

Nanotechnology is the enabling force behind the next industrial revolution which will impact nearly every aspect of our lives. In fact, the revolution has already begun. Last year, **thirty billion dollars** worth of manufactured goods incorporated nanotechnology. Commercial products from skin cream and stain resistant clothing to nanoelectronics and magnetic storage devices are in the market and have entered the mainstream. The true potential of nanotechnology, however, has yet to be realized in advanced electronics, healthcare, energy, homeland security and defense. All of these are important economic sectors for Virginia. To help realize this potential, **\$9.6 billion** was invested worldwide by corporations, governments, and venture capitalists on nanotechnology research and development. Companies from the developers and manufacturers of nanomaterials to the defense contractors who will eventually integrate the technology are **doing business in Virginia**. These organizations are supported by strong research programs at the Commonwealth's academic institutions and federal laboratories.

***Nano is here now.***

In 2005: **\$30 billion** manufactured goods incorporated nanotechnology.  
By 2014: **\$2.6 trillion** in global manufactured good will incorporate nanotechnology.

-LuxResearch 2006

In Virginia, approximately **\$1billion** manufactured goods will incorporate nanotechnology in 2006.

-Industry sources

Nanotechnology is the understanding, design and manipulation of matter at dimensions of less than a billionth of a meter, (approximately 1/100,000<sup>th</sup> the thickness of a typical sheet of paper). Since it is not a particular material or application but the understanding and control at the atomic and molecular level, the impact will be pervasive. Nanotechnology will not only enable our computers to get smaller and faster, but will impact the way we diagnose and treat disease, provide cleaner and more efficient energy, stronger, lighter materials for everything from golf clubs to airplanes, enable smart clothing not just stain resistant, but with sensors to keep us comfortable and safe, and even impact the food we eat.

### **Nanotechnology in Virginia**

Nanotechnology is a part of today's industry in Virginia. Nanomaterials are being commercially produced for application in sectors such as microelectronics, lifesciences, energy, and defense. Virginia firms active in nanotechnology range from the equipment manufacturers that enable fabrication or imaging at the nanoscale, to those that make the nanomaterials, and to companies that are or will become the integrators and end users of nanotechnology, (see insert on page two). At academic institutions and federal laboratories across the Commonwealth nanotechnology is an area of significant strength and the research expertise and infrastructure and the educational programs can be leveraged to support industry.

"It's (nanotechnology) going to impact virtually every one of our business areas and products."

-Sharon Smith, Director of Technology, Lockheed Martin Corporation.  
(Orlando Sentinel, Sept. 11, 2006)

This is particularly true in three areas, **Microelectronics, Lifesciences, and Energy**.

**Microelectronic devices** are now the leading manufactured export of the Commonwealth, in 2005 the value of memory devices exported (\$645.6M) by Micron Technology and Infineon surpassed tobacco products (\$439.5M). Nanotechnology is already impacting microelectronics and will continue to become more significant as electronics get increasingly faster and smaller. It is imperative that we sustain and enable increased capacity of this industry.

Nanotechnology promises to completely revolutionize **healthcare and medicine**, from early diagnosis and treatment options for diseases such as cancer, to wound care and tissue regeneration. Virginia industry is working with our hospitals and medical schools to accelerate advances in areas such as MRI imaging with carbonaceous nanomaterials and artificial vessels made from nanofibrous materials.

**Energy** is one of the most significant challenges of our generation. Nanotechnology will be key to development of alternative energy sources such as biorenewables, photovoltaics (solar cells), fuel cells, and wind power. Nanoscale catalysts will be critical in the development of biodiesels as well as for improved combustion kinetics to facilitate clean coal technologies.

**To enable Virginia to realize the economic benefit of nanotechnology**, the JCOTS Nanotechnology (Manufacturing and Research and Development) Advisory Committees make the following recommendations: (A more detailed discussion is included in the full report.)

- I. The JCOTS Nanotechnology Advisory Committees should continue to meet monthly throughout the year to develop recommendations to promote and advance the nanotechnology community.
- II. Charge the JCOTS Nanotechnology Advisory Committee to address the following task in 2007: Evaluate the necessary organizational structure to support and advance nanotechnology in Virginia. This may be recommending aligning tasks of existing organizations or recommendation of an authority such as the Biotechnology Authority in Virginia, the Ben Franklin Technology Partnership in Pennsylvania, or other successful state models. Activities for nanotechnology advancement include:
  - Facilitate University/Industry/Federal laboratory collaborations
  - Advocate legislation to promote nanotechnology
  - Support a Nanotechnology Users Network for shared instrumentation
  - Facilitate Commercialization of Nanotechnology Developed in Commonwealth Institutions
  - Support small nanotechnology businesses through:
    - development of SBIR/STTR programs (federal funding programs for small businesses)
    - funds for translational research
    - funds for matching federal grants
  - Encourage University research and development in nanotechnology with
    - funds for matching federal grants, in particular Center level research programs
    - support for nanotechnology patents

The JCOTS Nanotechnology Advisory Committee also makes the following short-term recommendations:

1. Legislation should be introduced in the 2007 session of the Virginia General Assembly which addresses the adverse impact of the machinery and tools tax on Virginia's manufacturing sector.
2. Develop policies to enable networking of and access to nanotechnology instrumentation at Commonwealth institutions, a Nanotechnology Users Network.
3. Nanotechnology should be specifically added to the list of eligible industries targeted for location in Virginia Technology Zones, which enables local governments to design incentive programs for the recruitment and growth of technology-based enterprises.
4. Task Virginia Economic Development Partnership to:
  - Aggressively recruit nanotechnology companies to VA.
  - Promote Virginia's nanotechnology businesses and products.
  - Promote the pro-nanotechnology business environment in Commonwealth of Virginia
  - Get visibility from regional and national associations
5. Enact HB 935, creating a Commonwealth non-stock corporation that encourages private sector research collaboration with state universities. The legislation is summarized as follows: State Council of Higher Education for Virginia; creation of nonstick corporation to support academic research.
6. Support HB 329 which creates a technology and biotechnology R&D fund to attract (and assist existing) companies to the Commonwealth.
7. Fund House Bill HB 1244, the Virginia Mathematics, Science, and Technology Education Grant Program.
8. Complete HJR25, the study of how to systematically enhance Science and Mathematics education in VA.
9. Task the Department of Education with convening a workshop with participation from the key stakeholders from universities, industry and the school system, engaged in K-12 outreach activities to identify best known methods, pursue collaborative activities, and define a set of actions which can impact the overall Commonwealth.
10. The Manufacturing Extension Partnership, in collaboration with the Virginia Manufacturers Association, should be charged with the task of determining potential applications of nanotechnology to their production processes.

**Sample of Virginia Companies Engaged in Nanotechnology**

4Wave, Inc (Sterling)  
 Abtech Scientific, Inc. (Richmond)  
 BAE Systems (Manassas)  
 CPFilms, Inc (Martinsville)  
 Lockheed Martin Corporation (Manasas)  
 Luna Innovations, Inc. (Blacksburg, Charlottesville, Danville, Hampton, McLean, Roanoke)  
 Materials Modification, Inc. (McLean)  
 Micron Technology (Manassas)  
 NanoChemonics (Pulaski)  
 NanoMatrix, Inc. (Richmond)  
 NanoSonic, Inc. (Blacksburg)  
 NanoTITAN (Potomac Falls)  
 NBE (Blacksburg)  
 Northrop Grumman Newport News (Newport News)  
 Phillip Morris (Richmond)  
 Qimonda (Richmond)  
 Science Applications International Corporation, SAIC (McLean)  
 Virginia Beach Sensors (Virginia Beach)  
 Vistec Semiconductor Systems (Chantilly)