



Cooperative Research Centre for

**Polymers**

Solutions for a better world

# polymernews

News from the CRC for Polymers

August 2009

## Welcome

*"The design of successful and durable polymer products needs optimisation at all scales from nano to micro to macroscopic."*

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## Benefits of polymers delivered through advanced design and engineering

Polymers are increasingly the materials of choice for manufacturing products because of their light weight (low density), relatively low cost, ease of processing and diverse range of end-use properties. The design of polymer components has been enhanced by computer aided engineering analysis, and increasingly includes consideration of the environmental, social and economic impacts of the product, as approximately 70% of these factors are locked in at the design phase.

The Cooperative Research Centre for Polymers (CRC-P) has a research program on *Design and Engineering* which will lead to new or substantially improved products. This program is featured in this issue of *Polymer News* and consists of two projects. One project is developing computer modelling software that allows better design of moulded components by relating composition and processing conditions to end-use properties. A second project is developing the polymer science and

engineering expertise needed to make high performance membranes which will be more efficient and less prone to fouling than conventional membranes.

The program is led by Professor Robert Burford, Head of the School of Chemical Sciences and Engineering at the University of New South Wales. His focus is on innovative structural and functional materials for diverse applications, and his research interests include polymer membranes, inorganic-organic hybrids and the characterisation of crystallisable polymers using small angle x-ray and neutron scattering. Professor Burford says "The design of successful and durable polymer products needs optimisation at all scales from nano- to micro- to macroscopic. The CRC-P's research touches on these aspects." Professor Burford was a Project Leader in an earlier CRC-P project that developed ceramifying polymer technology which is now used in the production of fire performance cables.



Professor Robert Burford, UNSW, Program Leader of the CRC-P's *Design and Engineering* research program

# Predicting the mechanical properties of an injection moulded product

Commercially available software is used by designers of injection moulded components to optimise mould designs, so that the moulds fill efficiently and meet dimensional specifications; however, it is not always possible to use software to accurately predict the mechanical properties and final shape of the resulting moulded component. This is due to the properties being a complex function of the polymer type, processing conditions and the effect of additives. The ability to predict mechanical properties would provide many advantages including potentially using less polymer raw material (by eliminating over engineering), reduction of the need to redesign moulds (which is expensive) and elimination of problems such as post moulding warpage.

The CRC-P is conducting a project on the *Prediction of the properties of processed polymers* which aims to meet this industry need by extending the range of polymers for which mechanical properties can be predicted. While the properties of fibre filled polymers can be estimated through prediction of fibre orientation distributions, the prediction of mechanical properties for unfilled semi-crystalline materials requires a deeper understanding of the crystalline microstructure which results after processing. The project is being conducted in two parts: the relationships between processing and microstructure, and between microstructure and properties.



Professor Roger Tanner, University of Sydney

The research required to forecast the relationship between moulding conditions and the resulting component microstructure is being carried out at the University of Sydney by a team led by Professor Roger Tanner. Professor Tanner, a Fellow of the Royal Society, has been researching this topic for over ten years. He says "This project was initiated by Moldflow (now part of Autodesk) and incorporates many aspects of my past research endeavours, I am fascinated

with working towards solving a practical problem in the plastics industry." Being able to predict mechanical properties of plastic components prior to manufacture has been an elusive goal for injection moulding. "The CRC-P, and the longevity of its research projects, has played an extremely important role as this is a challenging problem which has necessitated continuity of research over a number of years" reports Professor Tanner.

In conjunction with the work being undertaken in Sydney, the research to characterise the microstructures of moulded polymers and relate these microstructures to the resulting mechanical properties is being carried out by a team led by Associate Professor Graham Edward at Monash University. The group is focused on how polymer morphology changes with the use of common additives such as colorants. It has developed an understanding of how various pigments affect the eventual mechanical properties of injected moulded parts. Associate Professor Edward says "The potential impact of this research is the development of a world-leading computer program which would give competitive advantage to injection moulding companies." The group has depended on the use of synchrotrons - initially in Japan and now in Melbourne. Associate Professor Edward states "The synchrotron has been our major tool for understanding the morphology of moulded polymers. It gives us the necessary fineness of spatial resolution required to analyse cross sections of polymer. Having access to the synchrotron in Melbourne has enormously benefited the group, saving time and the expense previously required to travel overseas".

This project has also demonstrated the additional PhD training advantages accessible within a CRC. PhD students have the opportunity to work alongside an industry partner, gaining insight into real-life industrial challenges, whilst extending their network of contacts. The CRC-P has also hosted numerous training opportunities for its students such as its annual Polymer Summer School, now in its tenth year, and workshops on science-related topics such as commercialisation and intellectual property.



CRC-P post graduate student, Andrew Phillips, and Associate Prof. Graham Edward, both from Monash University at a Synchrotron research facility



Professor Vicki Chen, UNSW

## Engineering membranes with improved performance

and process downtime to enable cleaning. In addition, membrane lifetime and performance can be compromised with this frequent intervention. Thus membranes which resist fouling can improve both the economics and the environmental impact of membrane filtration.

The CRC-P is conducting a research project which is investigating several approaches to reduce membrane fouling. The focus of the research is to explore a variety of antifouling strategies for modifying polymeric membranes used in filtration. These include modification of the membrane to make it more resistant to the adsorption of biopolymers and development of biofilms.

Professor Vicki Chen (University of NSW) is one of the Project Leaders. She explains "Filtration using membranes is becoming the backbone of the water and waste water treatment, especially as water shortages become more acute in the many regions of the world. We are developing

technologies that will reduce localised fouling on the membrane surface and provide substantial cost-saving benefits."

In order to develop industrially useful new membranes and solve the technical challenges, it has been necessary to form a specialist team with the combination of membrane engineering, synthetic chemistry, polymer processing and understanding of physico-chemical interactions. This has been made possible via the CRC-P. Professor Chen continues "The CRC-P has allowed us to access the necessary range of expertise across these different fields around Australia and with our industrial partner."

The multidisciplinary project involves a collaboration between researchers at the University of New South Wales, CSIRO and the University of South Australia.

Polymer membranes are used for aqueous purification processes such as desalination, water recycling, and improving the quality of waste water treatment. One of the major problems encountered is membrane fouling. This leads to a loss of filtration performance, makes time- and cost-intensive cleaning steps necessary, and shortens the membrane lifespan. It is the deposition of macromolecules such as proteins and polysaccharides as well as biofilm formation which are the major causes of fouling.

Efforts to control membrane fouling frequently require increased chemical usage, energy

## Neutrons and X-rays assisting polymer research

On Friday 3 April and Friday 8 May the CRC-P, in collaboration with the RACI Polymer Division, ANSTO and the Australian Synchrotron, ran seminars on 'Learning more about polymers using neutrons and X-rays'.

The first seminar was held at the Australian Synchrotron and attracted 45 attendees who were given the opportunity to undertake a tour of the synchrotron facilities. The second seminar was held at ANSTO and attracted 38 attendees

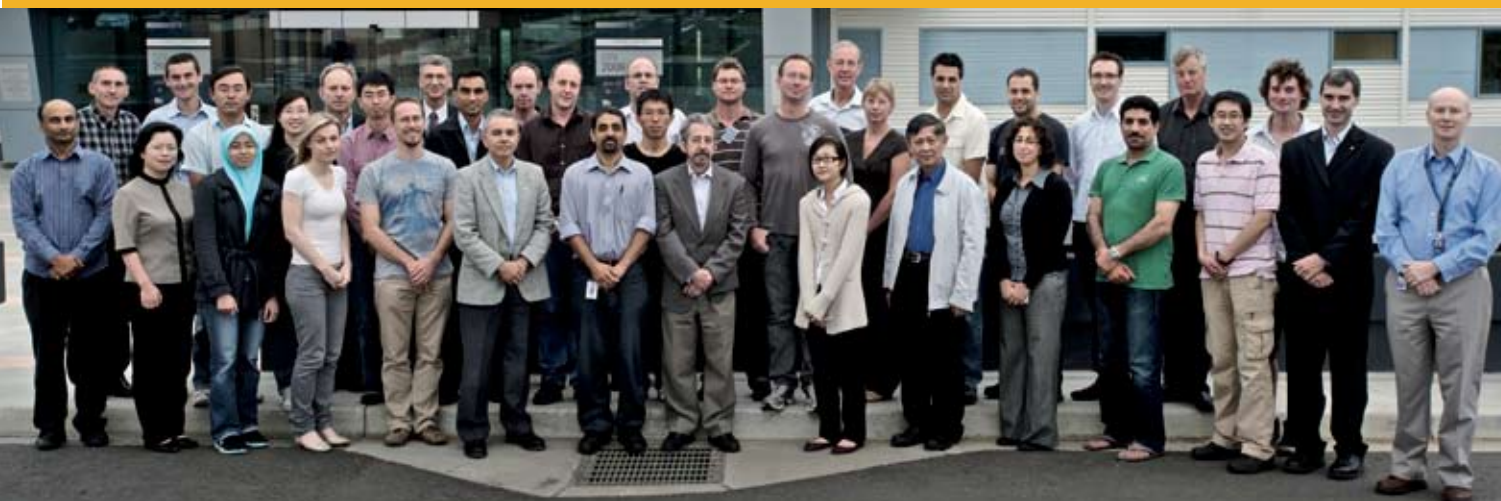
who were given the opportunity to undertake a tour of the Opal reactor.

Topics and presenters were:

- *The Australian Synchrotron*, Professor Ian Gentle (Synchrotron & ANSTO seminars),
- *Small angle scattering*, Dr David Cookson (Synchrotron seminar) and Dr Kevin Jack (ANSTO seminar),

Attendees at the seminar held at the Australian Synchrotron

- *Synchrotron x-ray imaging*, Dr Karen Siu (Synchrotron & ANSTO seminars),
- *What neutrons can tell us about polymeric systems*, Dr Bill Hamilton (Synchrotron seminar) and Dr Michael James (ANSTO seminar),
- *Vibrational spectroscopy*, A/Prof. Peter Fredricks (Synchrotron seminar),
- *Synchrotron infrared spectroscopy in the analysis of materials*, Dr Mark Tobin (ANSTO seminar).



# 11th AUSTRALASIAN POLYMER SUMMER SCHOOL 16th-19th February 2010



The RACI Polymer Division and the CRC-P are jointly sponsoring the 11th Australasian Polymer Summer School. This provides an excellent opportunity to gain an overview of important developments in polymer science and engineering from experts in their fields. Anyone interested in the topics covered is encouraged to register.

## VENUE:

Queens College, Uni Melbourne which is located at 1-17 College Crescent, Parkville, Melbourne.

Registration costs: (prices include GST)

Undergraduates	\$150
Postgraduates	\$200
Postdoctoral/Other	\$250

Visa/MasterCard preferred

The registration cost covers attendance at the summer school and all meals at Queens College. It also includes three night's student style accommodation at Queens College and bus transfer to and from Melbourne (Tullamarine) Airport for those attendees selecting these options.

- *Introduction to polymers: a chemist's perspective*, A/Prof Sébastien Perrier, Key Centre for Polymers & Colloids, University of Sydney
- *Studying polymer materials by vibrational spectroscopy: applications in synthesis, processing, modification and degradation*, A/Prof Peter Fredericks, School of Physical & Chemical Sciences, Queensland University of Technology
- *Living radical polymerization in solution*, A/Prof Michael J Monteiro, Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland
- *Synthesis, structure and property relations for branched polymers: from adhesives to food*, Professor Robert G Gilbert, Centre for Nutrition and Food Sciences, University of Queensland
- *Radical polymerization in dispersed systems*, A/Prof Per B Zetterlund, Centre for Advanced Macromolecular Design (CAMD), School of Chemical Sciences and Engineering, University of New South Wales
- *Polymer orientation: causes, characterisation and consequences*, A/Prof Graham Edward, Department of Materials Engineering, Monash University

11APSS Convenor, A/Prof Wayne Cook

Please contact Amy De Hey via email ([amy.dehey@crpc.com.au](mailto:amy.dehey@crpc.com.au)) or on 03 9518 0400 to obtain your registration form.

## Degradable packaging technology development recognised with a Chairman's Award

On 20 May 2009, Plantic Technologies entered into a license agreement with the CRC for Polymers for the commercialisation of technology for making high performance, high clarity starch-based thermoformable sheet (Plantic HP1) for packaging applications. The technology was developed in a CRC-P project *Degradable packaging materials derived from renewable*

*resources* which involves a collaboration between Plantic Technologies, CSIRO, Monash University and RMIT University.

The CRC-P has a tradition of recognising successful commercialisation of project technology through the presentation of a Chairman's Award. The following members of the project team received this award from

Dr Peter Coldrey during a recent Board meeting: Graeme Moad (Project Leader), Kishan Khemani (Project Leader), George Simon, Robert Shanks, Matthew Brooks, Antonietta Genovese, Wasantha Gunaratne, Jana Habsuda, Guoxin Li, Edmond Lascaris, Nick McCaffrey, Lance Nichols and Ann Roberts.



Some of the Chairman's Award recipients' pictured with the Chairman and CEOs from Plantic Technologies and the CRC-P



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