

Executive Summary

Nanotechnology is the enabling force behind the evolving economical and technological revolution which will impact nearly every aspect of our lives. In fact, the revolution has already begun. In 2005, **thirty billion dollars*** worth of manufactured goods incorporated nanotechnology. Nano-enabled commercial products such as magnetic storage devices have entered the mainstream. The true benefits of nanotechnology, however, are yet to be realized in an enormous range of applications, including 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 in 2005 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.

Nanotechnology embraces the understanding, design and manipulation of matter at dimensions of less than a billionth of a meter, (approximately 1/100,000th the thickness of a typical sheet of paper). The impact of understanding and control of matter at the atomic and molecular level will be pervasive. Nanotechnology will not only enable our computers to become smaller and faster, but will impact the way we diagnose and treat disease, provide cleaner and more efficient energy, produce stronger and lighter materials for everything from golf clubs to airplanes, and enable smart clothing not just stain resistant, but with sensors to keep us comfortable and safe, and will 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, life sciences, 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 enabling nanomaterials, and to companies that are or will become the integrators and end users of nanotechnology. At academic institutions and federal laboratories across the Commonwealth, nanotechnology is an area of significant strength and the research infrastructure and educational programs can be leveraged to support existing industry and spawn or attract new companies. Virginia's fundamental research expertise, including broad areas such as self assembly and nanocharacterization, can provide the foundation for future technological breakthroughs.

This is particularly true in four areas, **Microelectronics, Life Sciences, Defense, 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 Qimonda surpassed tobacco products (\$439.5M). Nanotechnology is already impacting microelectronics and will continue to become more significant as electronics become increasingly faster and smaller. It is imperative that we sustain and enable increased capacity of this industry.

Nanotechnology promises to 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 magnetic resonance imaging with carbonaceous nanomaterials and artificial vessels made from nanofibrous materials.

In **Defense and Homeland Security**, nanotechnology promises the development of many revolutionary technologies, including ultra-hard and corrosion resistant coatings for air, sea and land vehicles; self-repairing materials for space; ultra-quiet and light propulsion systems; and ultra-sensitive pathogen detection, among a myriad of possibilities.

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), and fuel cells. Nanoscale catalysts will be critical in the development of biodiesels as well as for improved combustion kinetics to facilitate clean coal technologies. More broadly, nanoscale understanding and control of chemical reactions will enable much more efficient chemical processing and manufacturing, and much great control over waste products with concomitant benefits to the environment.

Nanotechnology 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
*http://www.luxresearchinc.com/press/RELEASE_TNR4.pdf

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

-Industry sources

Sample of Virginia Companies Engaged in Nanotechnology

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