U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

HEARING CHARTER

The Transfer of National Nanotechnology Initiative Research Outcomes for Commercial and Public Benefit

Tuesday, March 11, 2008
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

1. Purpose

As part of the reauthorization process for the National Nanotechnology Initiative (NNI), on Tuesday, March 11, 2008, the Subcommittee on Research and Science Education will hold a hearing to review the activities of the NNI in fostering the transfer of nanotechnology research outcomes to commercially viable products, devices, and processes. In addition the hearing will review the current federal efforts related to support of research on nanomanufacturing.

2. Witnesses

Mr. Skip Rung, President and Executive Director, Oregon Nanoscience and Microtechnologies Institute (ONAMI)
ONAMI is a cooperative venture between government, academic institutions and industry in the Pacific Northwest and provides open user facilities, research expertise, industry connection to academic research, and gap-funding.

Dr. Julie Chen, Co-Director, Nanomanufacturing Center of Excellence, University of Massachusetts Lowell
The University of Massachusetts Lowell Nanomanufacturing Center of Excellence includes the Center for High Rate Nanomanufacturing, an NSF funded user facility that focuses research on manufacturing technology for nanoproducts.

Dr. Jeffrey Welser, Director
Nanoelectronics Research Initiative (NRI)
The NRI is a consortium of companies in the Semiconductor Industry Association which funds research to demonstrate novel computing devices with critical dimensions below 10 nanometers.

Mr. William Moffitt, CEO
Nanosphere, Inc. and representing the
NanoBusiness Alliance

Dr. Mark Melliar-Smith, CEO
Molecular Imprints, Inc.

3. Overarching Questions

- What are the barriers to commercialization of nanotechnologies? How can the NNI enhance technology transfer and help promote the commercialization of nanotechnology?

- Is the current investment in basic research for nanomanufacturing under the NNI adequate? Are the research areas supported under NNI relevant to the needs of industry? How can the nation's focus on manufacturing techniques position us for global leadership in specific technologies?

- Are user facilities supported under the NNI effective in assisting with the transfer of research results to usable products that benefit the public? Are the current user facilities adequate to meet the needs of the user community in terms of number of facilities and types of instrumentation and equipment available? Are there impediments to the use of federally funded nanotechnology user facilities for industry, such as intellectual property issues or administrative burdens that discourage their use?

- Is there a need for a research and development program under NNI focused on specific problems of national importance?

- Are mechanisms available for industry to influence the research priorities of the NNI?

4. Background

NNI Organization and Funding

The National Nanotechnology Initiative was authorized by the 21st Century Nanotechnology Research and Development Act of 2003 (P.L. 108-153). In accordance with the Act, the National Science and Technology Council (NSTC) through the Nanoscale Science, Engineering, and Technology (NSET) Subcommittee plans and coordinates the NNI. The Act authorized the National Nanotechnology Coordination Office (NNCO) to provide technical and administrative support to the NSET for this coordination. There are currently twenty-six Federal agencies that participate in the National Nanotechnology Initiative, with 13 of those agencies reporting a research and development budget. The total estimated NNI budget for FY2008 was $1.49 billion. Total funding for the NNI in FY2007 was $1.42

billion[1]. More information on the NNI program content and budget can be found at http://www.nano.gov/NNI_FY09_budget_summary.pdf and http://www.nano.gov/NNI_08Budget.pdf. Research related to the NNI is organized into eight program component areas including: Fundamental phenomena and processes; nanomaterials; nanoscale devices and systems; instrumental research, metrology, and standards; nanomanufacturing; major research facilities and instrument acquisition; environment, health, and safety; and education and societal dimensions.

The FY2008 estimated budget for nanomanufacturing research (a component that is closely tied to bridging the gap between basic research and the development of commercial products) was $50.2 million dollars which is 3.3% of the total budget. The NNI planned investment in nanomanufacturing research for FY2009 is $62.1 million, a 23% increase. This amount is 4% of the total FY2009 proposed budget. A working group for Nanomanufacturing, Industry Liaison, and Innovation (NILI) was formed by the NSET to facilitate innovation and improve technology transfer for nanotechnology. NILI has helped to facilitate industry liaison activities for the electronics, construction, chemical, and forest and paper products industries.

User Facilities

The NNI funding agencies support nanotechnology user facilities to assist researchers (academic, government, and industry) in fabricating and studying nanoscale materials and devices. The facilities may also be used by companies for developing ideas into prototypes and investigating proof of concept. The National Science Foundation supports 17 facilities under its National Nanotechnology Infrastructure Network (NNIN), four of which are focused on nanomanufacturing. The Department of Energy maintains five Nanoscale Science Research Centers, each focused on and specific to a different area of nanoscale research. The National Institutes of Health has a Nanotechnology Characterization Laboratory in Frederick, MD and the National Institute of Standards and Technology maintains a user facility in Gaithersburg, MD. The application processes for each facility varies; however, all are open to academic, government, or industry users. In addition to the user facilities, the NNI is carried out in over 70 centers and institutes[2] throughout the country mostly on university campuses, many of which have user facilities that are open to all applicants.

SBIR/STTR Programs

P.L. 108-153 encourages support for nanotechnology related projects through the Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) programs by requiring the National Science and Technology Council to "develop a plan to utilize Federal programs, such as the Small Business Innovation Research Program and the Small Business Technology Transfer Research Program, in support of the [NNI activities]…". Despite the lack of a formal plan, the SBIR and STTR programs have been used as a vehicle to bring nanotechnology research developed by small business concerns closer to commercialization. The total SBIR and STTR program spending in all technology

[1] *Summary of the FY2009 National Nanotechnology Initiative Budget*, February 2008. Available at http://www.nano.gov/.

[2] Information of NNI related user facilities and centers and institutes can be found at www.nano.gov.

areas in FY2006 was nearly $2.2 billion, of that budget $79.7 million was identified as nanotechnology related research[3]. This was 3.7% of the total SBIR/STTR spending in FY2006 and included nine federal agencies. SBIR/STTR funding is allowable for development of technologies from concept to prototype; however, funding of scale-up to manufacturing does not fall within the SBIR/STTR scope of funding.

Commercialization Issues

Federal Government spending in nanotechnology research and development since 2001 exceeds $5 billion. Global revenues from nanotechnology products are estimated at $50 billion annually, and are expected to reach $2.6 trillion by 2014[4]. Federal R&D funding vehicles traditionally limit funding to basic research through prototype development, leaving private sector funding to bring these emerging technologies to commercialization. A recent report by the U.S. Department of Commerce's Technology Administration cites "funding which favors research over development and commercialization…" as one of the most significant barriers to growth in the nanotechnology industry[5]. To bridge this gap, some states are developing gap-funding programs or tax incentives. Globally, countries such as New Zealand and Israel have developed incubator and granting programs that attempt to provide funding for commercial development past the prototype stage. These programs are privately and/or government funded. In addition to federal, state, and local efforts to bring products beyond prototype, industry liaison efforts such as the Nanotechnology Research Initiative[6] of the Semiconductor Research Corporation, and the Agenda 2020 Technology Alliance[7] are bringing scientists and industry partners together.

Nanomanufacturing

Commercialization of nanotechnology is dependent on the development of nanomanufacturing techniques and processes[8]. There are difficulties with scale-up methods for nanotechnology that are unique to nanomanufacturing. Nanomanufacturing processes are difficult to control and can sometimes require more expensive instrumentation for the large scale manufacture of nanomaterials and products. In addition, manufacturing defects that would not affect reliability or performance of macro-technologies can and do render nanotechnologies unusable. Because of these unique challenges, manufacturers can often produce prototypes but the rates to scale-up are slow, and the hurdles for commercialization are often prohibitive. Products that rely on nanoscale building blocks (e.g. carbon nanotubes and nanoparticles) need better manufacturing methods to control variability and better high throughput characterization methods to measure that control.

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[3] *The National Nanotechnology Initiative Supplement to the President's FY2008 Budget*. July 2007, p. 24.
[4] *Sizing Nanotechnology's Value Chain*, Lux Research, 2004.
[5] *Barriers to Nanotechnology Commercialization*, U.S. Department of Commerce, September 2007, p. 11.
[6] The NRI is a consortium of companies in the Semiconductor Industry Association which funds research to demonstrate novel computing devices with critical dimensions below 10 nanometers that will have application beyond the potential of the current circuit technology (CMOS).
[7] The Agenda 2020 Technology alliance is a project of the American Forest & Paper Association and supports and directs research efforts in nanotechnology to benefit the forest and paper products industry.
[8] Chemical Industry R&D Roadmap for Nanomaterials by Design: From Fundamentals to Function. December 2003, p. 83-91.

There is a need for instrumentation for measurement and inspection of nanomanufactured products on-line or at the very least, measurement at a higher rate. Current technologies for device measurement and inspection such as scanning electron microscopy (SEM), transmission electron microscopy (TEM), and atomic force microscopy (AFM) require time and instrumentation expertise and slow manufacturing processes when employed.

5. Witness Questions

All of the witnesses were asked to provide their views on the effectiveness, scope, and content of the current efforts under the NNI to foster transfer of technology and any recommendations they have on ways to improve the process by which nanotechnology is commercialized including, but not limited to, development of prototypes, use of federally funded user facilities, and nanomanufacturing practices and processes. In addition, the following specific questions were asked of each witness:

Mr. Skip Rung

- What are the significant hurdles for companies trying to commercialize nanotechnology? What examples of successful activities to overcome these hurdles has ONAMI seen? What recommendations for federal policy can you make based on the success of the companies affiliated with ONAMI?

- How can policies for access to facilities supported under NNI be structured to provide for increased use by industry and increased transfer of technology and knowledge from federally funded research?

- Are there ways that the NNI could be more effective in assisting the transition of research results to prototype development and full commercialization?

- What kinds of federal programs or activities can help bridge the "valley of death" successfully? How effective have the SBIR/STTR and ATP programs been in this regard?

- Are there any barriers to commercialization imposed by current intellectual property policies at NNI-supported user facilities, and if so, what are your recommendations for mitigating these barriers?

Dr. Julie Chen

- Please review the findings of the 2006 Small Times *Survey of U.S. Nanotechnology Executives* and comment on the results regarding companies' attitudes and views regarding federal support in nanotechnology research and development and needs regarding user facilities.

- What is the current state of nanomanufacturing basic research? What are the basic research needs to provide industry with the tools necessary to move towards high-rate nanomanufacturing?

- How does your center interact with industry in setting research direction?

- Do the companies that interact with your center make use of other facilities available through the NNI? Are current policies under the NNI supportive of such use?

Dr. Jeffrey Welser

- How does the electronics industry interact with NNI supported research activities?

- What is the role of industry in setting research directions through the NRI?

- What role should the NNI play in helping to foster commercialization of nanotechnology?

- Are federally funded user facilities meeting the needs of industry? Are there impediments to their use? How can user facilities be most effective in helping to bring NNI funded research to commercialization?

Mr. William Moffitt

- What are the hurdles to the commercialization of nanotechnology?

- What kinds of federal programs or activities can help bridge the "valley of death" successfully? How effective have the SBIR/STTR and ATP programs been in this regard?

- Are there areas of focus for commercialization that will position the nation for leadership in that technology?

- Are there any barriers to commercialization imposed by current intellectual property policies at NNI-supported user facilities, and if so, what are your recommendations for mitigating these barriers?

Dr. Mark Melliar-Smith

- Please describe your company's experience with federally funded user facilities (DOE, NSF, etc.)? Are user facilities easily accessible to small and medium businesses? If not, why not, and how would you recommend making improvements? How can user facilities be most effective in helping to bring NNI-funded research to commercialization?

- Is the research now being supported under the nanomanufacturing component of the NNI meeting the needs of industry? Do you believe industry has a voice in determining research priorities for these activities?

- Was your company successful in attracting venture capital? If so, at what stage in your products' development did you obtain VC funding? Are there any federal policies or agency directives that have impacted your ability to obtain VC funding, either positively or negatively?

- Are there ways that the NNI could be more effective in assisting the transition of research results to prototype development and full commercialization?