



**Research Subcommittee of the Committee on Science
of the United States House of Representatives**

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“A Successful New Paradigm for Innovation and Education”

University based, co-located with some of the biggest names in industrial innovation, and committed to building a thriving, educated and globally-competitive workforce, Albany NanoTech is a \$3 billion enterprise dedicated to creating partnerships for leading edge nanotechnology innovations. Through its unique, vertically-integrated model that includes the world’s first College for Nanoscale Sciences and Engineering at the University at Albany – State University of New York, Albany NanoTech’s partnerships with business, government and academia have created the world’s premier powerhouse for research, development, technology deployment, and education resource supporting accelerated nanotechnology commercialization.

Albany NanoTech is the umbrella under which the CNSE and the five Centers operate; namely, the Center of Excellence in Nanoelectronics, Center for Advanced Technology in Nanomaterials and Nanoelectronics, Interconnect Focus Center, Nanoscale Metrology and Imaging Center, and the Energy and Environmental Technology Applications Center. The CNSE and the five centers are all located at Albany NanoTech and have access to its facilities, but the nature of our model – through which there are no divisions between disciplines, or between academia and industry – means that there is great cooperation and cross-pollination among the various centers and between CNSE faculty and industrial partners. Faculty are involved in all of the centers and in some cases, the centers cooperate closely with one another to advance the science. Nobody is working in silos, and that is part of the reason why we have been able to get so much accomplished.

Partnerships

(How does Albany NanoTech interface with the private sector?)

Albany NanoTech seeks to leverage resources in partnership with business, government, and academia to create jobs and economic growth for nanoelectronics-related industries. Governor George E. Pataki created a Center of Excellence in Nanoelectronics at Albany NanoTech’s facilities in 2001 and since then has worked very closely on building relationships with leading industrial players in nanoelectronics like IBM, ASML, Tokyo Electron, and International Sematech. Since 2001, we have attracted over \$1 billion in direct private investment and now have over 100 industrial

partners many of whom are on site, which represent companies of all sizes that share a commitment to nanotechnology innovation.

Boasting over 100 partnerships with universities, federal labs, and industry such as RPI, Stony Brook University, Argonne National Laboratory, DARPA, NASA, General Electric, Honeywell, and IBM, to name a few, Albany NanoTech strives to help companies overcome technical, market, and business development barriers through technology incubation, pilot prototyping, and test-bed integration support leading to targeted deployment of nanotechnology-based products.

Albany NanoTech's partnerships encompass multi-year research programs with IBM, ASML, Tokyo Electron, Applied Materials, Infineon and Micron as well as sponsored research collaborations with national defense agencies, such as the Naval Research Laboratory and DARPA as well as start-up companies, such as Daystar Systems and Crystal IS. Small, medium and large corporate and university partners have access to state-of-the-art laboratories, shared user facilities, supercomputing capabilities, and an array of research and development centers serving the short, medium and long-term nanotechnology development needs while training the workforce for the 21st century. Partners are able to collaborate formally and informally, establish strategic alliances, or form joint ventures and consortia within a technically aggressive and financially competitive environment.

The CNSE & Centers

(What is the workforce outlook for nanotechnology, and how can the federal government and universities help ensure there will be enough people with the relevant skills to meet the nation's needs for nanotechnology research and development and for the manufacture of nanotechnology-enabled products?)

According to National Science Foundation, the U.S. will need approximately 2 million nanotech savvy workers by 2014. Approximately 20% of these workers are expected to be scientists, 80% must be highly-skilled engineers, technicians, business leaders, economists, etc., and that means children between the ages of 10 and 17 need to be educated NOW about the field that will define their job market as adults.

The location of the College in the Albany NanoTech complex provides students with a unique public-private education through research partnerships that are not available at any other college or university. This partnership allows maximum leveraging of synergistic resources to create a comprehensive, fully integrated powerhouse for the attraction and retention of highly qualified students to careers in the various disciplines of nanotechnology, from theoretical principles to experimental demonstrations and practical applications.

As the first of its kind, the College provides a comprehensive education of the highest quality enabling the discovery and dissemination of fundamental knowledge concepts and new frontier scientific principles in the emerging interdisciplinary fields of nanotechnology, from nanosciences and nanoengineering to nanoeconomics. The College offers Ph.D. and M.S. degrees in the science and engineering tracks pertaining to the nanoelectronics, optoelectronic, optical, nano/micro-electro-mechanical, nano/micro-opto-electro-mechanical, energy, and nanobiological fields with curriculum integrating the fundamental science principles of physics, chemistry, computational science and biology with the cross cutting fields of nanosciences, nanoengineering and nanotechnology.

In addition, the College supports hands-on workforce training by providing access to state-of-the-art facilities, training the entire spectrum of technicians, operators and technical trades through partnerships with community colleges, high schools and leading industry players. CNSE has established partnerships with several community colleges providing the hands-on workforce component to their associate degree education necessary to operate nanotechnology equipment. The CNSE works with local undergraduate colleges and high schools by sponsoring year round and summer internships for students and by hosting in partnership with the Semiconductor Equipment and Materials International (SEMI) four day “chip camps” targeting high school vocational students to encourage them to consider careers in nanotechnology through hands-on curriculum. Finally, Albany NanoTech participates in a \$6 million workforce training partnership for nanotech infrastructure construction trades in partnership with M+W Zander, one of the world leaders in nanotechnology facility design and construction, the Watervliet Arsenal Partnership and New York State.

Research & Facilities

The research performed at Albany NanoTech is broadly focused on all aspects of the emerging nanosciences including: nanoelectronics and microelectronics, Nano/Microsystems including MEMS, nanometrology, nanophotonics and optoelectronics, analytical sciences and process control, nanopower, and advanced computer modeling for nanosystems and processes.

To assist in accomplishing these prominent research goals, Albany NanoTech consists of over 500,000 square feet of on-site office, laboratory, and cleanroom incubation facilities. The complex includes the only 200-mm/300-mm wafer facilities in the academic world that encompasses nanoelectronics; system-on-a-chip technologies; biochips; optoelectronics and photonics devices; closed-loop sensors for monitoring, detection, and protection; and ultra-high-speed communication components.

Albany NanoTech has literally hundreds of tools, ranging from STMs and supercomputers to the ASML TWINSCAN AT:1500i scanner, the world’s first 300 mm wafer immersion lithography tool. Our tool arsenal is one of our best recruiting tools, since many of our scientists can do everything they need to advance their research right here.

NanoFab 300 South, which opened in January 2003, is a 138,000-square-foot technology acceleration facility that provides for business incubation, classrooms for the CNSE, workforce training, offices for Albany NanoTech, and large and small industrial sponsors and partners including IBM, TEL, Honeywell, and SEMATECH North. The facility also includes 16,000 square feet of cleanroom to support the SEMATECH North, IBM, and other next-generation nanotechnology research activities.

Scheduled to be completed by the end of 2005, NanoFab 300-North features a 35,000 square foot Class 1-capable 300-mm wafer R&D cleanroom, pilot prototype, incubation, and workplace training facility that will house a full nanoelectronics process line. The 500,000+ square-foot complex includes over 65,000 square feet of cleanroom space supporting the nanoelectronics-related industries. Albany NanoTech not only has the site where the world’s first 300 mm wafer immersion lithography tool was installed in August 2004, enabling partners like IBM to get a jump on this technology but Sematech has also announced that it is conducting the bulk of its research in extreme

ultraviolet (EUV) lithography at its laboratories located at Albany NanoTech. The fact that two leading organizations in nanotechnology research – IBM and Sematech – have both announced major lithography research milestones in the past year and both of these took place at Albany NanoTech demonstrates the effectiveness of the model.

The NY “Nano” State

(How does the state of New York provide support to Albany NanoTech and the College of Nanoscale Science and Engineering at UAlbany – SUNY? How does this complement funding from the federal government and the private sector? What, if any, gaps remain?)

New York and its industrial partners committed over \$1.4 billion to establish five Centers of Excellence throughout the State in nanoelectronics, photonics, bioinformatics, information technology, and environmental systems. Each Center of Excellence acts as a bridge between scientific discovery and commercialization by supporting pilot-prototyping development, workforce training and economic outreach. Combined, these distributed technology deployment centers represent a comprehensive nanotechnology commercialization effort reflecting regional strengths.

Government support encouraging private and public investment in nanotechnology is a key to industry success and future economic growth. New York’s tremendous support of nanotechnology development has caused industry leaders such as IBM, General Electric, and Corning to expand their research and development activities within the state. New York State’s support for joint technology research, development and deployment in the form of state-of-the-art facilities and capabilities has played an important role in lowering the risk and cost for companies to accelerate the commercialization of nanotechnology.

New York State already shows signs of being a ‘Nano Hub’ and, in particular, the capital region is becoming the world’s first ‘Nanopolis.’ Since 2002, two of the world’s most influential tool suppliers, Tokyo Electron and ASML, have chosen to open up their first cutting-edge R&D laboratories outside their home countries at Albany NanoTech. “Smaller high-tech startups like Starfire Technologies and Evident Technologies that were incubated at Albany are growing and attracting venture capital funding. Finally, we are finding companies are actually moving to Albany from other parts of the world.

The Future & Recommendations

Albany NanoTech’s overarching goal is to become the Bell Labs of the new millennium – bringing the best minds together, whether they are in industry, government or academia, to work on leading-edge technologies that can revolutionize our lives in the coming decades. In the immediate term, this means building partnerships and creating a paradigm that practically compels companies that value leading-edge nanotechnology research to establish partnerships at Albany NanoTech if they want to remain competitive. In the long term, it means reinventing and drastically speeding how innovation is brought to market.

The College’s goals are to completely redefine how scientists are educated by tearing down the traditional disciplinary silos in which they operate and by tearing down the barriers between the research institutions, community colleges, high schools, vocational schools and even the trades. We

are confident that subjects like biology, chemistry, physics and medicine will become increasingly irrelevant in the coming decades as science merges around the development of tool sets and methodologies. In the immediate term, we want CNSE to be part of this redefinition of research and pedagogy. In the long term, we aspire to create a world-class academic center on par with – but not a clone of – the world’s greatest research universities.

Atomic-scale manufacturing requires a closer coupling between research, development and manufacturing. A new generation of institutions executing dynamic cross-industry, cross disciplinary models are emerging, such as Albany NanoTech, that are responding to the unique challenges and opportunities created by nanotechnology. These institutions are establishing a new paradigm for state-of-the-art research, education and technology deployment that offers the Federal government a highly leveraged return on its investment in projects, programs and centers.

Federal funding must recognize the emergence of new university-based technology, educational, and business models that concurrently support long-term research, medium-term development and short-term manufacturing. Federal funding should reward universities and state governments who successfully pursue new paradigms for innovation and education by encouraging joint investments in shared-use infrastructure by industry. Federal investments in shared-use infrastructure supporting the entire continuum of nanotechnology research, development and manufacturing must be a strategic priority supporting. New business and technology models such as Albany NanoTech’s is critical for U.S. industry to convert nanotechnology discovery into commercial opportunities supporting national industrial competitiveness and defense and security priorities.

Shared investment and collaboration by industry, academia and government not only improves the probability of success, leading to economic growth for both small and large companies, but also provides the critical infrastructure necessary to support educational programs for the entire spectrum of workers to effectively compete in the 21st Century. Significant and consistent support for the operations of this university-based shared-use infrastructure by the federal government is critical for supporting the growth of small, medium and large companies, training the entire spectrum of nanotech savvy workers with hands-on educational programs, and achieving the grand challenges set forth under the National Nanotechnology Initiative (NNI) which are critical for national defense, public health and economic security. More specifically, continued support for the NNI should be a priority while recognizing that current programs neither effectively address nor accommodate less traditional models, and as such, requires a new category of funding to support “Successful New Paradigms for Innovation and Education”.

For more information about Albany NanoTech, its mission and its programs, visit our website at www.albanynanotech.org or contact Michael Fancher, Director of Economic Outreach at mfancher@uamail.albany.edu.