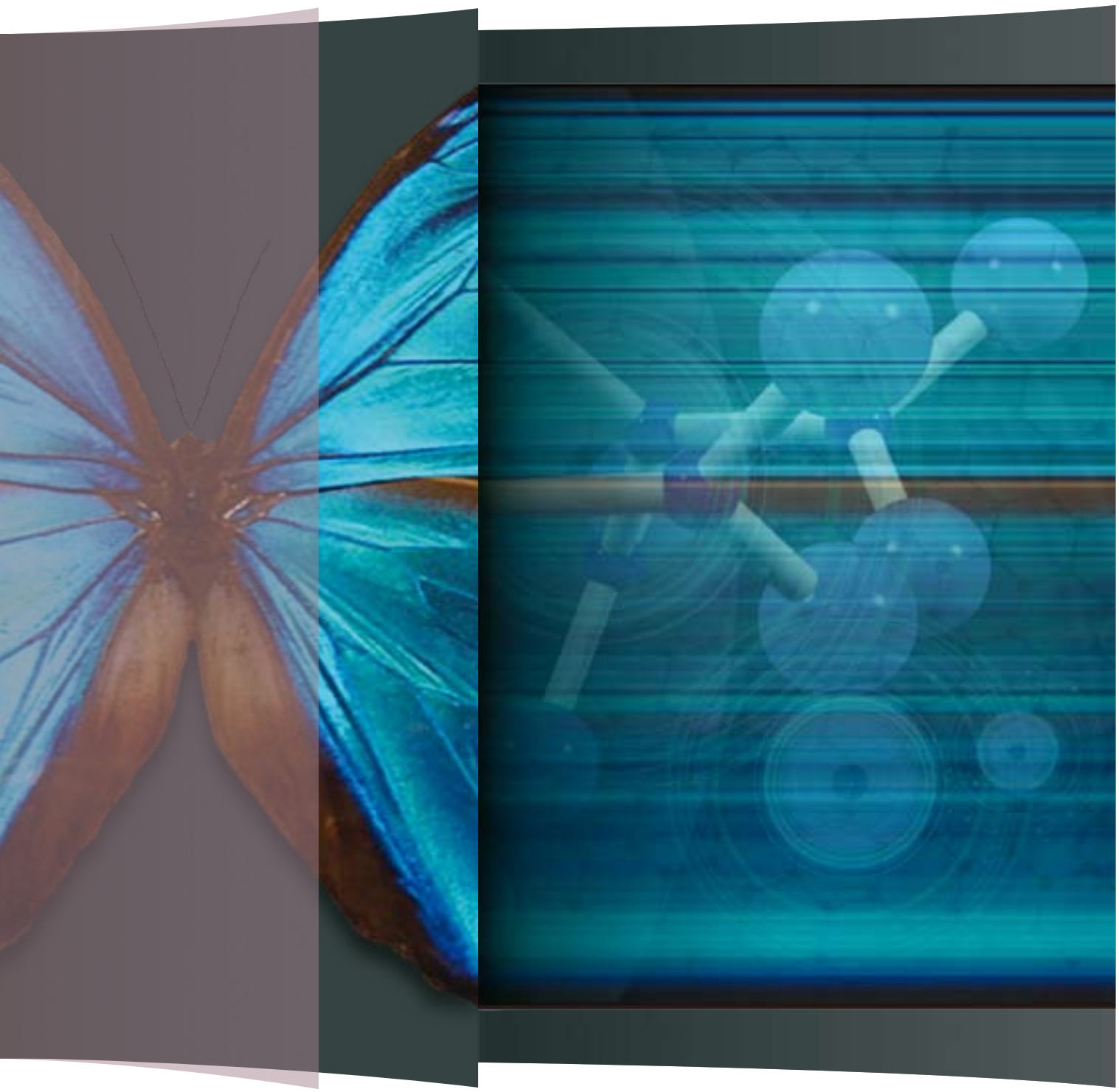

Victorian Nanotechnology Statement

Taking Leadership in Innovations in Technology

February 2008

www.business.vic.gov.au

Front cover:

Innovation Inspired by Nature: The complex micro- and nanometer-scale photonic structures that help give butterfly wings their color could provide the basis of environmentally-friendly colour paints and textiles as well as new displays and telecommunications systems.

Authorised by the Victorian Government, Melbourne

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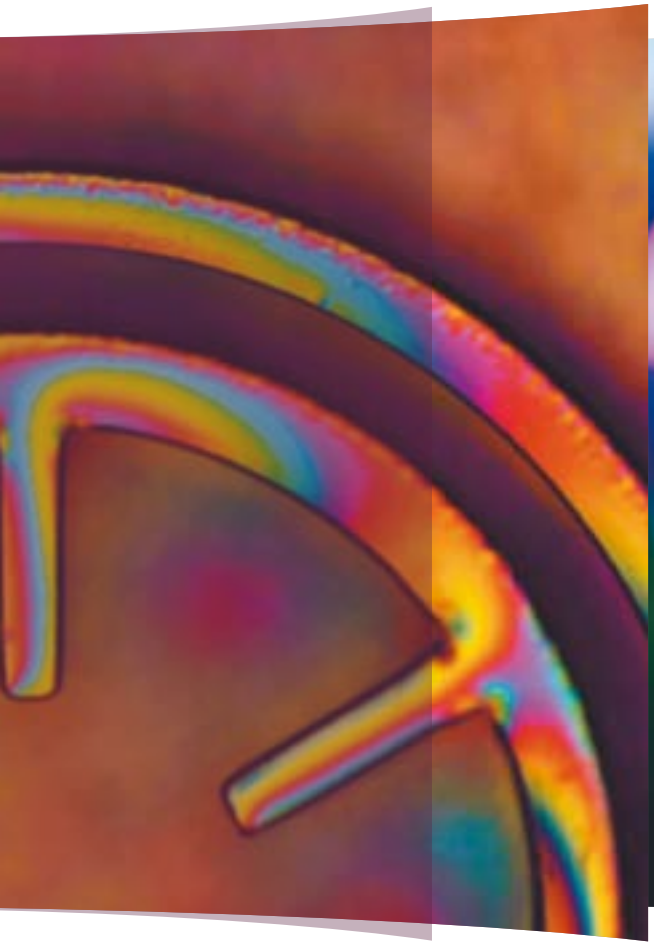
Tiny-pump: micro-scale vacuum pump flask created using synchrotron lithography.



Quantum dots; nanoscale particles used in medical imaging and potentially in next-generation displays.

Foreword by the Minister for Innovation

Gavin Jennings MLC
Minister for Innovation

Nanotechnology is a set of enabling technologies which hold great potential to improve our lives and wellbeing – from targeted drug delivery for cancer and other diseases, to cheap and rapid point-of-care medical diagnostics; from stronger and lighter materials for automobiles and aircraft, to new textiles for fashion, sport and wound care; from coatings for power generation and water purification, to tissue-regeneration and bio-compatible implants; and new sensors, chemical substitutes and additives that will help us to better monitor and manage our natural resources and the environment.

Through the Government's investment program over this decade, Victoria now has a deep understanding of the potential of nanotechnology, its issues, and how it should be managed. Victoria is now recognised internationally as a leading location for important nanotechnology initiatives. Our progress in nanotechnology has come about through the entrepreneurship and drive of our nanotechnology companies, the dedication of our researchers and the commitment of Government to championing Victorian nanotechnology to the world. This is creating new opportunities for Victorian businesses and industries, generating more high-value jobs and helping to make our economy more innovative and competitive.

To keep pace with global developments and remain leaders in our areas of strength, we must ensure that Victoria remains at the forefront of discovery, development and implementation of nanotechnology solutions. Complementary investments such as the Australian Synchrotron, the Victorian node of the Australian National Fabrication Facility and the Australian Stem Cell Centre will provide new product development platforms. The internationally renowned nanotechnology curriculum at St Helena College, Victoria will help to stimulate education and skill development so that we can benefit from global nanotechnology opportunities.

At the same time, we recognise that new technologies must be treated responsibly, and we are working with key stakeholders to define appropriate oversight and governance frameworks that will underpin the safe development of nanotechnology for workers, consumers and the community as a whole. Through the pioneering work of Monash University's Faculty of Law and the initiatives of NanoSafe Australia and the Australian Nano Business Forum, Victoria is leading Australia in the responsible development of nanotechnologies.

The Victorian Government believes that collaboration between government, firms and researchers at a local, national and international level offers the best prospect of achieving sustained growth for our industries and benefits for our community. We are already promoting nanotechnology linkages and convergence with our strengths in biotechnology and other areas, and applying these advances to provide 'cleantech' solutions for our most urgent challenges in health, energy, water, transport, climate, manufacturing and environmental sustainability.

Victoria's 2008 Nanotechnology Statement provides a focus for coordinating and consolidating our existing capabilities and resources in nanotechnology to accelerate Victoria's transformation into a forward-looking, knowledge-based economy. It also provides a framework of priorities for a new strategic partnership between government, industry bodies, industry and the research sector and a basis for action to ensure that we capture the substantial health, economic and environmental benefits that global developments in nanotechnology are generating.

The Statement will boost Victoria's prosperity over the coming decades by driving business growth in existing and new industries and contributing to productivity, investment, exports and jobs growth. It will be a critical milestone in Australia's economic development.

Introduction

Nanotechnology is the design and engineering of the unique properties of materials at the molecular scale – one billionth of a metre – into the synthesis and manufacture of products that bring significant advances to many goods and services. It has the potential to impact on many aspects of our lives, carrying with it opportunities but also challenges for Government, industry and the community.

Over the next decade, the global value of revenues related to nanotechnology is expected to increase from US$32 billion to US$2.6 trillion – representing a significant opportunity for Victoria.

To capture the benefits of this rapidly emerging technology, the Victorian Government is releasing this Nanotechnology Statement as part of an overall strategy to assist Victorian industry to make responsible investment decisions and to ensure that the community is part of this endeavour.

Nanotechnology has the potential to impact on many aspects of our lives

Victoria – leading Australian Nanotechnology

Victoria enjoys a reputation for excellence in biomedicine, pharmaceuticals, instrumentation, materials and agriculture, and is well-placed to exploit the opportunities in nanotechnology.

Victorian leadership in nanotechnology-related industry development is being shown by Government, universities and businesses.

Since 1999, the Victorian Government has invested over $2 billion into science, technology and innovation – laying the foundation for a growing and sustainable economy and prosperity for all Victorians. Of this, over $250 million has been invested in nanotechnology and related activities.

Victoria has over half of the growing national base of nanotechnology-related businesses, including a number of globally-recognised publicly-listed companies. These businesses are providing major advances in areas such as drug delivery, environmental and medical sensors, materials and additives.

Infrastructure investments such as the Australian Synchrotron, Bio21, the Melbourne Centre for NanoFabrication, MiniFab and the Monash Centre for Electron Microscopy are providing the fundamental tools for the complementary fields of nanotechnology, microtechnology and biotechnology. These are supported by a deep, robust and vibrant R&D base across the State, including dedicated facilities at the University of Melbourne, Monash University, La Trobe University, RMIT, Swinburne University of Technology, Deakin University and the CSIRO.

Government-supported entities such as Nanotechnology Victoria, the Small Technologies Cluster, the Victorian Centre for Advanced Materials Manufacturing and the Australian Nano Business Forum are forging new directions in industry–research collaboration and fostering business growth.

Victoria already has Australia's strongest nanoscience base, and leads Australian nanotechnology-related industry development

Left photo:

Patch for transdermal 'needle-free' delivery of drugs is made possible through micro- and nanotechnologies.

Below:

Stain and wrinkle proof fabrics with new fashion design creations are possible with nanotechnology.

Why further investment in Nanotechnology is important

Nanotechnology is at once both an enabling and a disruptive technology – presenting opportunities and challenges to Victoria's economic, social and environmental future.

The impact of nanotechnology can potentially extend to almost every industry sector, through:

- lighter, stronger materials;
- more effective drug delivery;
- tissue repair;
- more environmentally friendly chemicals and consumer products;
- functional coatings that generate power and improve energy efficiency;
- membranes that provide clean water;
- sensors for medical and environmental monitoring;
- more efficient computers and displays; and
- more cost-effective and environmentally sustainable manufacturing processes.

Nanotechnology has the capacity to radically shift the competitive landscape by disrupting existing market and value-chain structures. This is already very evident in existing products – particularly in electronics, textiles, cosmetics, many consumer goods, materials, medical diagnostics and therapeutics, and manufacturing – where enhanced utility or cost-benefit ratios offer competitive advantages or displace existing businesses in the supply chain.

Governments, businesses and venture capitalists are investing aggressively in nanotechnology. In 2005, US$9.6 billion was spent on R&D worldwide: US$4.6 billion in government spending; US$4.5 billion in corporate R&D; and US$497 million in venture capital. Private sector investment is growing at 17 per cent, compared to a 3 per cent rise in public sector spending[1].

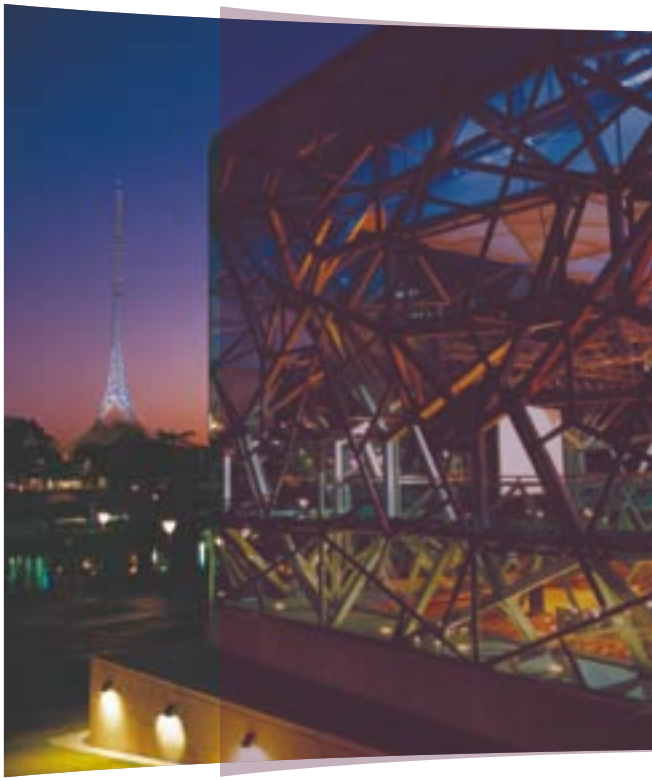
Global sales of nano-enabled products accounted for US$32 billion in 2005. By 2014, this is expected to rise to US$2.6 trillion – 15 per cent of total output. This is approaching the size of the information technology and telecom industries combined, and is 10 times larger than biotechnology revenues[2]. A recent Australian Government report[3] estimated that nanotechnology could be worth up to AUD$50 billion to the Australian economy in new products and processes.

A 2006 survey of 135 Australian businesses likely to be affected by nanotechnology, showed a significant increase in awareness and interest in nanotechnology's potential, with 61 per cent of businesses expected to derive revenue from nanotechnology within five years.

In this context, investment in nanotechnology in Victoria is required to ensure that our existing industries remain viable in the face of competition from overseas companies producing superior products using nanotechnology, and to support home-grown start-up nanotech companies.

The Victorian Government acknowledges its responsibility to ensure that the environment for the development and use of nanotechnologies allows Victorian businesses to fully capture opportunities so that benefits outweigh any risks. This Statement sets out an approach that will build long-term potential, while keeping this consideration at the forefront.

Victoria sees a clear need to enhance its capacity to manage the potential opportunities and challenges that nanotechnology can bring



1 'Nanotechnology Report', Lux Research, 2004
2 'Sizing Nanotechnology's Value Chain,' Lux Research, 2005
3 'Nanotechnology: Enabling technologies for Australian innovative industries', PMSEIC Report, 2005

The Victorian Nanotechnology Statement

The Victorian Nanotechnology Statement articulates Victoria's leadership in nanoscience and industrial capabilities. It builds on investments already made in our people, research institutions and business infrastructure.

This Statement clarifies the primary focus of the Victorian Government in this area – industry stimulation and development, and attraction of investment. It consolidates Victoria's leadership role within Australia in terms of support for emerging technologies and related factors which improve the competitiveness of Victorian business and the benefits for the community.

The Victorian Nanotechnology Statement positions Victoria as a leader in nanotechnology

The Hon John Brumby MP congratulates the ANBF's CEO, Ms. Tina Rankovic, for stimulating national industry development and international alliances – July 2007.

Key Priorities

The actions of the Victorian Government in securing sustainable benefits from nanotechnology for our businesses and the community will be organised around five priorities. These are:

The Victorian Government will act through a framework of five key priorities

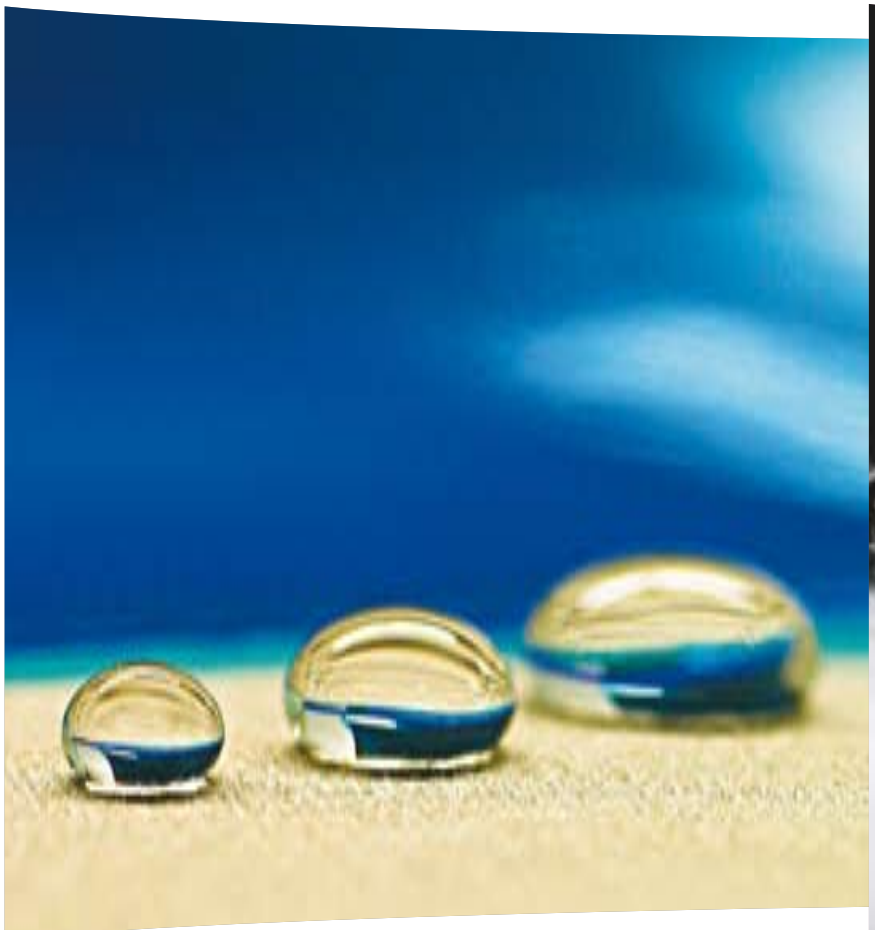
1. Industry Uptake

Early adopters of nanotechnology come from all sectors, and include both start-up ventures and long-established enterprises. Priority will be given to encouraging and supporting companies at the forefront of nanotechnology adoption.

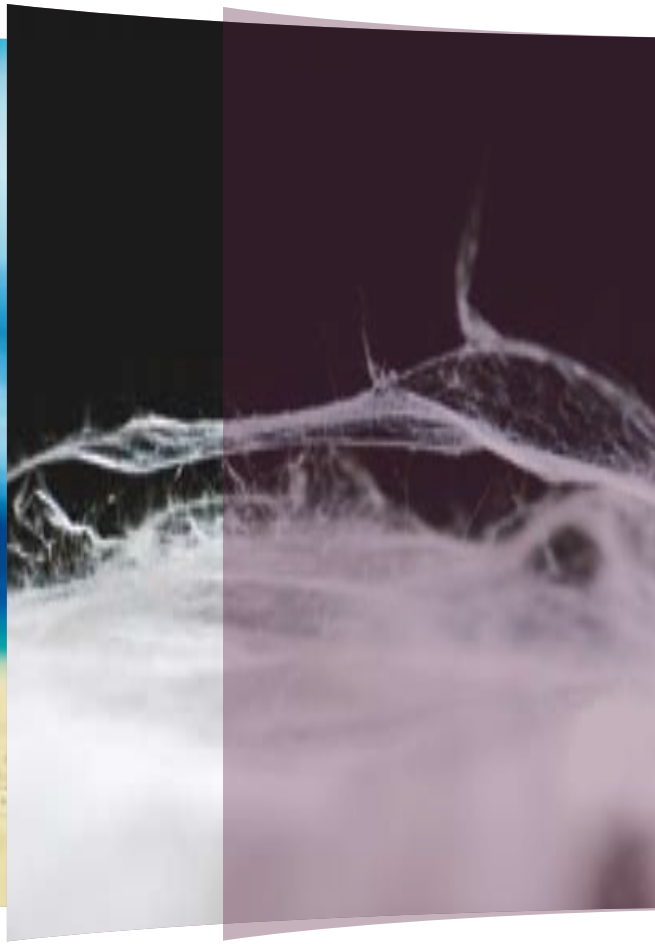
Victoria already has mechanisms for fostering innovation in companies in all sectors. Areas of focus for nanotechnology development include:

- **Industry-research clustering:** Exploiting the potential of Victoria's existing nanotechnology-oriented 'innovation hubs' around central Melbourne, Ballarat, Geelong and the Dandenong-Clayton-Scoresby corridor. International experience has shown that clustering of companies is critical to the establishment of new technologies.
- **Access to capabilities:** Encouraging the establishment of product-development facilities and assisting businesses to access core research and prototyping platforms. International experience has shown that this capacity to test manufacturability and marketability is critical for innovation and business growth.
- **Small business assistance:** Identifying and fostering the emerging and established businesses which drive economic growth, particularly in the sectors in which Victoria has natural competitive advantage or a powerful presence, and who can benefit from the adoption of nanotechnologies.
- **Information access and management:** Exposure to opportunities across markets and along the industry value chain with rapid and high-quality flow and coordination of information and knowledge flow, through support for industry bodies such as the Australian Nano Business Forum.

Textiles treated to produce a water repellent nanoscale surface for protective and sports wear and medical products.



Electrospun nanoscale textile fibres demonstrate new properties for application ranging from medical treatments to industrial filtration.



2. Forging Global Connections

Nanotechnologies serve global markets through sophisticated supply chains configured to meet emerging demand and a variety of new applications.

The Government will continue to make it easier to do business overseas and with international organisations, by supporting access to these global markets and international supply chains. Exposure of Victorian businesses to talent and ideas from the world's leading nanotechnology economies will be a primary objective along with efforts to attract inward investment for commercial nanotechnology activities.

Areas of focus include:

- **Strategic alliances:** Victoria has deep historic, economic and cultural relationships with some of the global leaders in nanotechnology commercialisation, including the USA, China, Japan, Italy and Israel. Partnerships such as the Australian Urban Systems (AUS) Cluster, the Victoria Israel Science and Technology R&D Fund and trade agreements accelerate the development and introduction of new technologies, particularly nanotechnologies.
- **Inward investment:** Invest Victoria plays a major role in both attracting new technology-based firms and in ensuring that they continue to invest; a prime example is the $130 million upgrade of Pilkington Australia's Dandenong plant to drive innovation and markets towards energy-efficient glass.
- **Export:** The Government intends to create new opportunities for Victorian companies to enter new markets with nanotechnology products and services, and to facilitate the reduction of the cost of international marketing and distribution.
- **Promotion:** The Victorian brand has never been stronger, and provides outstanding leverage for Victorian companies. A strong Victorian nanotechnology capability is emerging, and will be exploited in key international markets.
- **International panels:** The Government intends to convene an international panel of experts to provide advice to Government, industry and academia and stimulate international business and research partnership and investment opportunities.

New nano-materials may make non-polluting renewable energy sources such as solar collectors both cost-effective and scalable.

Nanotechnology is truly global in scope with the potential to impact on issues such as water, energy and health.

3. Skills and Education

The Victorian education sector is one of the most advanced in the world, and provides competitive advantage for our economy. Victorian nanotechnology education, particularly in secondary schools, is now pre-eminent. The Government will continue to strengthen the education package, with particular emphasis on those skills necessary for nanotechnology-based businesses and activities.

Areas of focus include:

- **Industry skills:** Development of vocational education and skills support for nanotechnology applications and processes.
- **Secondary education:** Support for the secondary education curriculum (St Helena College's SHINE), and leverage of this into other Australian and international markets.
- **Tertiary education:** Coordination of the existing nanotechnology degrees into a coherent framework with established degree curricula, to maximise the output of nanotechnology-aware and capable graduates.
- **TAFE sector:** Through Victoria's strong TAFE system, the State will place particular focus on the practical skills to support nanomanufacturing.
- **Public awareness and understanding:** Recognising their importance in understanding and decision-making, the Government will support activities to engage and involve the community and stakeholders in nanotechnology.

The St Helena Innovation in Nanotechnology Education (SHINE) program is a 'learn-by-example' curriculum designed by visionary teachers such as Francesca Calati for Australian schools.

The manufacture of micro-nanotechnology devices and materials requires advanced facilities and a high level of professional technical skills.

4. Responsible Development

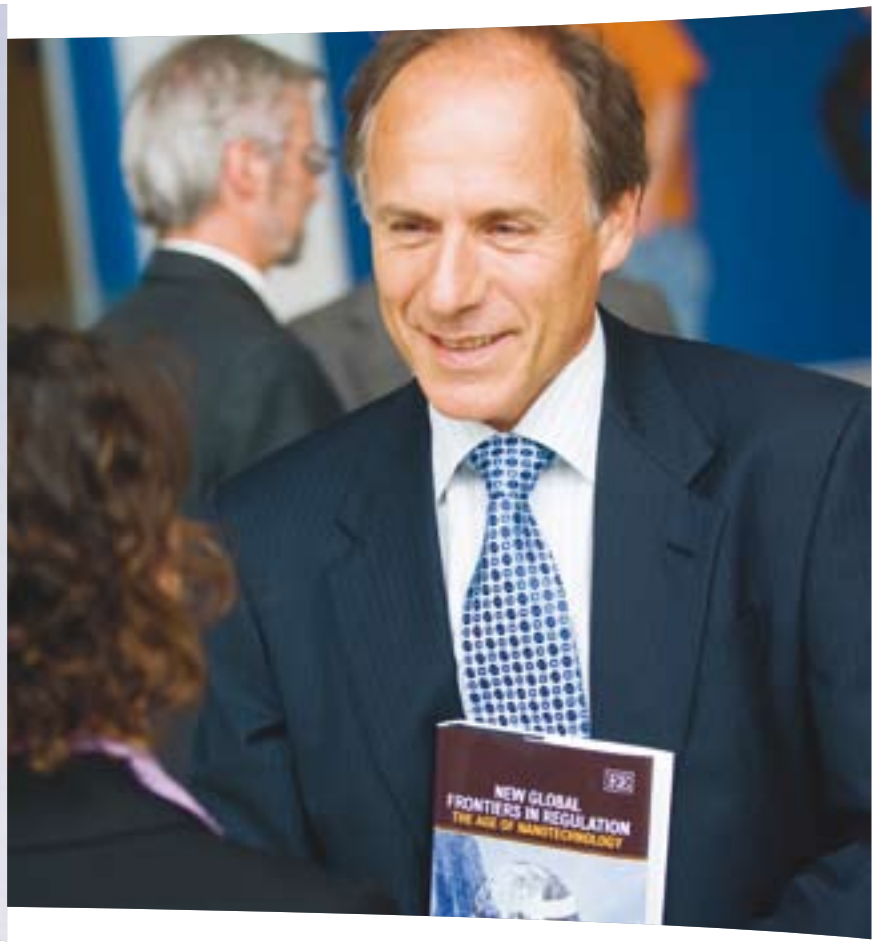
The success of nanotechnology-based industrial growth is critically dependent upon a regulatory and oversight framework which is cognisant of health, safety and environmental issues. Victoria has a unique opportunity to address these issues.

Areas of focus for the Government include:

- **National regulation:** Collaboration with the Federal Government and all other States in the development and introduction of a regulatory framework which protects workers, customers, the community and the environment from any potential dangers from nanomaterials, and therefore encourages investment and product development by companies and industries.
- **Industry self-regulation:** To complement the formal regulatory framework, encouragement of the establishment of industry-designed and led protocols for responsible management of nanotechnologies. The existing employee representative and community advocacy groups will play a vital role in these protocols.
- **Supporting infrastructure:** Effective regulation requires measurement and monitoring equipment, standards, and processes. Victoria hosts Australia's leading characterisation facilities. These will be utilised to ensure the establishment of appropriate parameters and monitor compliance in all aspects of nanotechnology development and commercialisation.
- **Public participation:** The Victorian Government will support activities that address social and ethical issues through balanced and factual information and seek involvement through dialogue that allows the community to make informed choices and encourages business investment.

Safety labels designed by Young Achievement Australia team QYANTEK.

Dr Alan Finkel, Chancellor of Monash University, launches a seminal Victorian book on Nanotechnoly regulations – January 2008.



5. Building Platforms for the Future

Victoria has superb scientific infrastructure and research capabilities. The Government will protect and enhance these capabilities, but will shift emphasis from new investment to capturing the benefits of recent spending, by working to make them more accessible to industry. In nanotechnology, priority will be given to stimulating collaboration within and between institutions and across disciplines, and developing robust linkages with industry.

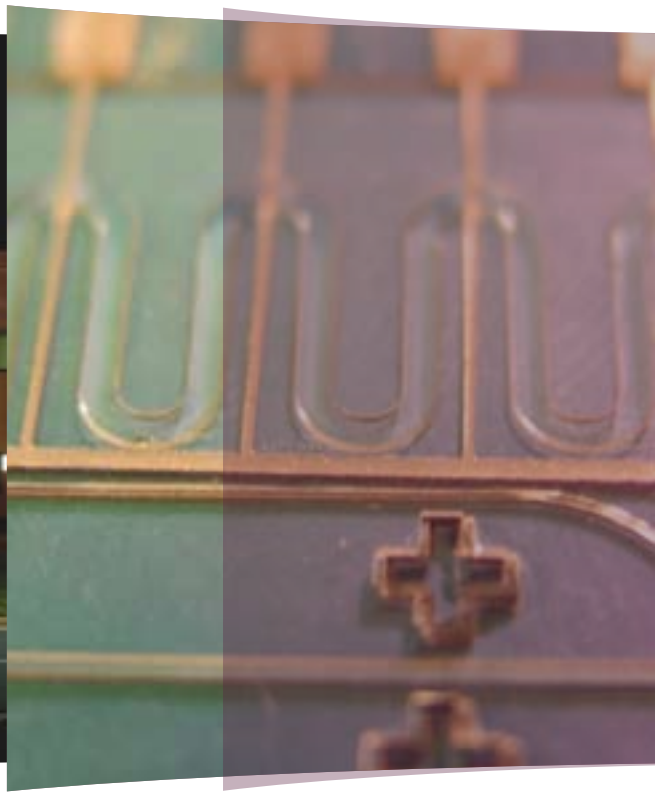
The Government recognises that publicly-funded R&D activity does not directly support current commercial development. The role of publicly-funded R&D is to provide platforms and to 'keep the pipeline full' for future industry growth and new generations of highly skilled people, through new understanding of fundamental nanoscience.

Areas of focus include:

- **Investment in R&D:** The Victorian Government is already a major supporter of nanotechnology R&D, particularly in universities, independent medical research institutes and CRCs. It will maintain this support, and protect the ability of universities to conduct basic research.
- **Infrastructure:** Some applications of nanotechnology require access to unique characterisation and fabrication infrastructure. The Victorian Government will seek to capture the benefits of its investment in facilities such as the Australian Synchrotron, the Monash Centre for Electron Microscopy and the Melbourne Centre for NanoFabrication, by encouraging open access, multiple use, and utilisation by industry as well as academia.
- **International collaboration:** Nanotechnology research is as international as nanotechnology business, and over the last five years approximately 50 per cent of nanoscience publications in Australia involved collaboration with non-Australian institutions. The Government will continue to promote Victorian nanoscience research groups to work effectively with the best teams from around the world.
- **Translation to industry:** In attempting to reap the benefits of nanotechnology, every nation faces the challenge of translation from laboratory to the manufacturing environment. Government-supported entities such as Nanotechnology Victoria, the Small Technologies Cluster, the Victorian Centre for Advanced Materials Manufacturing and the Glass Centre of Excellence represent new models for coordinating research activity towards solutions for industry which complement the CSIRO's traditional role in this area.

The Australian Synchrotron, located in Melbourne's South-East, is a fundamental tool for the analysis and fabrication of nano-scale materials and structures.

Microfluidic channels with sensing electrodes are an integral part of lab-on-a-chip devices which are revolutionising medical diagnostics and environmental monitoring.



The Future

Victoria is well-positioned to exploit nanotechnology and ensure global competitiveness in this platform technology. By international standards, the State has a competitive base of nano and micro technology capabilities and companies. Victoria is investing significant resources in key components of the nanotechnology value chain. Widespread adoption of nanotechnology across a number of Victorian industries will become critical to maintaining international productivity, competitiveness and relevance.

This Statement provides the framework for a common vision and a coordinated approach to help to build capability in existing companies and industries, and to attract new high technology companies to Victoria, supported by its outstanding research and regulatory base. In developing new, globally competitive nanotechnology companies, Victoria will strengthen its position as an economic force in our region and continue its leadership in emerging technologies. It will also demonstrate that new technologies can develop with the support of a fully-informed and participative community.

The vision is for all Victorians to reap the economic, technological and social benefits that nanotechnology promises

Focus for Victorian Nanotechnology

Industry stimulation and development
Attraction of investment

Key Priorities

INDUSTRY UPTAKE

- Industry-research clustering
- Access to capabilities
- Small business assistance
- Information

FORGING GLOBAL CONNECTIONS

- Strategic alliances
- Inward investment
- Export
- Promotion
- International panels

SKILLS AND EDUCATION

- Industry skills
- Public awareness
- Secondary education
- Tertiary and TAFE education

RESPONSIBLE DEVELOPMENT

- National regulation
- Industry self-regulation
- Supporting infrastructure
- Public participation

BUILDING PLATFORMS FOR THE FUTURE

- R&D investment
- Infrastructure
- International collaborations
- Translation to industry

Image credits:

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Page 10: The Age.

Page 11: Dr Alan Finkel: Monash University.


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