Joining the polymer research community through further studies

Jatin Kumar had always been interested in research but it wasn't until his final year of undergraduate studies that he realised the need to undertake postgraduate studies in order to best position himself for a career in process engineering. The combination of an interesting research project and an attractive scholarship from the CRC for Polymers convinced him to undertake a PhD at UNSW. His research is focused on the synthesis of polymers with complex architectures and functionalities. Using controlled free radical and polymer conjugation techniques, he is synthesising star, comb and glycosylated polymers as well as polymeric micelles, all of which may have potential for biomedical applications. About doing a PhD sponsored by the CRC-P, Jatin says "The CRC-P ensures that their PhD students are well looked after in order for them to get the most out of their postgraduate experience. Members of the CRC-P are experts in almost every facet of polymer science and engineering. The CRC-P has strived to create a polymer community within Australia by bringing together these experts from academia as well as industry. The resultant holistic and well resourced experience has meant that I have had opportunities to interact with this community, enriching my education in the field of polymer science beyond that of my peers who do not have the benefit of an association with a CRC."

Mr Jatin Kumar

Gaining further skills by undertaking a higher degree

Before starting her PhD, Fran Ercole worked in industry and CSIRO for over 10 years. Fran commenced her PhD funded by the CRC for Polymers, in association with the Centre for Advanced Macromolecular Design (UNSW), in August 2007. She is investigating the behaviour of photochromic-polymer conjugates which find application in UV-protecting lenses and photo-responsive materials. Fran says "I like my project because it has given me the chance to further develop both my chemistry and polymer skills. There is always something new to learn and different applications to consider. Being a student with the CRC-P has provided a connection to industry, many opportunities to liaise with experienced scientists, and I have access to a broad range of training. By conducting most of my work at CSIRO, which has great facilities, and with ample trips to UNSW, I have an even greater access to expertise and resources. I appreciate that the CRC-P has made this possible for me."

Ms Fran Ercole

Cooperative Research Centre for
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News from the CRC for Polymers
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The impact of declining rainfall: Upper Coliban Reservoir in 2002 (left) and in 2007.

Welcome

"Researchers with the CRC-P and based at the University of Melbourne have developed new science, resulting in a major advance in chemical technology for suppressing evaporation."

in this issue

- Polymer solution to photochromic dye switching problem
- Development of new evaporation suppression technology
- Gaining further skills

CRC AUSTRALIA

Established and supported under the Australian Government's Cooperative Research Centres Program

Evaporation suppression research enters demonstration phase

Three years of laboratory research conducted at the CRC for Polymers (CRC-P) has resulted in a new technology for suppressing evaporation. The CRC-P has now commenced a new phase of the project that will accelerate the translation of this technology through the development and demonstration stages, so that the resulting evaporation reduction system can assist Victoria by preserving its declining reserves of stored water. Annually evaporation from storages results in losses of more than 880 GL of water, which is greater than 15% of the State's water consumption.

Evaporation reduction using the new technology is achieved by the controlled application, monitoring and maintenance of non-toxic chemicals that form a thin surface layer which restricts transfer of water to the air, while still allowing oxygen transfer. The laboratory performance of the evaporation suppressant substantially exceeds that of the commercially available products of this type.

Researchers with the CRC-P and based at the University of Melbourne have developed new science, resulting in a major advance in chemical technology for suppressing evaporation (see article on page 3). Laboratory results have shown a major improvement in evaporation reduction, considerably improved wind resistance and the need for less frequent application compared to current alternatives.

These exciting findings encouraged the CRC-P to assemble a collaborative team to enable the new technology to be developed and commercialised. The assembled entities each contribute particular strengths to the project:

- The University of Melbourne team will be refining the chemistry formulation and working on the additional performance features that are desirable in the final application.

- Orica Australia will be taking the product from the laboratory bench to commercial production, as well as managing the toxicity and environmental testing and registration.

- Coliban Water will provide the perfect facilities to trial and test the new product in the field.

Orica's existing sales and distribution network, that already provides a range of water treatment chemicals to Water Authorities and other water users, is the ideal for taking the product to market.

Polymer solution to photochromic dye switching problem

Dr Richard Evans (centre) and Dr Nino Malic (right) at CSIRO with CRC-P student Fran Ercole (left) and Advanced Polymerik CEO, Kirsty Cleland, in the background.

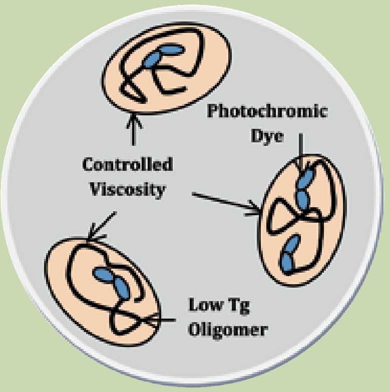
One in ten spectacle wearers choose photochromic lenses. Many find that they are walking around in the dark for too long when they come indoors – this arises because the photochromic dyes switch comparatively slowly from dark to clear states, as the molecular movements accompanying that colour change are retarded by the rigid polymer matrix of the lens.

When Dr Richard Evans, a member of the CRC-P and based at CSIRO, considered this problem he embarked on a decade of polymer research that provided elegant science, a practical solution, a family of six patents, and a series of high impact papers including one in Nature Materials. Richard notes, "We took a new approach to solving the problem. The traditional approach is to make the lens matrix softer, which compromises other important properties of the lens. We provided the dye with its own mobile environment by using polymer chemistry, and have demonstrated that the properties of the attached tail can provide an array of new opportunities for tailoring switching speeds."

Richard has collaborated with several other CRC-P researchers and two PhD students on this research, but his longest-term collaborator has been Dr Nino Malic who is also at CSIRO. Nino's most recent research has led to technology for harmonising the switching speeds of combinations of dyes. He explains, "The desired lens colour typically requires use of a combination of dyes, each with a different colour and switching speed. The result can be an unappealing cascade of different colours, known as colour shift, as the lens fades. We now have a polymer science-derived solution for synchronising switching speeds."

The high-speed switching technology is owned by Advanced Polymerik, a spin-off company from the CRC for Polymers. CEO Kirsty Cleland explains, "The technologies developed by Richard and his team provide the opportunity to re-set the industry standard in fade speed and have the potential to revolutionise the photochromic lens market. Companies in the industry recognise this as a major advance and we are in discussions with several parties interested in implementing this new technology in their product ranges."

How the photochromic dye technology works



The patented technology enables high-speed switching of photochromic dyes in a hard polymer matrix, such as a lens. The technology is based on the covalent attachment of a flexible short-chain polymer (oligomer) "tail", which has a low glass transition temperature (Tg), to an organic photochromic dye. The polymer forms a fluid microenvironment around the dye without changing the dye's electronic structure. The lubricating microenvironment aids conformational change between the clear and coloured forms of the dye to achieve solution-like switching speeds, even when the photochromic is located in a hard matrix. Using this technology the lenses become darker faster and fade times can be reduced by up to 95%.

Development of new evaporation suppression technology

A CRC-P project team, based at the University of Melbourne and led by Professor David Solomon, has developed radical new technology for employing benign chemicals to provide a surface barrier to the loss of water to air through evaporation. The project team also includes Dr Emma Prime, who has managed the project, and Professor Greg Qiao and Dr Devi Sunartio who also have made major contributions.

Professor Solomon reflects, "I undertook the project because of my desire to use science to address the Nation's emerging issue of climate change and declining reserves of water," paralleling his leadership of a project in CSIRO in the 1970s that developed the world's first plastic banknote at a time of national concern about counterfeit currency.

Dr Prime was attracted to the project because, "It provided the opportunity to find a solution to a major national problem and the chance to see the science that I helped develop through to a product that could be widely used to benefit society." She and Professor Solomon jointly arrived at the breakthrough inventive concept for the new generation of evaporation suppressants and she conducted the critical experiments that demonstrated the new class of suppressants had considerably superior performance compared to existing products.

Professor Solomon notes, "I came to undertake both the evaporation suppressant challenge and the banknote development without expertise specific to either application, but in both cases the application of a sound scientific approach, an acquired understanding of the relevant science, and a questioning mind were common elements in finding practical solutions."

He reflects that, "The development of this new evaporation suppressant technology would not have occurred without the CRC Program. The project commenced when three CRCs (Polymers, Irrigation Futures, and Cotton Catchment Communities) provided the first round of funding. The CRC for Polymers then provided a second round of funding for a two year period, and has now attracted additional funding for the demonstration phase of the development."

Professor David Solomon.

Drs Devi Sunartio (left) and Emma Prime.

The CRC-P has a strong track record which has seen the Centre develop and licence nine technologies to its participants in the past seven years. The Centre's CEO, Dr Ian Dagley, notes, "A key element of our successful approach to achieving commercial outcomes is to work closely with companies and end users, and that is why the involvement of Orica Chemical and Coliban Water in the next phase of the project is so important. Another critical aspect is being able to work with, and adequately resource, some of our country's most outstanding scientists and their dedicated teams of early career researchers, providing them with the opportunity and time to generate truly breakthrough technologies."

He praised the CRC Program "for providing a source of long-term funding that allowed the time required to develop and refine concepts until a major advance on a problem of national significance was achieved".