP Nano-Technology

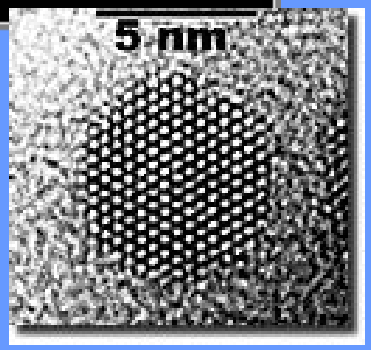
Silicon Nanowires: *radically improving the energy density of the next generation of Li-ion batteries*



- Silicon has 10x the capacity of carbon: 4,200 mAh/g vs. 370 mAh/g
- Silicon swells 400% when fully lithiated, inducing stresses which present a barrier to reasonable cycle life
- Program goal: scale-up laboratory production process to high-volume roll-to-roll process

NIH _ Health Care, Therapeutics, and Nanodiagnostics

- ***Blood 'Fingerprinting': A First Step Toward Personalized Medicine***
- **SurroMed, Inc., Mountain View, CA**
- Other Participants: Quantum Dot Corporation, Hayward, CA



November 2001 to October 2003
Total Project Budget: $11,304k
ATP Cost Share: $5,595k

Project

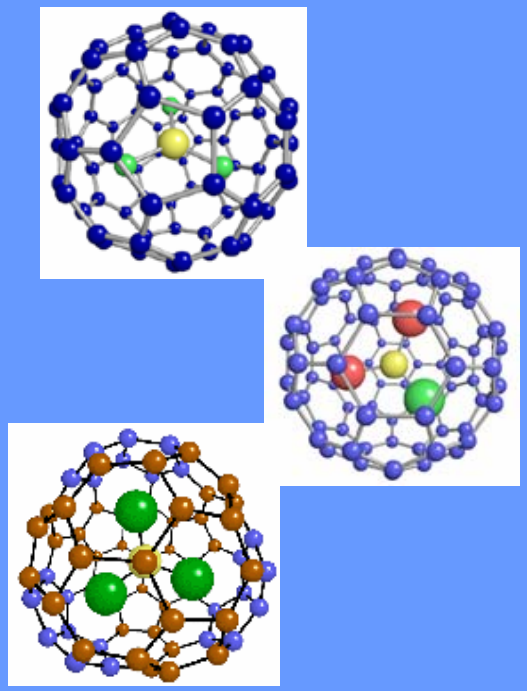
Develop a novel blood analysis system based on micro-volume laser scanning cytometry and light-emitting nano-crystals for the rapid and comprehensive analysis of whole blood for cell-surface markers, pathogens and biologically-important soluble factors.

Potential Impacts

- Dramatically improve the efficiency and safety of blood screening.
- Reduce blood screening costs while eliminating the adverse consequences of transfusions.
- Identification of biological markers with predictive value in making the use of blood safe and effective.
- Spin-off applications in photonics and biotechnology.

NIH - Nanodiagnostics

- ***New Medical Applications of Carbon Nanomaterials***
- **Luna Innovations, Inc., Blacksburg, VA**



October 2001 to September 2003
Total Project Budget: $2,857k
ATP Cost Share: $1,984k

Project

Develop powerful new medical reagents, based on endohedral metalofullerenes, for use in diagnostic and treatment applications.

Potential Impacts

- Brighten and enhance the contrast of MRI images by 100 fold, enabling earlier detection of cancer.
- Reduction in health care costs and improvements in patient quality-of-life through earlier detection.
- Development of smaller, less-costly instrumentation, enabling wider accessibility of MRI tests.

DOE Nano-Technologies

Lithium Air Battery
10 times the energy density of lithium-ion battery
(Similar energy density to gasoline.)

Lithium Anode
Gel polymer electrolyte membrane
Porous carbon air anode

Contact Information:
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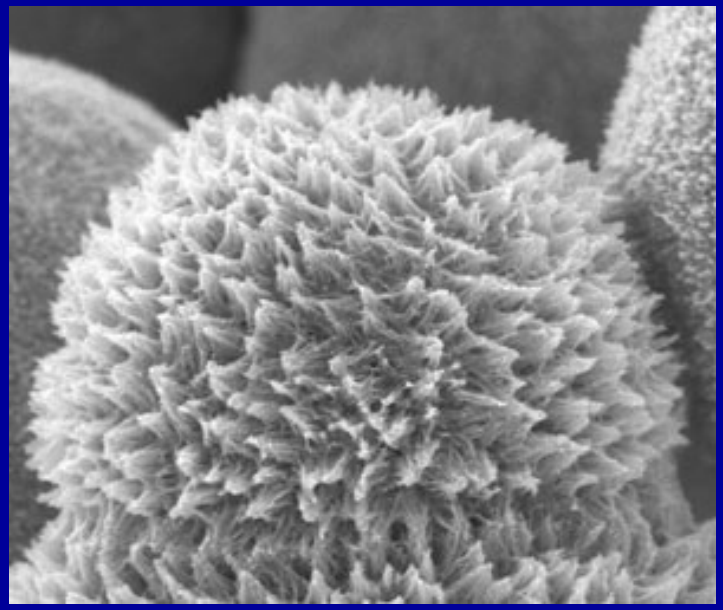
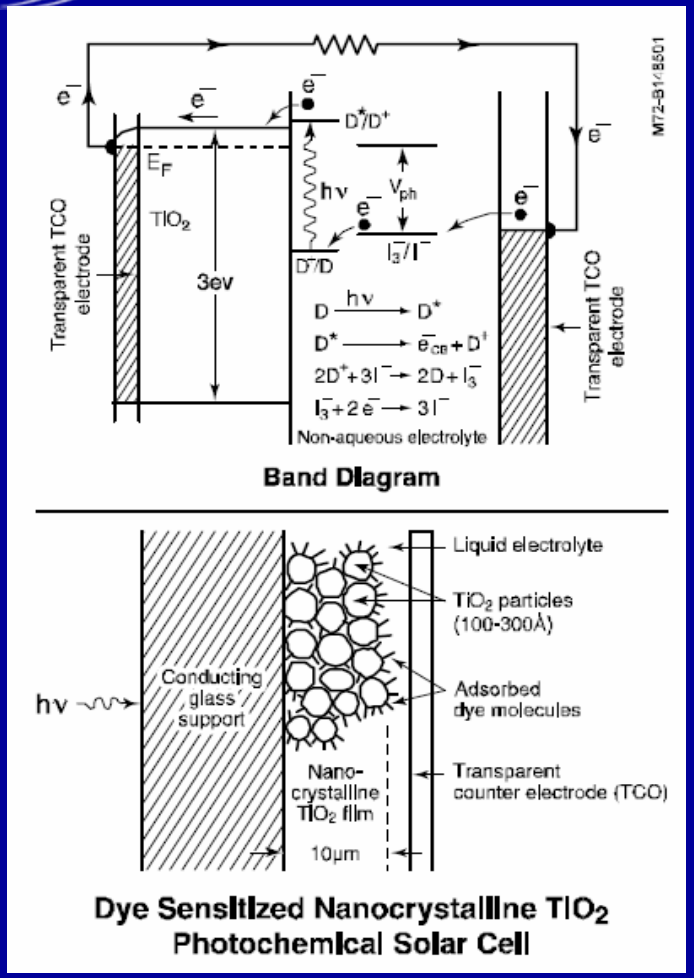
Proton Exchange Membrane Fuel Cell



- Platinum based PEM fuel Cell is at $60 per KWatt.
- Gasoline engine is at $30 per Kwatt
- Single crystal platinum nano-wires on carbon sphere triples the efficiency of the cathode

A scanning electron microscopy (SEM) image of platinum nanostructures. The nanostructures consisted of numerous single-crystal Pt nanowires with diameters of ca. 4 nm and lengths that may reach hundred nanometers.

Dye-Sensitized Solar Cells



Dye-coated inorganic nano-particles

Mono-layer of light-absorbing dye coats nano particles of TiO_2 in a liquid electrolyte (I^- / I_3^-)

- Interface: Nano-TiO_2 coated with Ru-based dye
- Dye extends absorption into the visible (~ 500 nm)
- Thick TiO_2 layer for high absorption
- Pores of TiO_2 filled w iodide/triiodide redox couple

S.K. Deb, et al., "Photochemical Solar Cells Based on Dye-Sensitization of Nanocrystalline TiO_2", 2nd World Conf. on PV Solar Energy Conv., July 1998.

DOE - Future PV Devices Might Use Nanorods and Nanopores

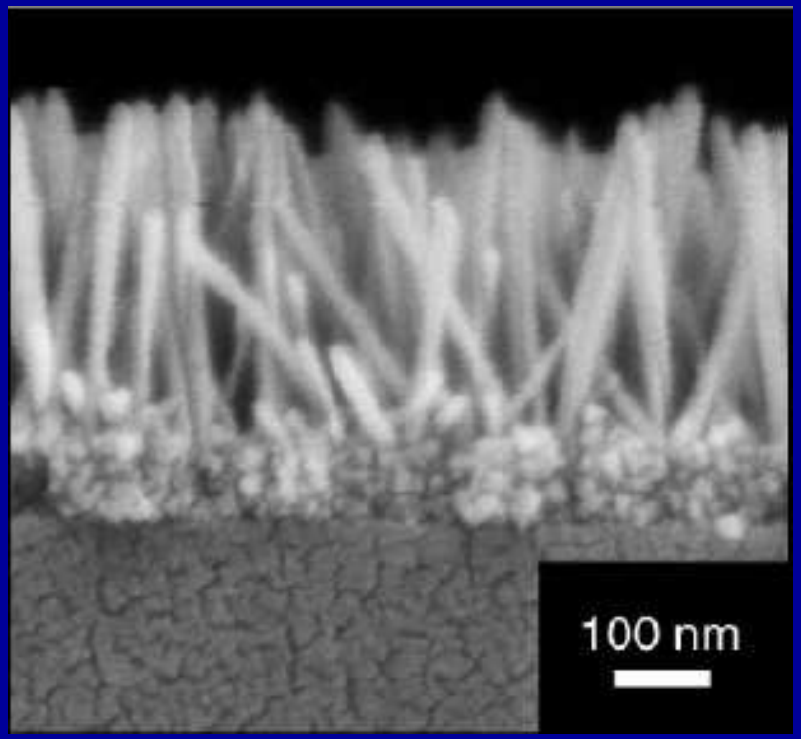


Photo by S. Shaheen, NREL

- NREL has investigated a sensitized heterojunction with nanotubes
- Oriented n-type TiO_2 nanotubes / p-type $CuInSe_2$

Civil Infrastructure: Inspection & Wireless Monitoring

Cyber-enabled Wireless Monitoring Systems for the Protection of Deteriorating National Infrastructure Systems

University of Michigan, Ann Arbor, Michigan.

Other Joint Venture Participants: Li, Fischer, Lepech & Assoc. LLC, Ann Arbor, MI; Weidlinger Assoc., Inc., New York, NY; Monarch Antenna, Inc., Ann Arbor, MI; SC Solutions, Sunnyvale, CA; Prospect Solutions, LLC, Loudonville, NY.

February 1, 2009 to January 31, 2014
Total Project Budget: $19,162k
TIP Cost Share: $8,998k

Project

Novel system including self-sensing materials, ultra low power wireless nodes using only harvested power, embedded data processing for automated data interrogation, vehicle-infrastructure integration, grid-based FEM analyses, and cyber-enabled inspection.

Potential Impacts

- Offers a next-generation structural health monitoring architecture for a comprehensive decision making;
- Proposes a new paradigm to structural sensing based on multifunctional materials; and
- Allows for embedment of sophisticated data processing algorithms directly into the wireless sensor network.

DOT Nano-Technology

Civil Infrastructure: Inspection & Monitoring

Development of Rapid, Reliable, and Economic Methods for Inspection and Monitoring of Highway Bridges

University of Texas at Austin, National Instruments Corporation, and Wiss, Janney, Elstner Associates

March 1, 2009 to February 28, 2014
Total Project Budget: $6,723k
TIP Cost Share: $3,357k

Project

Develop new approaches to maximize the safe, service life of each bridge and develop priorities for replacement.

Focus on sensor networks for monitoring accumulation of damage due to fatigue and corrosion.

Develop energy harvesting techniques to support low-power, wireless sensor networks.

Develop passive sensors that can be powered and interrogated using radio frequency (RF) communication.

Potential Impacts

- Allow accurate assessment of the remaining service life of bridges and long range scheduling of necessary repairs or replacement
- Provides current information of the structural condition of bridges

For Info on TIP . .

- Visit TIP's website
  - *www.nist.gov/tip*
- Register for the TIP mailing list
  - *http://tipmailing.nist.gov/forms/mailing_list.cfm*

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