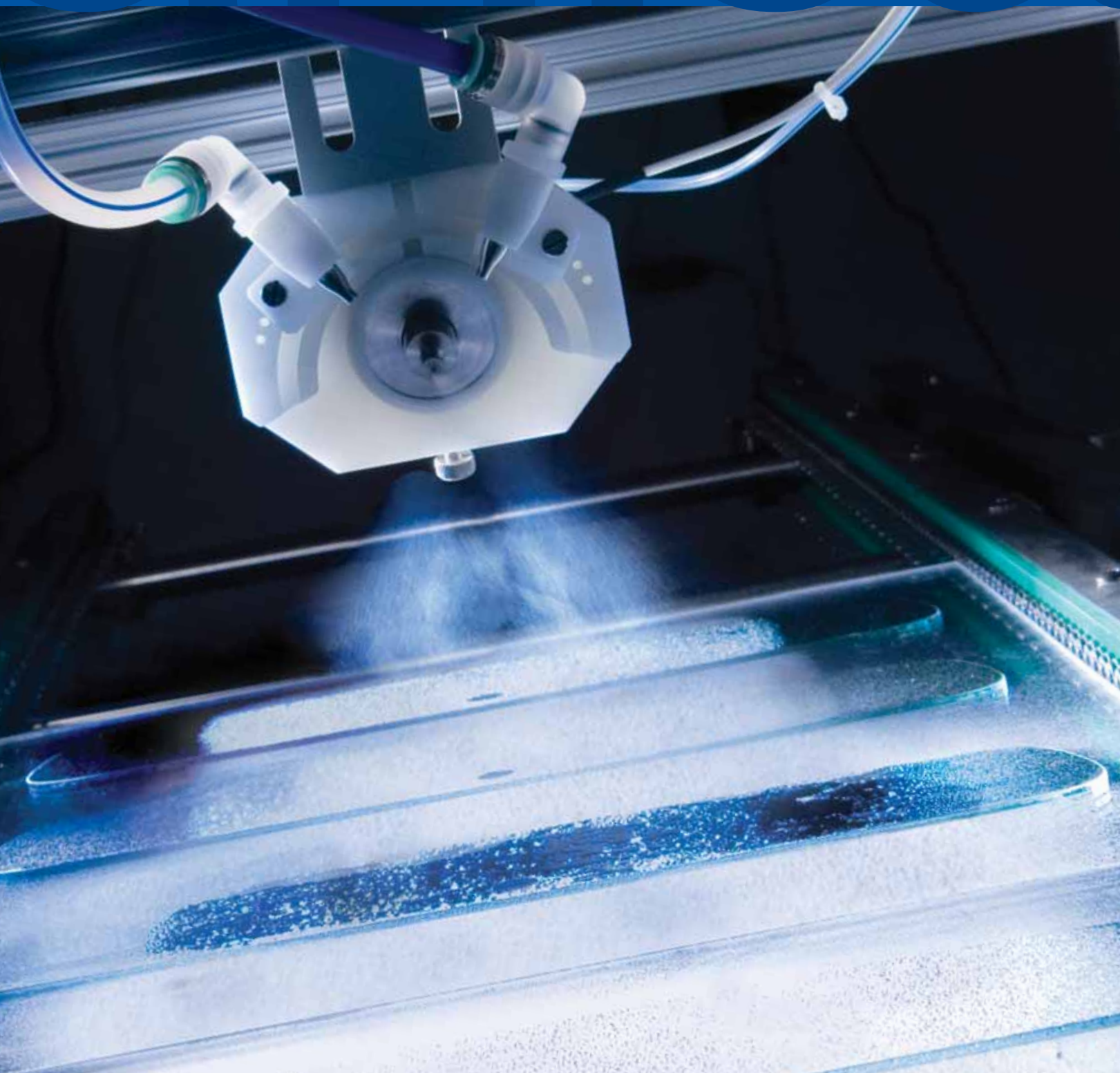
University of South Australia

Mawson Institute

Advanced manufacturing: anticipating the future.

Experience. The Difference.



This brochure focuses on the technological capability we are building at the Mawson Institute. I welcome the opportunity to acknowledge the strong financial commitment from the State Government and UniSA to help realise this for South Australia.

Welcome to the Mawson Institute.

In an increasingly complex global environment, today's manufacturer needs to stay competitive and ahead of the pack. Manufacturers must stay abreast of rapid advances in science and technology; they must keep up with environmental challenges and meet societal needs.

As our community is increasingly concerned with our natural surroundings, manufacturers need to discover new, energy and resource-saving technologies. Also, South Australians are facing a new era of social needs as our population continues to age. Industry needs to be aware of the important role which this changing demographic will have in guiding the future of manufacturing.

The South Australian Manufacturer has immense potential to be part of a larger, more sustainable and growing economy in the Asia-Pacific region. But, their success is dependent on continuous innovation, resulting in access to frontier technologies that will modernise the local manufacturing base. These achievements will be underpinned by stronger links with enquiry and research and a commitment to building the necessary infrastructure.

With the above challenges in mind, the Mawson Institute promotes a strategy based on strong basic and applied research that will encourage scientific and technological innovation for South Australian manufacturing. Fundamental to this will be the Institute's multidisciplinary approach, building research teams in concentrations that encompass a diverse range of disciplines and collaboration with a range of partners from academia, industry and knowledge-intensive SMEs.

Professor Robert Short
Director, Mawson Institute

Cover Image: Ultrasonic spray coater

Our mission.

The Mawson Institute will, through enquiry and investigation, contribute to the future of manufacturing in South Australia. By developing frontier technologies or adding functionality to existing ones, the Institute will create wealth, opportunity and social benefit.

Through the application of intelligent and sustainable solutions we will provide the foundation for South Australian manufacturers to successfully face the challenges presented by an increasingly competitive global market, both today and in the future.

The Mawson name and legacy.

The Mawson Institute takes its name from one of Australia's great explorers, Sir Douglas Mawson. He opened up new horizons for the people of his time, being driven by a spirit of enquiry to explore and understand new territories and to map a new geography.

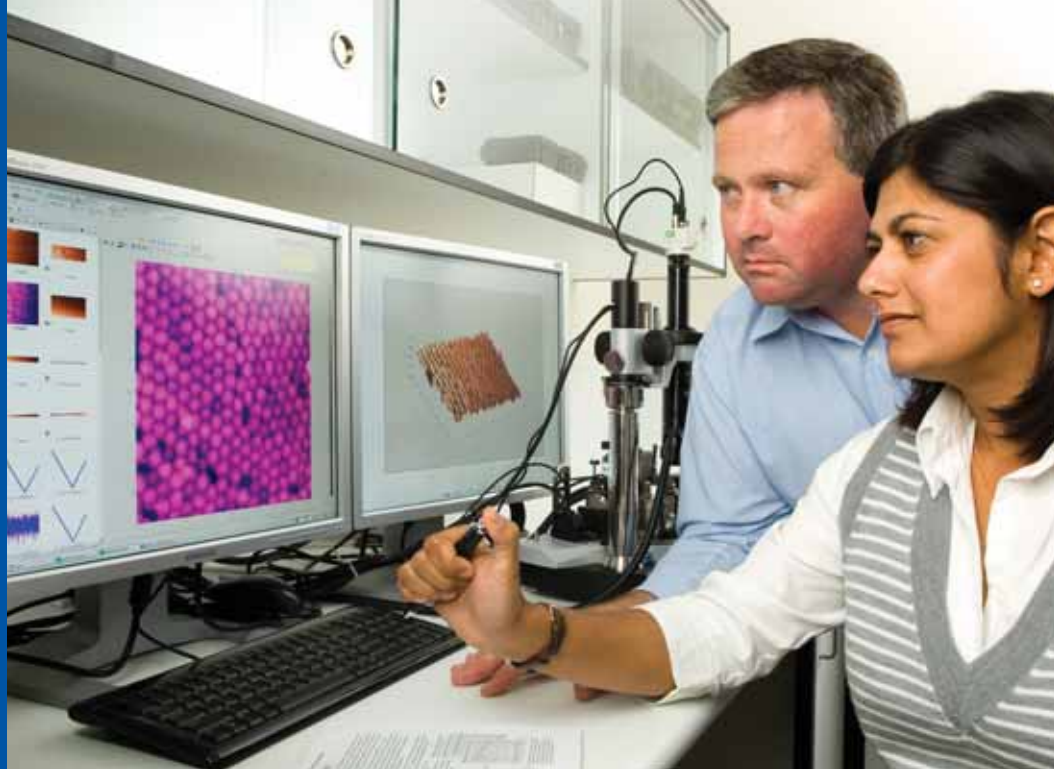
The Mawson Institute embraces these characteristics of enquiry, innovation and education. Like Sir Mawson, we are dedicated to scientific exploration. Each and every day we draw upon our breadth of knowledge as we show commitment to finding solutions for complex industry problems and achieving major developments for frontier technologies. We are leading the way - identifying and addressing future manufacturing challenges that will face our future.

Mawson's inspiration was universally acclaimed. He was knighted and honoured with awards and fellowships for his persistence and his ability to work through problems and obstacles to achieve success. The Mawson Institute aspires to these same values. We aspire to be an institute of global recognition and international accolade. We are building on decades of accomplishment of our own university researchers, partners and research teams and we have the dedication and the determination to remain at the leading-edge.

Plasma cleaning apparatus

Anticipating and addressing manufacturing challenges of the future.

Our multidisciplinary approach ensures the Institute will build capacity to address complex problems across discipline boundaries.



Our focus.

Collaborating with leading researchers in science, engineering, information technology and manufacturing, the Mawson Institute addresses opportunities and future challenges facing Australia. Our focus is on the basic science and engineering that underpins 'next generation' manufacturing, providing new technologies based upon new knowledge and innovation that can be integrated into products or processes. Scientists and engineers will work in parallel, rather than sequentially, on concept and commercialisation, significantly reducing the time and steps for new product development.

Based at UniSA's Mawson Lakes campus, the Mawson Institute is currently building state-of-the-art laboratories. These purpose-built facilities will support the innovation cycle from conception to creation, meeting the research and development needs of advanced manufacturers, and showcasing our ability to create and utilise new technologies.

Staff members at the Mawson Institute aim for and achieve excellence in their fields of research. This core of knowledge that the University boasts will see continued improvement in developmental strategies which will in turn bolster results for the community.

Our expertise.

Our strength lies in the application of fundamental science to develop knowledge-based technologies that will increase functionality and provide intelligent solutions for tomorrow's manufacturing industry.

Rapid advances and convergence in areas such as materials science, nano-biotechnology, biomaterials and tissue engineering, sensor technology and advanced computing, leading to new products and production processes will radically change the scope of manufacturing in Australia. Through a multidisciplinary approach, the Institute will work on research questions of international significance and build capacity to address major questions across discipline boundaries. Leveraging upon local, national and international business and industry networks, the Institute will engage with the whole lifecycle of manufacturing, from enquiry to concept, right through to commercialisation.

Core research concentrations.

Surface Engineering Technologies.

The global value of surface engineering is estimated to be a staggering A$12500bn per annum, with surface-engineered coatings applied to products with a (combined) value in excess of A$50000bn per annum. Surface engineering achieves a number of objectives; it broadens the breadth of applications for many materials, enhances performance and increases the value of commodity materials. It is relevant to all types of materials and products and is particularly important in Advanced Manufacturing, where the emphasis is on process or product innovation. The next generation of surface-engineered products include lab-on-chip devices, where an entire chemical plant can be scaled-down to a laboratory bench, or the next generation of electronics, fabricated on polymers rather than in silicon.

The Mawson Institute in partnership with the Ian Wark Research Institute (The Wark™) is developing the next generation of surface engineering technologies.

Nanomanufacturing.

In the future, nanotechnology will provide significant socio-economic benefits across all major sectors. Support for new cancer treatments, novel concepts for solar energy and photocatalytic systems, the re-designing of manufacturing processes, and much wider use of recyclable concepts will all be available with the help of nanotechnolgy.

An important aspect of the broader implementation of nanotechnology is the development of approaches and techniques for the sustainable manufacturing of nanomaterials and nanostructured surfaces.

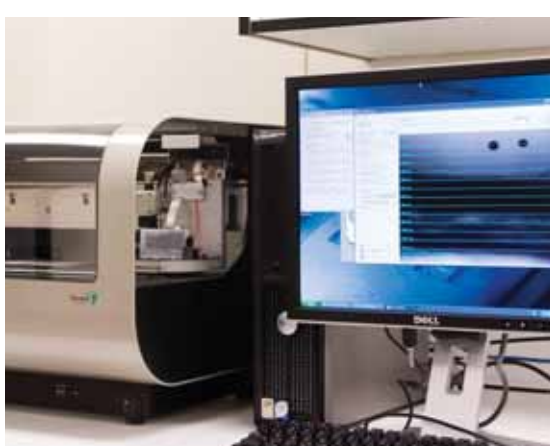
Nanomanufacturing will focus on the design, engineering, and commercialisation of specific devices and tools, such as microfluidic devices as well as the manufacturing of nanomaterials. This bilateral approach will deliver expertise and outcomes in the two areas of know-how in the design, engineering and manufacturing of specific state-of-the-art devices and expertise in the actual manufacturing of nanomaterials using these devices.

This concept will provide significant opportunities for SA's advanced manufacturing industry base for participation in the world-wide advancing nanotechnology market.

Visualisation and Virtual Design.

Sensing technologies, relevant in many areas of science, have a particular scope in the manufacturing, environmental and healthcare fields. The Mawson Institute will focus on the development and novel uses of sensing and monitoring technologies, especially those associated with the manufacturing process and more broadly, an ageing population.

Increasingly, competitive advantage is being derived from the use of advanced computing in product and process design. At the Mawson Institute we are developing capability and capacity in advanced computing technologies to solve very complex, highly interdependent manufacturing problems (model-based reasoning), to reduce the number of prototyping steps (augmented reality) or to model human interaction with products (motion capture technologies).



Research showcase.

Industry and innovation go hand in hand and at the Mawson Institute researchers are using their skills and knowledge to anticipate the future. Designs and ideas which would have seemed far fetched just a few years ago, are now being used to break new ground in a variety of fields. The following case studies are just a snapshot of the outstanding work that is being achieved at the Mawson Institute.

Concept illustration of the augmented reality visualisation laboratory

Bridging the gap between reality and virtual reality.

Automotive manufacturers are increasingly using virtual engineering to replace physical prototypes. Yet companies also have an extensive platform and component re-use strategy going from program to program. Augmented reality helps to marry these two systems, allowing a smoother operation overall.

Augmented reality enables users to show virtual data in the physical context. It is a powerful concept that will shape profoundly the automotive product development of the future. The Mawson Institute is constructing a revolutionarily new visualisation virtual environment to support a wide range of augmented reality visualisation tasks for manufacturing.

Imagine viewing a car, and instantly the colour of the paint changes or a spoiler is virtually added. Real-time wind flow simulation data is projected over an existing or partially complete vehicle. Professor Thomas and his team at the Wearable Computer Laboratory have been developing world leading augmented reality visualisation and user interface technologies for more than a decade. This new augmented reality visualisation laboratory will be the largest special purposed built laboratory in the world. The laboratory houses forty sets of projectors and computers with mounting systems, and supports up to six people working simultaneously.

Proceed to your nearest exit.

The way people enter and exit cars may soon change. In conjunction with GM Holden and SomaDynamics, the Mawson Institute is developing a new CAD tool that will enable the design of cars to improve ingress and egress, and help members of our community who are mobility impaired.

In the first stage of this project, sophisticated motion capture is being used to study Australians of typical age, shape and gender getting in and out of motor vehicles. This information, once input into CAD simulation tools, will help designers alter car cabins to better accommodation the human form. This approach replaces the need to build costly seating bucks, which often involves several generations across a single model design. This project is being conducted under the auspices of the AutoCRC (Cooperative Research Centre for Advanced Automotive Technology.)

Clean water with nanotechnology.

According to researchers from the International Journal of Nanotechnology, tiny particles of pure silica, coated with an active material, could be used to remove toxic chemicals, bacteria, viruses, and other hazardous materials from water much more effectively and at lower cost than conventional water purification methods.

The availability of drinking quality water is fast becoming an international major socio-economic issue. Current water purification methods are often complicated, requiring sophisticated equipment. They are also expensive to run and maintain and often require a final costly disinfection stage. Researchers at the Mawson Institute and The Wark™ believe nanotechnology offers a simple answer to the problem.

UniSA researchers have investigated how silica particles can be easily coated with a nanometer-thin layer of active material based on a hydrocarbon with a silicon-containing anchor. The coating is formed through a chemical self-assembly process, and involves nothing more than stirring the ingredients to make the active particles.

These active particles, Surface Engineered Silica (SES), have been tested to demonstrate that they could remove biological molecules, pathogens such as viruses like the Polio virus, bacteria like *E-Coli*, and *Cryptosporidium Parvum*, a waterborne parasite. Results show that organic species can efficiently be removed at pH ranges of drinking water by stirring the coated particles in the contaminated water for up to one hour and filtering the powder.

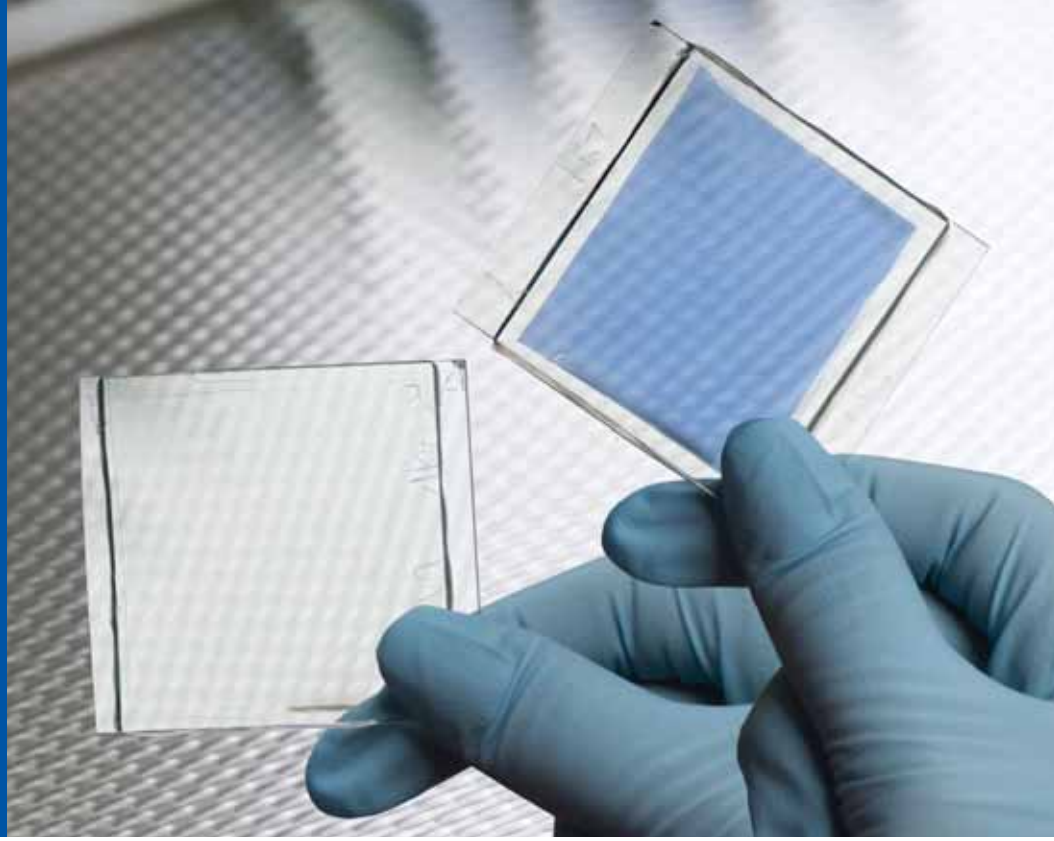
The recent report entitled 'Water for People - Water for Life' from the World Water Assessment Program of UNESCO says that more than 6,000 people die every day due to water-related diseases, including diarrhoea, worm infections, and infectious diseases. Additionally, organic pollutants from industrial waste water from pulp and paper mills, textiles and leather factories, steel foundries, and petrochemicals refineries, are a major cause of illness in parts of the world where regulations do not necessarily protect people from such industrial outflows. Our researchers' nanotech approach to water purification could help prevent disease and poisoning for potentially millions of people.

Seeing clearly with Cell Therapy.

The 21st century has brought with it significant challenges, and here in South Australia, as our population continues to age, there are specific health areas which will need to be considered. The Mawson Institute aims to address these difficulties through novel manufactured materials and novel applications of materials.

The cornea, the eyes window on the world, plays a vital role in ocular function by allowing passage of light through a transparent surface. Maintenance of corneal clarity and vision is dependent upon the integrity of the corneal surface which, when damaged through injury or disease, can lead to blindness. Plasma polymer coatings are films produced from organic compounds which can be used to provide surfaces for specific types of cells. By applying this technology to coat contact lenses we have the potential to restore vision by transplanting a new corneal surface grown in the laboratory from the patients own cells. The coating technology was first developed by Professor Short *et al* for resurfacing skin after trauma such as burns or scalds and subsequently used in the treatment of chronic wounds. Now, in an international collaboration involving the Mawson Institute, this technology is being developed for use in a number of eye conditions such as ocular trauma and age related macular degeneration, a disorder of the retina, which is the single largest cause of blindness in people aged over 65.

This project will create a unique facility within South Australia to investigate advanced manufacturing methods for the development of electrochromic technologies.



Change in optical contrast in an electrochromic cell utilising conducting polymers.

A new pathway to electrochromic materials.

Electrochromic materials are able to alter their optical characteristics to switch between either a dark or clear state. The transition can be stopped at any point, creating the potential for applications requiring a variable tint, such as architectural glass, aircraft windows, sunglass lenses and automotive windows. Working with our industry based collaborative partners at Visiocorp and Carl Zeiss Vision, the Mawson Institute will develop several of these applications. The materials research and engineering facility aids us to develop and demonstrate methods of technology scale-up, a vital step in demonstrating the robustness of the technology to potential industry partners.

This project will create a unique facility within South Australia to investigate advanced manufacturing methods for the development of electrochromic technologies.

The project is a joint partnership between The Wark™ and the Mawson Institute, and aims to create a unique relationship whereby UniSA can investigate and demonstrate technology scale-up methodologies.

Benefits to South Australia arising from this project will include:

- The development of Intellectual property that is South Australian owned (two PCT patent applications have already been filed and more will follow).
- The potential for local investment in new manufacturing facilities to produce high value added product.
- The possibility of manufacturing high technology product in local facilities for world-wide export.
- Establishment of a show case facility within UniSA for attracting new industry and academic partners both nationally and internationally.

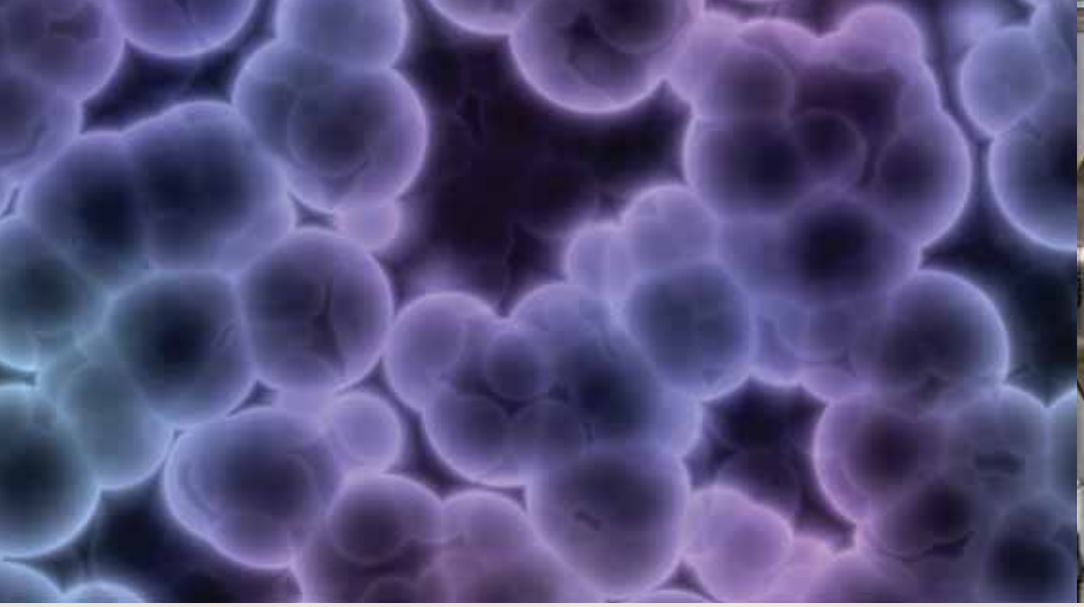


Photo courtesy of the University of Liverpool

A better solution using nanoengineering.

Thanks to research at the Mawson Institute, nanocavities, nanocontainers and nanoreactors offer better solutions for a range of medical situations including drug delivery and catalysis.

At the Mawson Institute, plasma deposition has been used in the fabrication of nanostructures within ultra-thin films, which can be applied a wide range of materials and products.

Template-assisted fabrication of nanocavities has been achieved within plasma polymer films with thicknesses of <100 nm. Gold nanoparticles are used as a sacrificial template. The advantage of using gold nanoparticles is ease of synthesis, control over desired size and size distribution. Gold nanoparticles are incorporated within plasma polymer films and then dissolved, forming empty cavities. These cavities can be filled with drugs for drug delivery applications.

Replacing the gold with silver produces surfaces that resist bacteria adsorption, and kill bacteria. These show excellent antiseptic efficiency. This is important in biomedical applications since the amount of silver should be just sufficient to kill small prokaryotic bacteria cells but not the bigger mammalian eukaryotic cells.

A new tool for material processing.

The Mawson Institute, in collaboration with the Universities of Illinois and Liverpool is working on a $1.3M project, with a further $1M of support from the State Government, to develop and perfect the use of mirco-plasma discharge fabrication in silicon for material processing.

Plasma is a key surface modification technology, but has to date, been restricted in utility to providing uniform (homogeously) modified surfaces. Local, non-uniform treatments can be achieved but only through multi-step, sequential masking processes, which are both time-consuming and costly. Development in this area is a “hot” topic at the moment as the scaling-down of plasma discharges to the micron scale could provide a new, high-throughput platform technology for parallel surface modification. The project will see plasma sources scaled-down from 300 microns to 10 microns.

This three-year project is funded in Australia by the Department of Education, Science and Training and by research councils in the US and UK. The aim is to develop a platform technology applicable across a wide range of industrial sectors.

The Mawson Institute collaborates with a number of local and international partners on a range of research and commercial projects.

Working with one of our collaborative partners, Visiocorp.

Engage with us.

Providing world-class research and education, the Mawson Institute will support the South Australian manufacturing industry into the future. Reflecting our importance to the State, initial funding comprises an $8M grant from our major partner the State Government with a $6M co-investment from UniSA.

Importantly the formation of the Mawson Institute strengthens existing relationships with the State's manufacturing base, and provides new opportunities to collaborate with the expanding health and resource sectors.

Our major collaborative partners include:

Austofix
Becton Dickinson and Co, USA
Bernard O'Brien Institute of Microsurgery™
BioInnovation SA
Celltran Ltd, UK
Centre for Eye Research Australia
Cooperative Research Centre for Advanced Automotive Technology (AutoCRC)
Cranfield University, UK
Department of Innovation, Industry, Science and Research
Dynek Ltd
Electronics Industry Association
Flinders University
GM Holden Ltd
LV Prasad Eye Institute, India
Medical Device Partnering Programme
Research Laboratories of Australia
Soma Dynamics
South Australian State Government
South Australian Water Quality Centre
United Water International
University of Illinois, USA
University of Liverpool, UK
University of Manchester, UK
University of Wollongong
Visiocorp
Women's and Children's Hospital, Adelaide

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"The Mawson Institute is being funded by the SA Government to build the State's research infrastructure and capacity in key industry sectors. This investment is in research and innovation. The Mawson Institute will showcase as a national and global leader in manufacturing research with a focus on adaptable technology and sustainability."

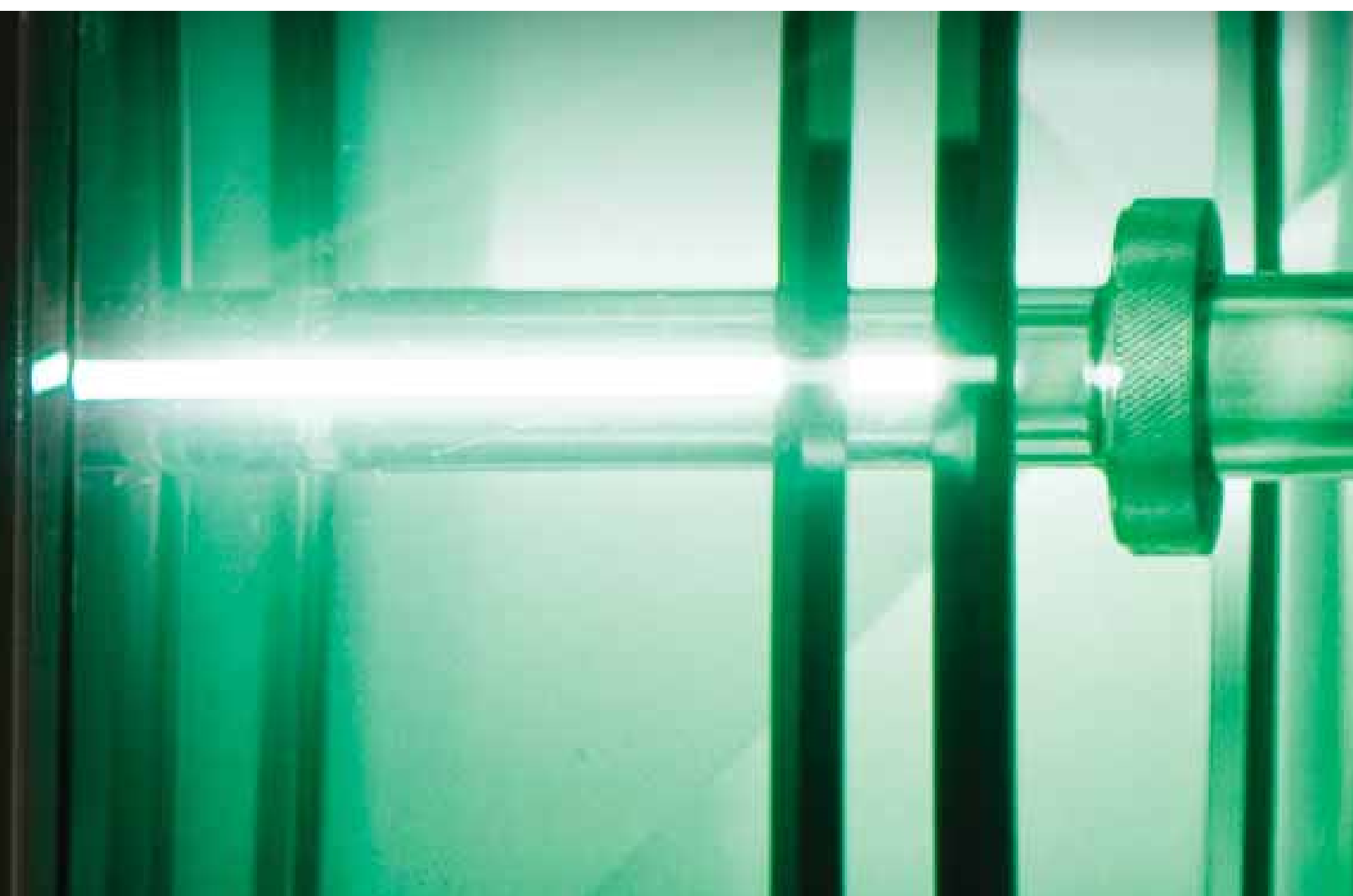
Department of Further Education, Employment, Science and Technology

"The Mawson Institute is playing a critical role in enabling Visiocorp to plan strategically for its future by developing innovative technology and processing methodologies that will be used, in the near future, to establish a pilot manufacturing facility in South Australia."

James Nicholson,
Director of Engineering,
Visiocorp, Australia

"The Mawson Institute has been instrumental in forging new partnerships with the automotive industry in South Australia. Under the auspices of the AutoCRC, exciting breakthroughs have been made in the area of motion capture and the way in which future vehicles will be designed to allow for easier ingress and egress for an increasingly ageing population."

Dr Matthew Cuthbertson,
CEO, AutoCRC



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