

# Polymer LINKS

THE QUARTERLY POLYMER IRC NEWSLETTER

## MULTI-SCALE MODELLING OF COMPOSITE MATERIAL SYSTEMS

*Multi-scale modelling of composite material systems* by Professor Costas Soutis, University of Sheffield, and Dr Peter Beaumont, University of Cambridge, summarises the key research of composites and the development of modelling techniques to predict the response of composite materials to different types of stress. With contributions from international

leaders in composite engineering, *Multi-scale modelling of composite material systems* is set to become standard reference for academics and manufacturers alike.

The book was published by Woodhead Publishing Ltd in August 2005. It can be purchased on the website for £150.

[www.woodheadpublishing.com/en/book.aspx?bookID=809](http://www.woodheadpublishing.com/en/book.aspx?bookID=809)



## THE POLYMER IRC JOINS THE BRITISH PLASTICS FEDERATION



The Polymer IRC has recently joined forces with the British Plastics Federation's (BPF) Business Support Network to further strengthen links between industry and active research groups in UK Universities. The IRC joins leading names in the field of innovation and training such as PERA, Loughborough University and Polymer

Training Limited. BPF is the UK trade association for the plastics industry, representing the whole supply chain including polymer producers, distributors, additives suppliers, machinery manufacturers, processors and recyclers.

The Business Support Network is a unique BPF Group which consists of companies working in support of the Plastics Industry. The Network aims to give executive decision-makers from the plastics industry a competitive advantage by highlighting 'best-in-

class' suppliers.

Philip Law, BPF Public and Industrial Affairs Director said: "We are delighted to welcome The Polymer IRC to the BPF's Business Support Network. Affiliations with Universities is essential for the UK Plastics Industry in order to enable continued support to those companies moving to a higher technical plane."

For more information about the BPF please visit their web-site; <http://www.bpf.co.uk/>

## CLOSER LINKS

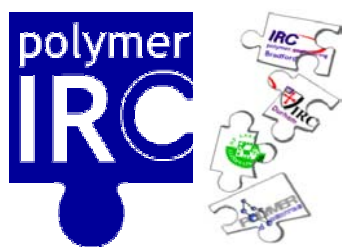
Polymer Links is now the newsletter for the whole of the Polymer IRC. This reflects the increasingly close relationship between the four Universities, Leeds, Bradford Durham and Sheffield and the Industrial Club members, involved in the collaboration. Through combining our news we hope to bring you a broad spectrum of articles from around the IRC and demonstrate the wide-ranging nature of our activities and capabilities. If you're not already familiar with the Polymer IRC it encompasses in excess of 150 scientists and technologists across the sites with interests in synthesis, processing, modelling, micro/

nanotechnology, to name but a few and interacts strongly with industry, through, the Polymer IRC Club, contract research, C.I.C.s and provision of facilities. The Polymer IRC co-operates closely with the Regional Development Agencies and the DTI and runs the high-profile "UK Polymer Showcase" meeting each September. All this provides a rich source of news and we hope that we can pass on information that is interesting and useful.

We would also like to welcome Arizona Chemical, Bayer Material Science, Procter & Gamble and the BITE CIC as new members of the IRC Industrial Club.

## UNDER LABORATORY CONDITIONS

As part of the BBC documentary "Under Laboratory Conditions", broadcast on January 10th, Richard Jones, Jon Howse and Haining Zhang were filmed and interviewed doing a neutron reflectivity experiment at the Rutherford Appleton Laboratory. This section of the program aimed to give viewers an idea of the romance and frustration of doing experiments in the middle of the night, and Richard and Jon in particular gave a very convincing impression of being tired and haggard.



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# FOCUS: Composites

## CURV COMPOSITE IN SUITCASES BY SAMSONITE

The self-reinforced polypropylene single polymer composite material, developed at the University of Leeds, has recently been utilised by luggage innovator Samsonite, to launch a new range of suitcases under the X'Lite name. The Curv® material, produced under licence by Propex Fabrics GmbH at their factory in Gronau, Germany, ([www.curvonline.com](http://www.curvonline.com)) combines lightweight and outstanding impact strength which makes it ideal for protective applications. It is already used by Nike for a range of soccer shinguards (BPS Contour). For further details email Dr Peter Hine; [p.j.hine@leeds.ac.uk](mailto:p.j.hine@leeds.ac.uk)

## IN VITRO - BIOCOMPATIBILITY OF DENTAL COMPOSITE RESINS

In recent years the use of resin-based restorative materials has increased in dentistry because of better aesthetics and improved adhesion to enamel and dentine. Since restorative materials come into direct contact with the surrounding tissues, residual monomers can be released into the oral cavity and cause adverse effects on oral mucosa. Therefore it is necessary to evaluate their biological interactions and effects on human oral mucosa. Since it is difficult, expensive and time-consuming to carry out such experiments *in vivo*, there is a tendency to replace animal tests by *in vitro* methods.

In this study *in vitro* biocompatibility of resin-based dental materials was assessed using a variety of laboratory techniques.

The results of cytotoxicity study

## NANO-FILLED ACRYLIC RESINS FOR DENTURES

The use of polymethyl methacrylate (PMMA) in the medical field has been common practice since the 1940's. PMMA has been utilized for dental prostheses, bone cement for hip implants, inter-ocular lenses, repair material for cranio-facial surgery as well as many other medical devices. The chemical inertness and biocompatibility of PMMA has been positively discussed in many scientific articles. However, as a dental material its mechanical properties are less than satisfactory. Sheffield Dental School is

## REACTIVE BLENDING - COLLABORATION BETWEEN DURHAM UNIVERSITY AND CATEDRÁTICO DE UNIVERSIDAD, MADRID

Blends with two-phase morphologies with typical length-scales of the order of microns have proven to be valuable in advanced materials technology. Examples include rubber toughened adhesives and high impact polystyrene.

A particularly promising route to producing novel materials from multicomponent mixtures involves reactive compatibilization of thermosets. A specific example, recently developed by the group of Juan Baselga<sup>1</sup>, is the curing of epoxy resins using a functionalised silicone as hardener. The initial binary mixture is immiscible and forms an emulsion in which the silicone is dispersed in the form of spherical droplets in the epoxy matrix. When the material cures it becomes a transparent and relatively tough thermoset with a morphology that greatly depends on curing temperature. Prof. Baselga has observed that even at moderate curing temperatures, interdiffusion of the epoxy

and the silicone induced by chemical reaction is not complete and concentration gradients of both components appear. The concentration profiles have been measured on those domains but there exists no theory to facilitate interpretation of the results. Such a theory is critical to achieve the ultimate goal: a method to develop nanostructured thermosets by size reduction of the initial morphology with better thermal and mechanical properties and better behaviour under humid conditions. Nigel Clarke (University of Durham) has recently started working with Prof. Baselga in order to develop theoretical tools that will facilitate interpretation of these intriguing results.

For further details contact Nigel Clarke [nigel.clarke@durham.ac.uk](mailto:nigel.clarke@durham.ac.uk)

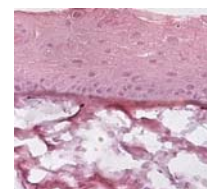
<sup>1</sup> Cabaneles, J.C.; Serrano, B., Baselga, J., *Macromolecules*, 2005, 38, 961-970.

revealed that resin monomers were toxic to fibroblasts and keratinocytes. However, they could not induce IL-1 release from these cells by themselves. Alamar Blue assay was a sensitive method for evaluating the cytotoxicity of resin monomers and it could differentiate between sensitivities of different cell lines to dental resin components.

HPLC analysis of composite resins showed that TEGDMA-based composites could release high quantities of monomer into aqueous media and the type of extraction media had a significant effect on the detection of monomer released from composite resins.

Recently we developed a well-differentiated and highly reproducible

full-thickness oral mucosal model that resembled native human oral mucosa and has the potential to be used for biological assessment of resin based dental materials (Figure). Further work on optimisation and characterisation of the model is still in progress.



Tissue engineered human oral mucosal model

For further information contact; [k.moharamzadeh@sheffield.ac.uk](mailto:k.moharamzadeh@sheffield.ac.uk)

of the study will focus on improving the adhesion between the filler particles and resin matrix to reduce the flaw effect in composites.



Production of acrylic resin discs in a dental flask.

For further information contact; [t.nejatian@sheffield.ac.uk](mailto:t.nejatian@sheffield.ac.uk)

# FOCUS: Conferences & Courses

## IRC POLYMER SCIENCE AND TECHNOLOGY MODULAR COURSE 05

The Polymer IRC was very pleased at how well the course was attended. The feedback from the delegates affirmed their approval and the presentations by all the speakers were very well received.

The course is due to be run on 30 October - 10 November 2006 at the Novotel in Sheffield, with the additional module Polymeric Bio Materials. For further details or suggestions for further courses contact Shelagh Cowley, course organiser: [s.h.cowley@sheffield.ac.uk](mailto:s.h.cowley@sheffield.ac.uk)

## MATERIALS CONGRESS

The one day symposium on *Biomaterials for Regenerative Medicine*, which is part of the 2006 congress, will take place on the 5/7 April 2006 in central London. The symposium is co-organised by Professor Paul Hatton of the Polymer Centre and Centre for Biomaterials and Tissue Engineering at Sheffield.

Full details of Congress may be found at: <http://www.iom3.org/congress/>

## PPE05 INTERNATIONAL CONFERENCE: "HIGH TECHNOLOGY – ALL THINGS GREAT AND SMALL, BY DESIGN"

Polymer Process Engineering 05, 5/6 July 2005, included an exciting meeting of the ways in 2 keynote talks. Moldflow MD Roland Thomas covered the forward looking philosophy of morecoherent manufacturing with technical design as an integral part of the process, whilst Sebastian Conran (Conran Design Partnership) dealt with creative design – Poly Value. The exciting high technology,

## RSC NANOTECHNOLOGY 4 CHEMISTS - 7/9 JUNE 06, NOVOTEL, SHEFFIELD.

This course is an introduction to the basic concepts that underline nanotechnology. It explains how nanomaterials are made and characterised and gives pointers to ways in which these properties will be exploited in the future to make new high added-value products.

The course is presented by several international specialists including Profs Tony Ryan OBE and Richard Jones (Univ of Sheffield) who will include examples from their research. For information contact: [s.h.cowley@sheffield.ac.uk](mailto:s.h.cowley@sheffield.ac.uk)

## POLYMER NETWORKS GROUP CONFERENCE

3/7 September 2006. "Call for contributions" – oral or poster presentations. Please go to

[www.polymernetworks.group.shef.ac.uk](http://www.polymernetworks.group.shef.ac.uk)

An independent international organisation for the promotion of international contacts and the stimulation of research in the field of polymer networks. The meeting will be organised around a series of themes each half a day long and presented by world renowned academics. A special conference banquet is included in the registration fee.

## MNT SHOWCASE – 'BOTTOM UP OR TOP DOWN'

8 June 2006, Novotel, Sheffield UK 19.00pm – 21.00pm

"Nanotechnology providing solutions for the future of innovative business." The MNT in conjunction with the Nanofactory are hosting a drinks reception for invited guests to showcase their most up to date technology in Micro and Nanotechnology in the Yorkshire and Humberside region.

## UK POLYMER SHOWCASE

The UK Polymer Showcase 12/13 September 2006 is a free event open to anyone with an involvement in polymers or soft nanotechnology. An impressive collection of speakers, including Prof Tony Cheetham, University of California, John Grasmeder and Terri Jordan, Victrex PLC and award winning science broadcaster Sue Nelson present their own perspectives on "Managing Technology and Innovation". 200 free places are available, non-club members are advised to book early to secure a place. To register email: [polymer.showcase@leeds.ac.uk](mailto:polymer.showcase@leeds.ac.uk)

presented by an international range of speakers, with around 100 delegates, was hosted at the Polymer IRC laboratories, School of Engineering, Design & Technology at the University of Bradford. There was the bonus of a commercial exhibition, student poster displays and live demonstrations at the end of each day, plus a Conference Dinner. The opening of the Yorkshire Forward funded Centre for Micro and Nano-

Moulding was also celebrated, with 3 new Battenfeld Microsystems, 2 new Fanuc high precision machines and a novel Bradford/Rondol micromoulding in line compounding line.

The event, an excellent addition to the PPE series with many delegates expressing great satisfaction was sponsored by EPSRC, Yorkshire Forward, Faraday Plastics and was co-sponsored by the IoM3.

## INTERNATIONAL POLYMER MATERIALS ENGINEERING CONFERENCE

Prof Phil Coates was invited to deliver a keynote lecture (Micromoulding) at the International Polymer Materials Engineering Conference, Shanghai, run by 10 leading Chinese Universities in the polymers area.

Prof Coates met with Prof Charles Han Director of the Joint Laboratory for Polymer Physics and Chemistry, and Engineering Plastics, at the Institute of

Chemistry of the Chinese Academy of Science, Beijing and with Prof Dujin Wang, Director of the Engineering Plastics laboratory, <http://pmp.iccas.ac.cn>. Charles Han emphasised high levels of interest in developing links with the Polymer IRC.

At IPMEC Prof Xi Xu, University of Sichuan, Chengdu, and Prof Qi Wang also expressed very keen interest to

establish cooperation and have specifically invited Prof Coates to visit them. They are the State Key Laboratory for Polymer Materials Engineering

[www.sklpme.labs.gov.cn/en/intro.htm](http://www.sklpme.labs.gov.cn/en/intro.htm)

and have a 'branch' at the excellent Shanghai Jiao Tong University.

Prof Coates is grateful to the Royal Society for their support for this visit.

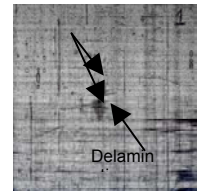
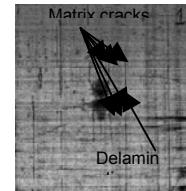
## TECHNOLOGY OFFER

### Self Healing Composites

Patented technology which enables the autonomous repair of microstructural damage in composite materials based on carbon, glass, aramid and other high-performance reinforcing fibres. Impact, vibration and fatigue damage to composite microstructures is notoriously difficult to detect and repair. The invention provides the capability to:

Detect and locate the position of the damage, using active smart sensing, giving an assessment capability approaching 3D. Repair the damaged zone, non-invasively and with no additional materials, enabling the structure to recover most of its original strength.

For more information contact Dr. Malcolm Butler  
[m.a.butler@sheffield.ac.uk](mailto:m.a.butler@sheffield.ac.uk)



Example of a glass fibre composite panel before and after healing.

## POLYMER TRAINING COURSES/CONFERENCES

### Materials Congress

Wednesday 5 – Friday 7 April 2006

### MNT Showcase

Thursday 8 June 2006

### DYFP (“Churchill” Conference)

Thursday 13 April 2006

### Polymer Networks Group Conference

Sunday 3 – Thursday 7 September 2006

### RSC Nanotechnology 4 Chemists

Wednesday 7 – Friday 9 June 2006

### UK Polymer Showcase – “Materials By Design”

Tuesday 12 – Wednesday 13 September 2006

For further information contact: Shelagh Cowley, The Polymer Centre, [s.h.cowley@sheffield.ac.uk](mailto:s.h.cowley@sheffield.ac.uk) or Helen Clancey, IRC, [H.E.Clancy@leeds.ac.uk](mailto:H.E.Clancy@leeds.ac.uk)

## VACANCY FOR BUSINESS RESEARCH FELLOW

Can you take on the dynamic challenge of utilising the extensive Polymer Centre expertise and facilities to solve industrial problems and commercialise new technologies? You will meet with companies, present the Polymer Centre capabilities and then identify potential projects for applying new technologies or current expertise to their business whether this is for day-to-day problem solving, consultancy or longer-term new product development.

For further details contact Malcolm Butler on: 0114 2229553 or e-mail [m.a.butler@sheffield.ac.uk](mailto:m.a.butler@sheffield.ac.uk)

## LAST BUT NOT LEAST...

We would like to say congratulations to Professor Tony Ryan, who has been awarded an OBE in the 2005/6 New Years Honours list for services to science, ‘I was chuffed to bits when I got the letter, it was a complete surprise and its not just for me, its great for the University and a recognition of the Polymer IRC.’

And congratulations to Professor Frank Jones who has been awarded the Holiday Prize in recognition of significant or technical contribution relating to any type of composite material.

## SUDOKU

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## HOW TO PLAY

Fill in the grid so that every row, every column and every 3x3 box contains the digits 1 through 9, with no repetition!

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E-mail the highlighted numbers to us and you will receive a mystery prize!

[Jen.Harris@sheffield.ac.uk](mailto:Jen.Harris@sheffield.ac.uk)



## CONTACT US

For further enquiries or feedback on our Newsletter:

Helen Clancey, Polymer IRC Administrator: [h.e.clancy@leeds.ac.uk](mailto:h.e.clancy@leeds.ac.uk)

Jen Harris, Polymer Centre: [Jen.Harris@sheffield.ac.uk](mailto:Jen.Harris@sheffield.ac.uk)

