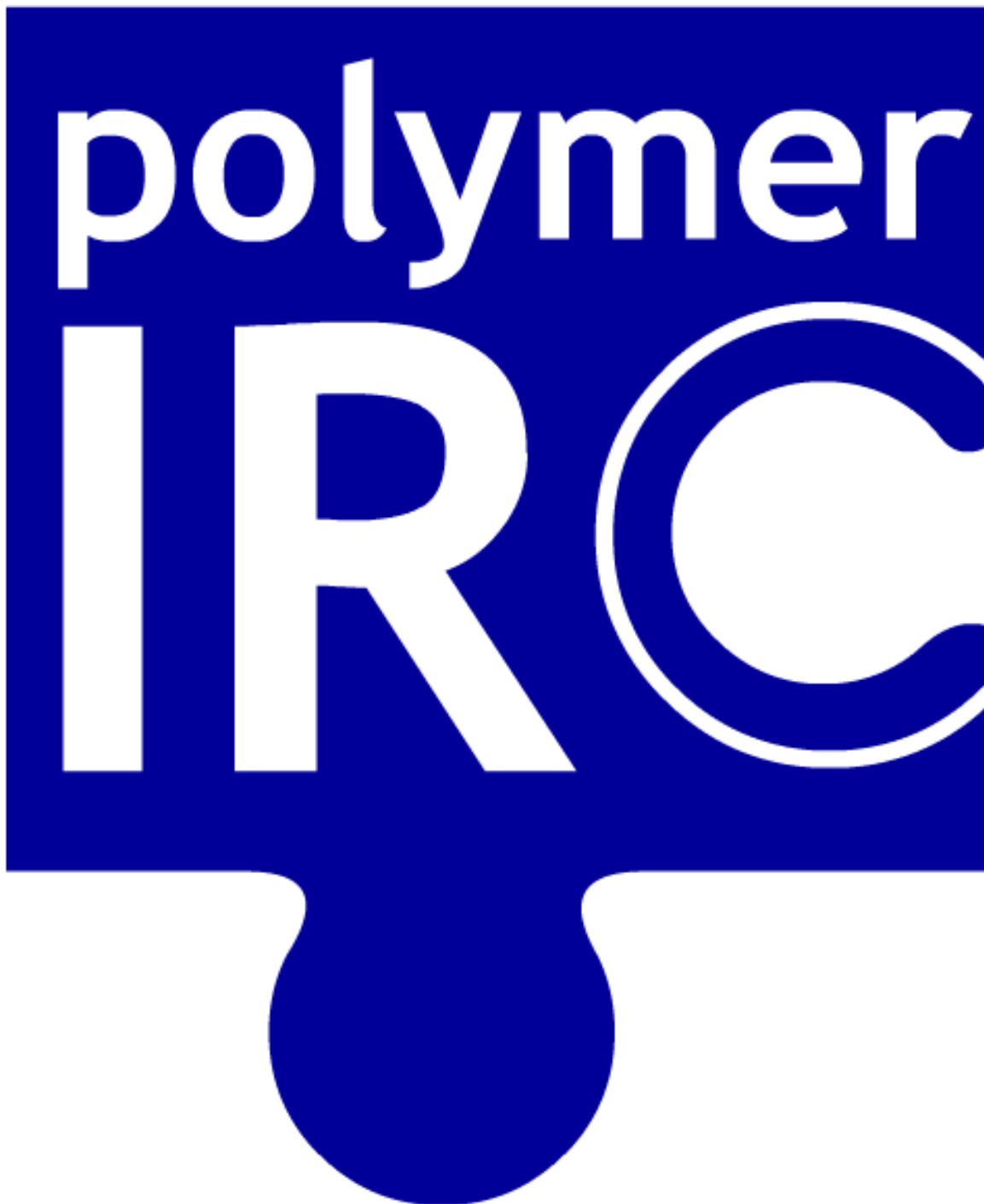




Professor Ian Ward FRS
Original Director, Polymer IRC

Professor Phil Coates FREng
Director, Polymer IRC
&
RCUK Bradford Science Bridges
China

Polymer IRC: the beginning

The IRC in Polymer Science & Technology
was established at the Universities of Leeds,
Bradford and Durham on 1st October 1989

Polymer IRC original board (1989)



top: Prof Robin Harris, Durham Dr Geoff Davies, Leeds Bill Colwell, Administrator
middle: Dr Phil Coates, Bradford Prof Eric McIntyre, Leeds Dr David Bower, Leeds, Dr Alan Duckett, Leeds
bottom: Prof Jim Feast, Durham Prof Ian Ward FRS, Leeds Prof Tony Johnson, Bradford
Director

The principal objectives were:

1. To establish a recognised focal point for the future development of polymer science and technology in the UK.
2. To provide a more effective interface between academic research and industrial research in polymer science and technology in the UK.
3. To produce a more substantial flow of polymer scientists and technologists.

New Projects were initiated:

1. The Synthesis, Characterisation and Application of Dendritic Polymers.
2. Designed Networks.
3. Electroactive Polymers:
 - (a) Ionic Transport in Polymers
 - (b) New Piezo and Pyroelectric Polymers
4. Polymerisation Scale-up – Block Copolymers and Telechelic Polymers from Living Polymerisations.

5. Novel Liquid-Crystal Polymers.

6. Polymer Composites:

- (a) Mechanical Behaviour of new High Temperature Composites
- (b) Lightweight High Energy Absorbing Composites
- (c) High Temperature Low Cost Polymer Composites

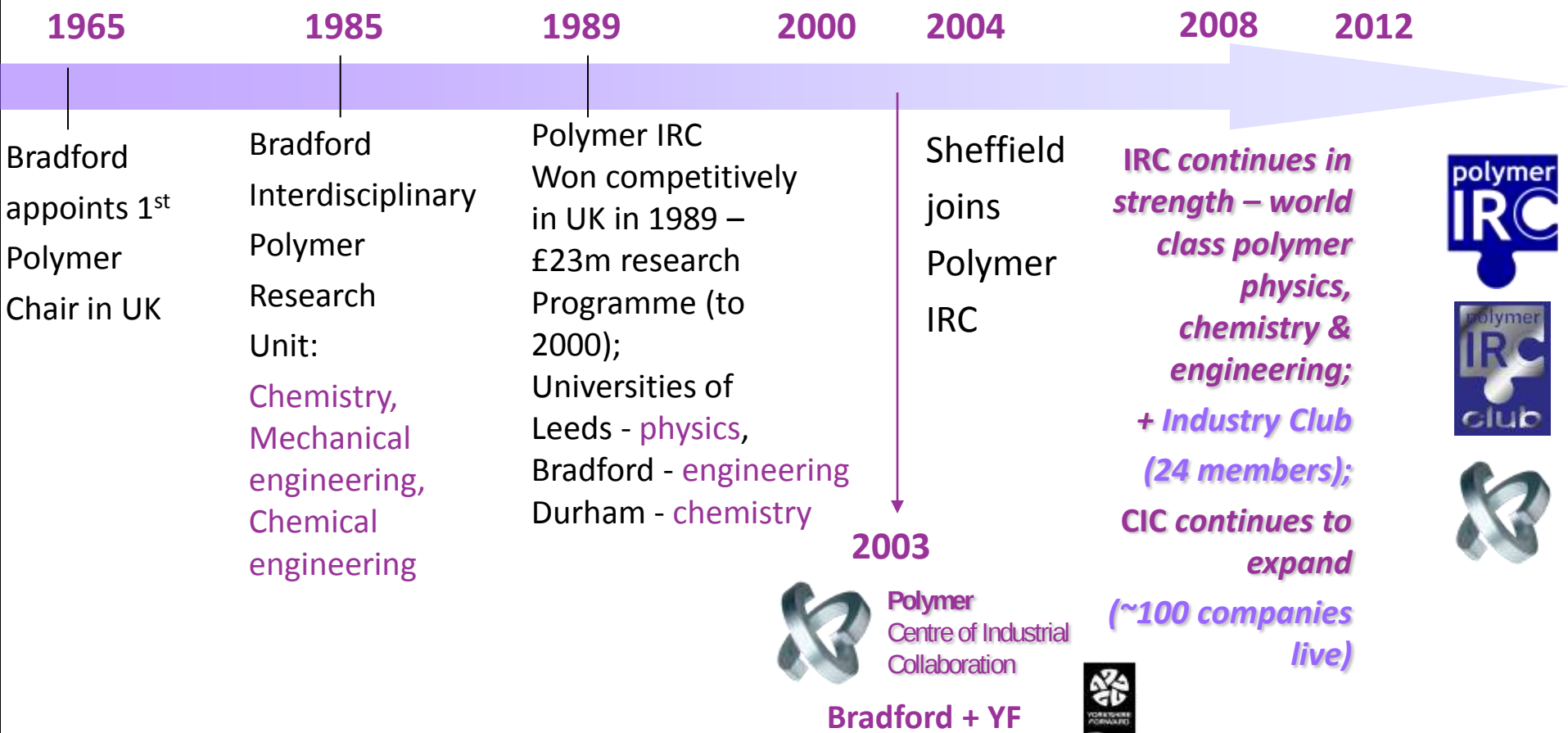
7. Polymer Process Modelling, Measurement and Control:

- (a) Solid Phase Deformation processing
- (b) Polymer Fluid Processing

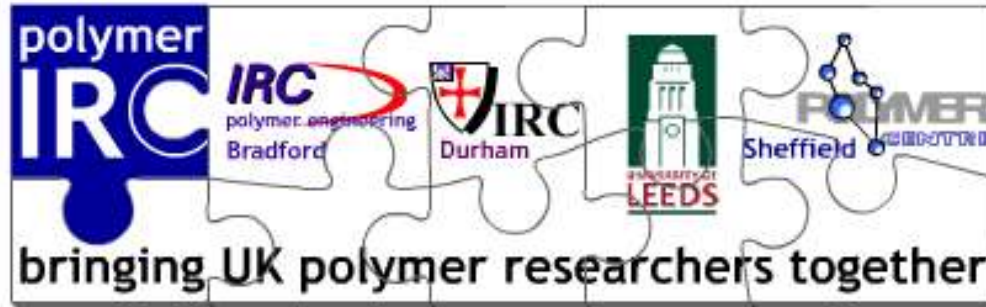
UK Polymer IRC

www.polymerirc.org

www.polyeng.com



Polymer Interdisciplinary Research Centre



Universities of

- Leeds - polymer physics
- Bradford – polymer engineering
- Durham – polymer chemistry
- Sheffield – polymer science



Sites

Durham University
-polymer chemistry



IRC
Polymer
Chemistry
Durham
UNIVERSITY

Leeds University
-polymer physics



IRC
Polymer
Physics
Leeds
UNIVERSITY

Bradford University
-polymer engineering

IRC

Polymer
Engineering
School of Engineering,
Design & Technology
UNIVERSITY OF BRADFORD

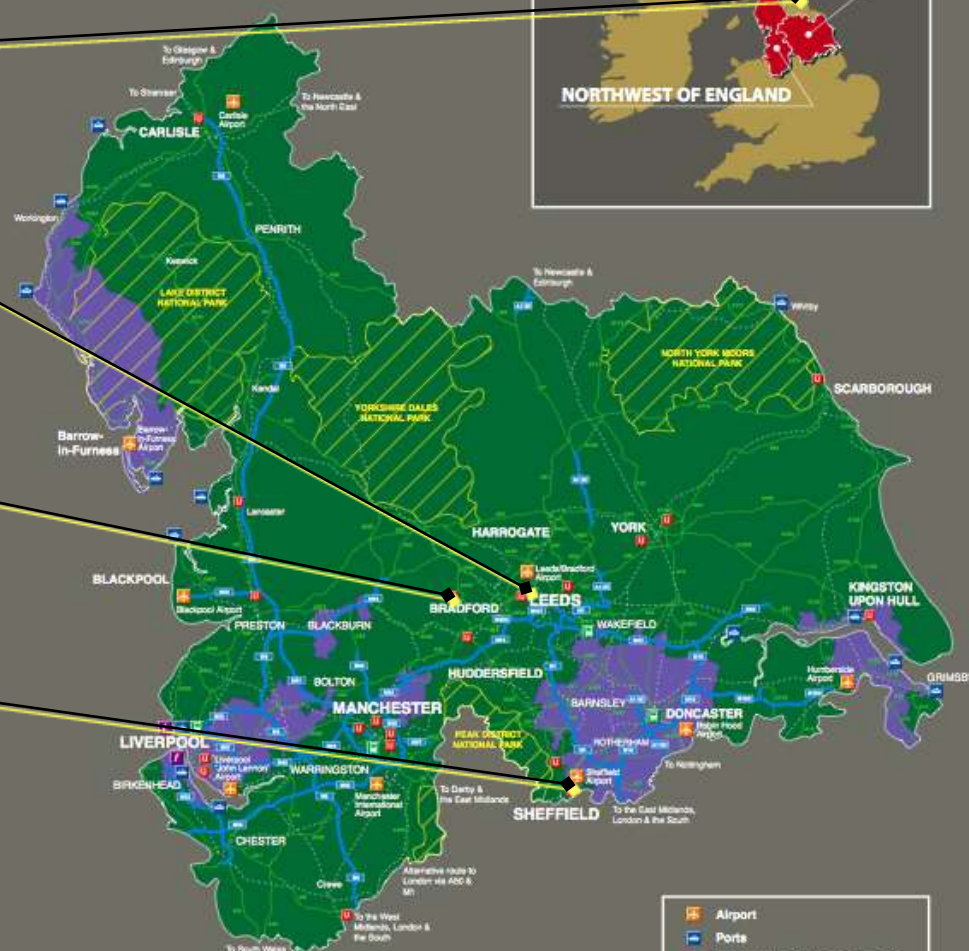
Sheffield University
-polymer science



+
the Industrial Club
-polymer products

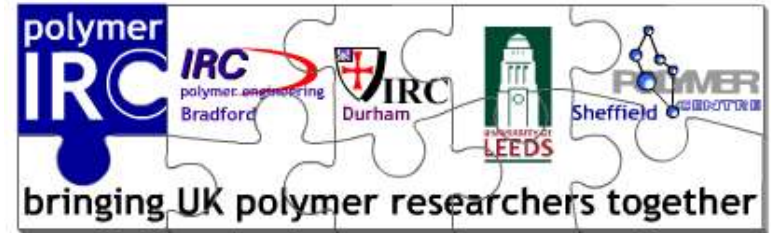


THE NORTH OF ENGLAND



i · b · l · c
Idea Bank Liaison Center

The Polymer IRC



Chemistry Polymer Materials Science

Engineering

*Physics/Chemistry/
Appl. Maths*

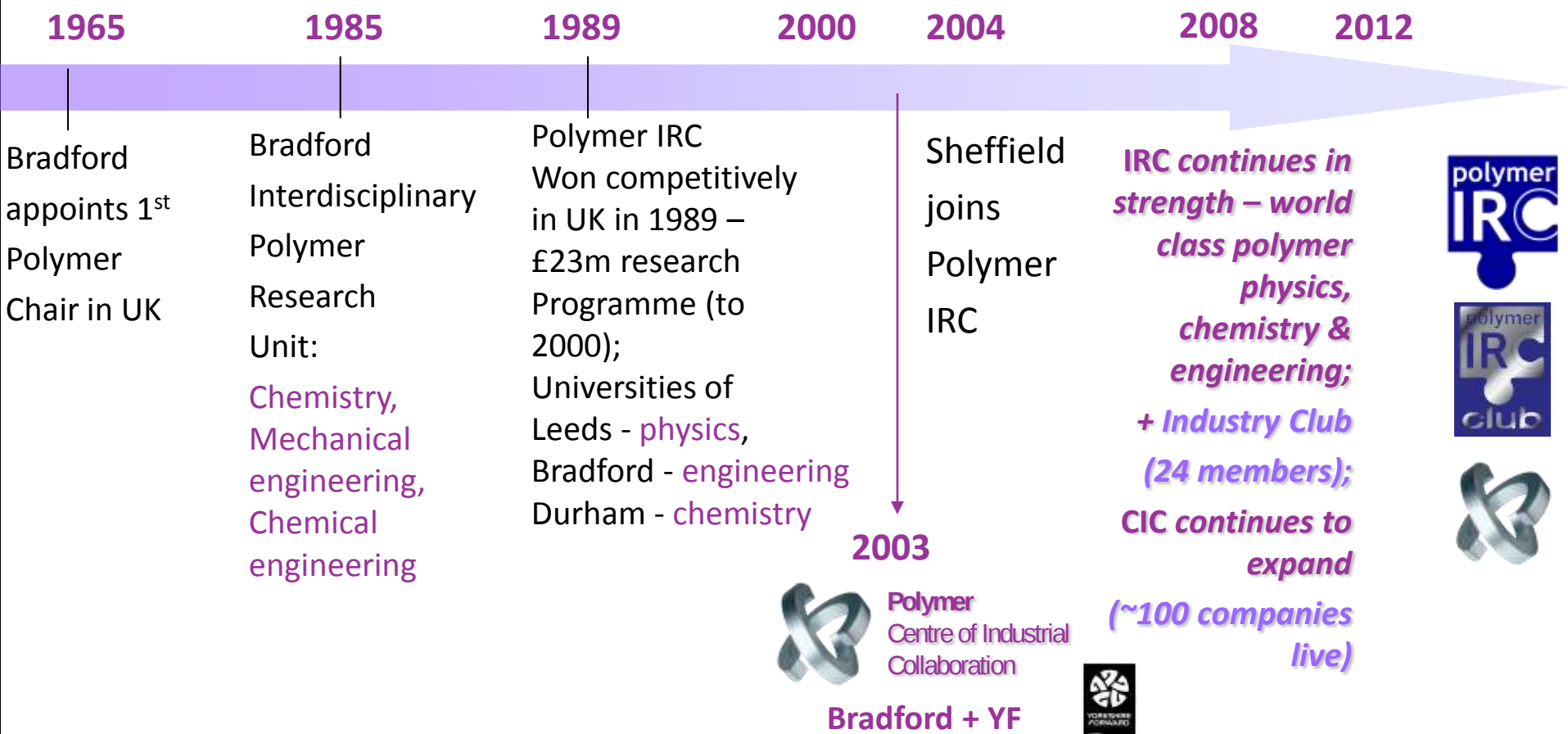
- A focal point for UK Polymer/Soft Matter Science since 1989
- Connecting Industry and Academia
- Linking Chemistry-Physics-Engineering
- >100 staff over 4 sites + >150 PhDs and PDRAs
- Research spending of >~£5M p.a.
- Core Science + Knowledge Transfer
- Industrial training and conferences

Polymer IRC original board (1989)



top: Prof Robin Harris, Durham Dr Geoff Davies, Leeds Bill Colwell, Administrator
middle: Dr Phil Coates, Bradford Prof Eric McIntyre, Leeds Dr David Bower, Leeds, Dr Alan Duckett, Leeds
bottom: Prof Jim Feast, Durham Prof Ian Ward FRS, Leeds Prof Tony Johnson, Bradford
Director

UK Polymer IRC



PolymerIRC@Leeds—

Fundamental enabling science for myriad applications

Non-equilibrium Physics

Glass Transition

Polymer Dynamics

Colloids

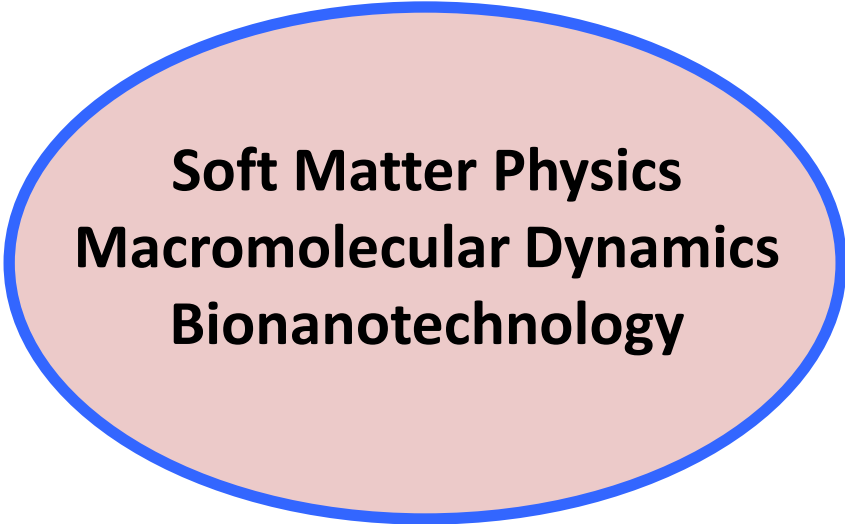
Biopolymers

Industrial Collaborations

Spin-out companies

Polymer Processing

Energy and Environmental
Applications



Soft Matter Physics
Macromolecular Dynamics
Bionanotechnology

Biomolecular Dynamics and Structure

DNA

Membranes

Drug Delivery

Protein processing

Tissue Mechanics &

Design

Biofilms

Polymer IRC@Leeds [a partial list!]

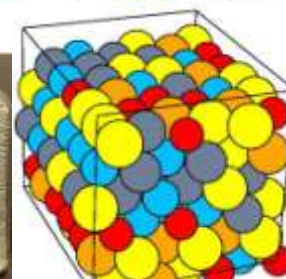
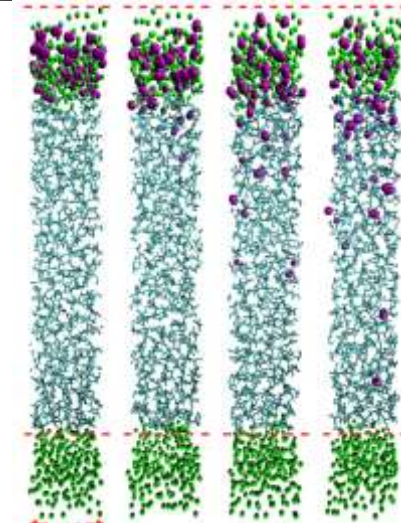
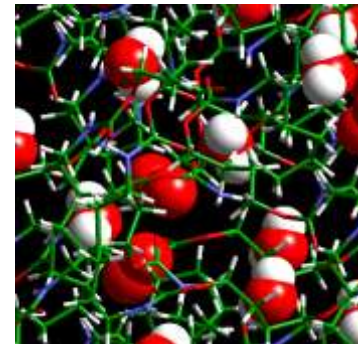
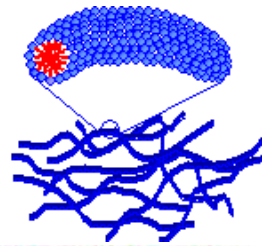
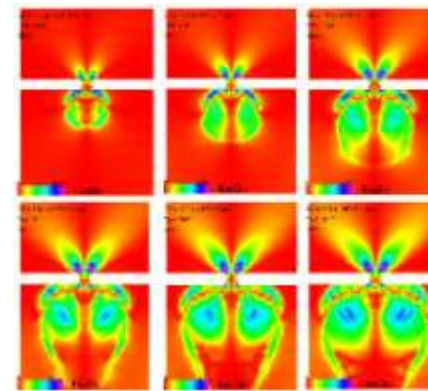
- Soft Matter Physics (SMP)
 - **Prof PD Olmsted** (dynamics of polymers, membranes, proteins), **Drs RML Evans** (Non-equilibrium statistical mechanics, rheology, pattern formation)
 - **SA Harris** (Biomolecular simulation)
 - **Drs KJL Mattson** (glasses, polymer dynamics), **ME Ries** (Cellulose/ionic liquids, NMR), **AM Voice** (Li-ion gel electrolytes)
 - **Dr DB Adolf** (simulations of polymer dynamics: permeability)
 - **Prof IM Ward** (processing, industrial applications, gel electrolytes)
 - **Dr PJ Hine** (mechanical properties, hot compaction)
- Department of Applied Mathematics
 - **Drs OG Harlen and DJ Read** (polymer and protein dynamics and theory, CFD, modelling)
- Molecular and Nanoscale Physics (MNP)
 - **Prof SD Evans** (microbubbles and membranes, light harvesting, liquid crystals)
 - **Dr L Dougan** (proteins under extreme conditions, water/H-bonding)

Polymer IRC@Leeds [a partial list!]

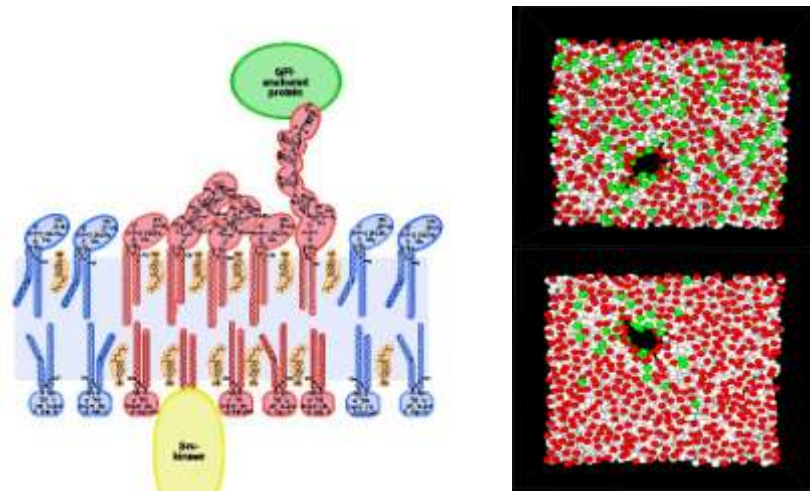
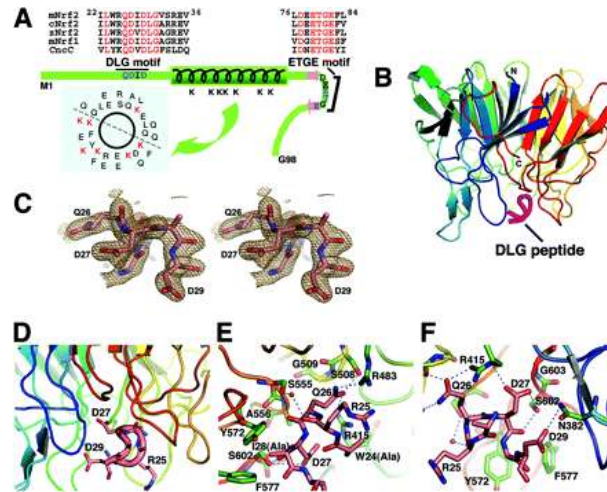
- Chemistry/Centre for Molecular Nanoscience (CMNS)
 - **Drs Paul Beales and Rongjun Chen** (delivery: vesicles, polymer/membrane interactions, toxicity)
 - **Dr Dejian Zhou** (nanoparticle design for delivery and sensing)
 - **Dr Amalia Agelli** (peptide aggregation and design), **Dr Stefan Auer** (simulation: proteins, membranes, aggregation)
 - **+ 3 AN Others** (advertising for 1 synthetic and 3 polymer materials chemists in Colour Chemistry)
- Engineering (Institute for Particle Science and Engineering, Mech Eng, ...)
 - **Prof Simon Biggs** (microgels, responsive copolymers, emulsions, colloids, ...)
 - **Prof John Fisher** (tissue regeneration)
 - **Dr N Kapur** (engineering rheology and [micro]fluidics)
- Food Science
 - **Dr R Ettalaie, Prof B Murray** (food biopolymers: proteins at surfaces, rheology, mucins)
- Biology
 - **Dr E Paci** (protein simulations)
-

Non-Equilibrium Science

- Shear banding, dynamics and instabilities in complex fluids
 - Bioprocessing; wormlike micelles/surfactant solutions, entangled polymer solutions, biopolymers, colloidal suspensions, microgels;
- Non-equilibrium statistical physics
 - The glass transition and ageing materials; hydrogen bonded liquids, non-equilibrium statistical mechanics, pattern formation in colloidal suspensions and other complex fluids, mechanisms of molecular motors; colloidal crystallization.
- Polymer Dynamics
 - Mechanical properties and processing of multiphase polymeric materials, design of strongly oriented polymer materials, non-Newtonian fluid mechanics and flow instabilities.



-



Some Industrial Application/Interest

- Hot Compaction and Oriented polymers
 - Material behind top-of-the-range Samsonite suitcase, licensed to Propex. New EU project to develop next generation of materials.
- Polymer Gel Electrolytes for Lithium Ion Batteries
 - Novel techniques for combining electrolyte (polymer gel) with electrodes in continuous process.
- Cellulose Regeneration
 - Use of ionic liquids for green processing; cellulose aggregation, processing and phase behaviour.
- Lipid Membranes
 - Delivery through membranes, skin membranes, design and science of targetted release, microbubbles for targetted medical imaging, ...
- Polymer Dynamics
 - Delivery through membranes, skin membranes, design and science of targetted release.

Collaborations & Funding

- Some industrial collaborations
 - Unilever, Innovia Films, Mitsubishi/ETH Zürich, Lucite, DSM, Smith & Nephew, Propex, QinetiQ, Victrex, Pharmaceuticals.
- Some Current Funding
 - DYNACOP Initial Training Network (+11 partners on branched polymers)
 - ESMI (FP7 Soft Matter Infrastructure Network).
 - SOFTCOMP (FP7 Network of Excellence)
 - HIVOCOMP (FP7 4 year project; polymer composites for road applications)
 - EPSRC: DNA dynamics; Inkjet Printing (Programme Grant); Lipid bilayers (parts of 2 Programme Grants);
 - EPSRC/Welmech Regenerative medicine/Cartilage MRI imaging of mechanics/dynamics
 - Unilever (membranes), Mitsubishi/ETHZ,
 - PROPEX: hot compaction technology
 - Leeds BHRC Biomedical and Health Research Centre
 -



Whatever you
want to do with
polymers

The Polymer Centre at the University of Sheffield

Dr Liam R Sutton

Polymer Centre Manager
MD, FaraPack Polymers Ltd



Polymer
Centre



The
University
Of
Sheffield.

The University of Sheffield

- Our Faculty of Science “works to improve the world by seeking to understand it, through application of our research excellence. Whilst knowledge itself has intrinsic value, we are committed to the transformation of the new knowledge we generate into real benefits, whether they are economic, ecological, or societal.”

What is the Polymer Centre?

- Around 45 Sheffield-based academics from Science, Engineering and Medicine
- Generalist, non-academic team based in Faculty of Science
- Integral to 3 multi-university networks
- 3 broad technological areas
 - Advanced materials and manufacturing
 - Electronics and photonics
 - Bioscience and healthcare



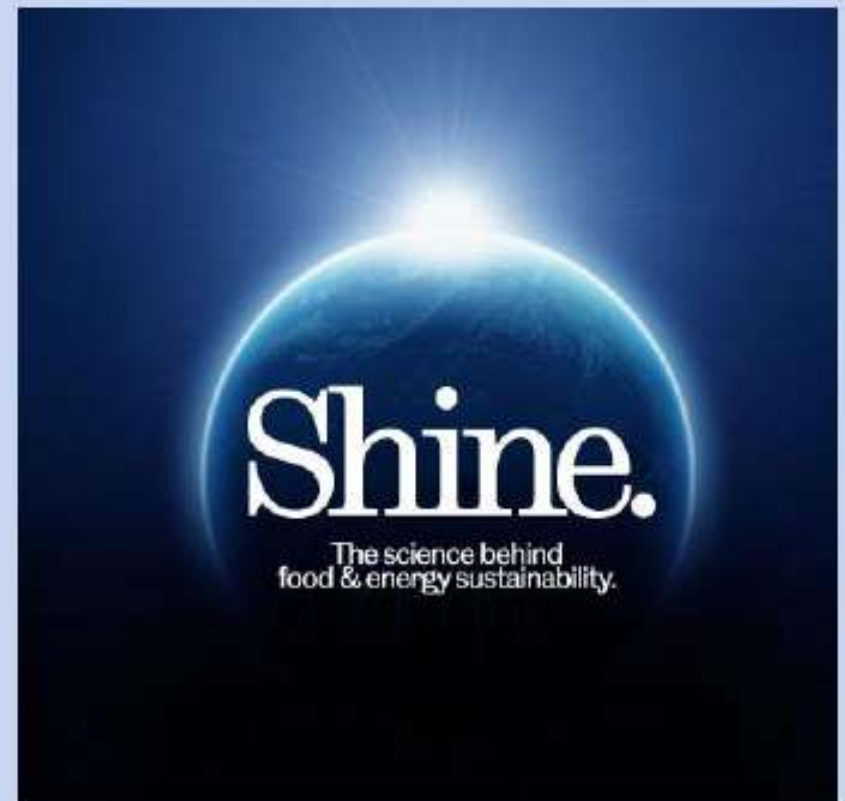
Advanced materials & manufacturing

- Chemistry, physics and materials science
- Composite Systems Innovation Centre
- Additive manufacturing



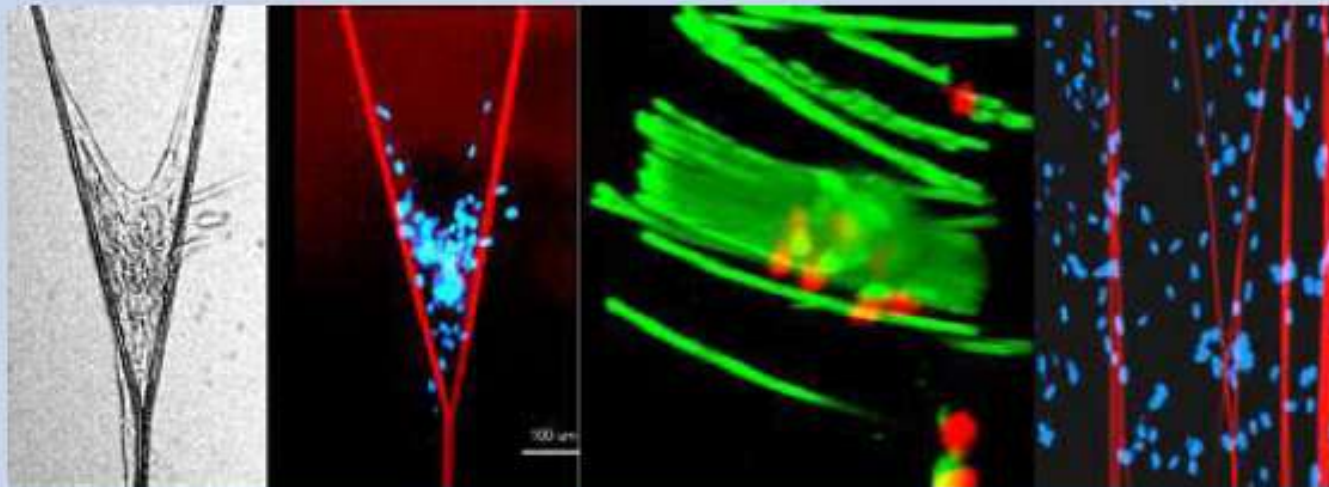
Electronics & photonics

- Electronic and Photonic Molecular Materials
- Physics, chemistry, chemical engineering
- Sheffield Solar Farm



Biomaterials & healthcare

- Centre for Biomaterials & Tissue Engineering
- Materials science, chemistry, biology, clinic

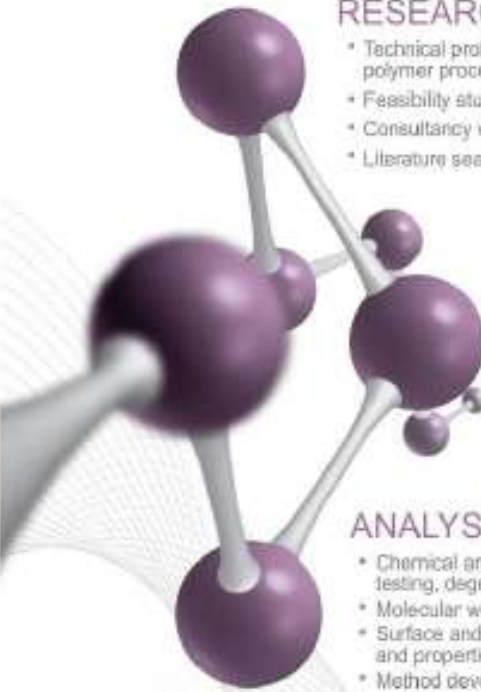


Working with us

- Training opportunities
 - Basic Polymer Science, May 21-23
 - Modular course, Oct/Nov
- Technology opportunities
 - Nanofactory “Tech Check”
 - Bespoke development of long term collaborative R&D: contract; TSB; RCUK; UoS; KTP; METRC; PhD; MSc.
 - Consultancy brokerage
- Flexibility and response

FaraPack Polymers Ltd

HOME	RESEARCH	SYNTHESIS	ANALYSIS
------	----------	-----------	----------



RESEARCH

- Technical problem solving in polymer materials, polymer processing and polymer manufacturing
- Feasibility studies
- Consultancy with polymer experts in your field of interest
- Literature searches

SYNTHESIS

- Specialists in bespoke polymer synthesis
- Functionalised polymers
- Surface modification using polymers
- Block, random and star copolymers
- Smart materials, reactive polymers and controlled release

ANALYSIS

- Chemical analysis, mechanical testing, thermal testing, degradation testing
- Molecular weight determination
- Surface and bulk analysis of polymer structures and properties
- Method development

 The University of Sheffield

“Providing industry with technical expertise and problem solving capabilities in all areas of polymer science”

 **FARAPACKPOLYMERS**

Contact us

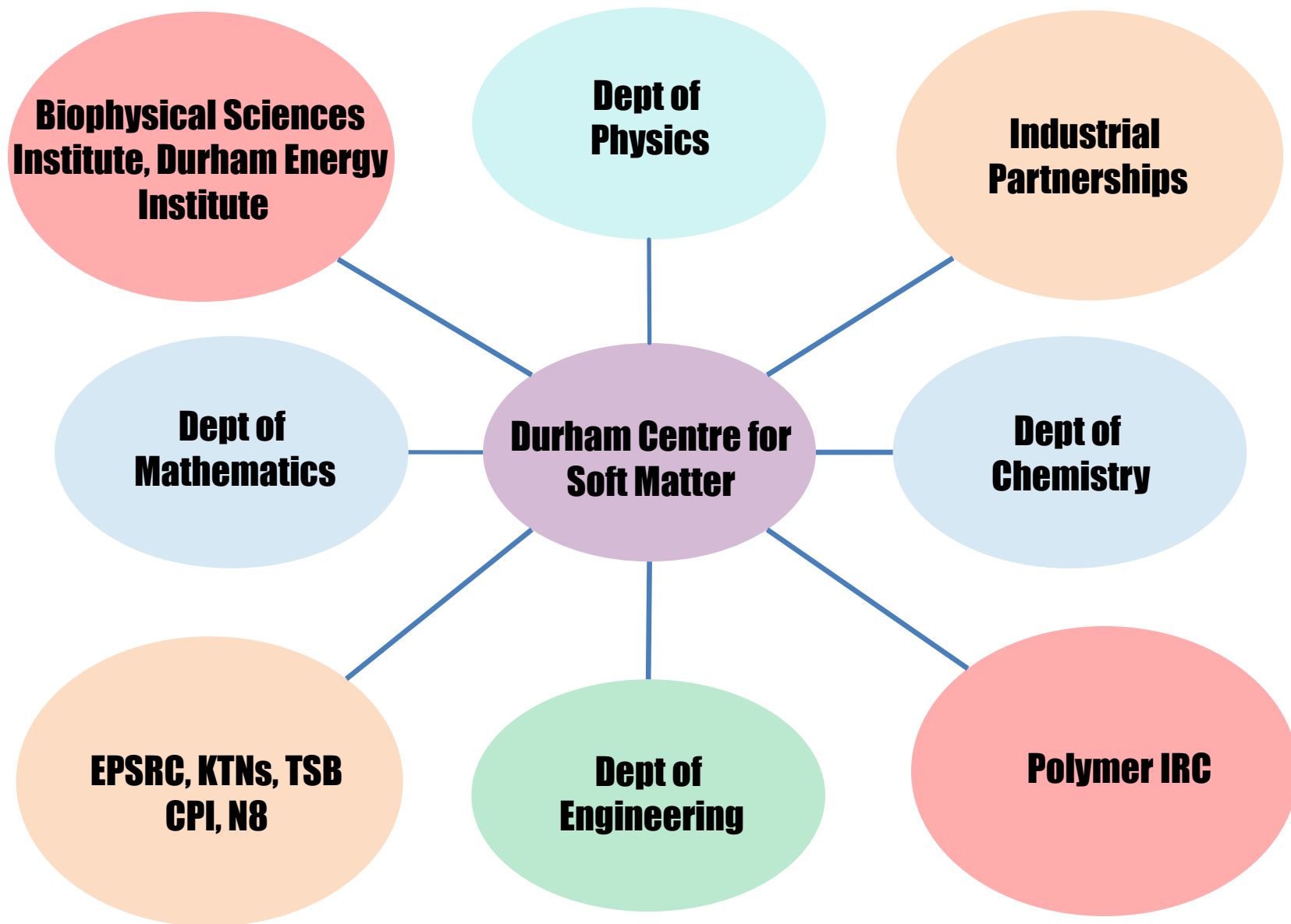
- polymers@sheffield.ac.uk
- www.polymercentre.org.uk
- 0114 222 9537



**Durham Centre
for Soft Matter**

What's New in Durham?

- Durham still does polymers!
- Launch of Durham Centre for Soft Matter
- Major Collaboration with P&G
- APME 2013





- Officially launched in Feb 2011
- 15-20 members of staff (and growing)
- 40-50 PhD students
- Polymers; colloids; gels; vesicles; emulsions; films; surfactants; micelles; suspensions; liquid crystals
- Biological Soft Matter
- Complex Fluids (polymers, melt rheology)
- Surfaces and Functional Interfaces
- Director – Tom McLeish
- Deputy Director – Lian Hutchings
- Management group
 - Dr Richard Thompson (Chemistry)
 - Dr Buddhapriya Chakrabarti (Mathematics)
 - Dr Suzanne Fielding (Physics)
 - Dr Jun Jie Wu (Engineering)



A Centre of Excellence with P&G, CPI and Peerless

Durham Chemistry and Physics Departments have recently initiated a £14M (£5.3M RGF) research project with Procter and Gamble, CPI and Peerless systems under project "CEMENT" - a Centre of Excellence in Methods and New Technologies for Surface Modification and Cleaning.

- Functional polymers
- Surfaces and Functional Interfaces

10th International Conference on Advanced Polymers via Macromolecular Engineering (APME)

Hosted by the Durham Centre for Soft Matter

Durham University, August 18th – 23rd 2013

Chairman/Organiser – Lian Hutchings

Scope of the Conference

Living and Controlled Polymerization

Radical Polymerization

Step Growth Polymers

Functional Polymers

Supramolecular Polymers

Polymer Colloids

Polymer Characterization

Biomaterials and Polymers for Medical Applications

Renewable/Sustainable Polymers

Polymers at Surfaces and Interfaces

Plastic Electronics

Polymers for Energy Applications

Complex Macromolecular Architectures

Polymers and Industry

Confirmed Speakers

Prof Craig Hawker (UCSB)

Prof Mitsuo Sawamoto (Kyoto University)

Prof Kris Matyjaszewski (Carnegie-Mellon)

Prof Andy Cooper (Liverpool University)

Prof Ludwik Leibler (ESPCI Paris)

Prof Chao Gao (Zhejiang University)

Prof Steve Rimmer (Sheffield University)

Prof Brigitte Voit (Leibniz-Institut, Dresden)

Dr Rachel O'Reilly (Warwick University)

Prof Taihyun Chang (POSTECH, South Korea)

Prof Holger Frey (University of Mainz)

Dr Jean-Francois Lutz (ICS, Strasbourg)

Prof Ian Manners (Bristol University)



polymer
IRC

Bradford
Leeds
Durham
Sheffield

Polymer IRC at Bradford

www.polyeng.com

RKT Centres:



Polymer Centre of Industrial Collaboration

Industry facing aspect
of our research labs

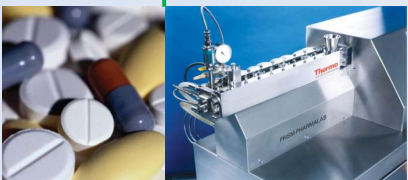
Bradford Industry Group

Industry technical/
consultation group
(>100 companies)
www.polymercic.com

Pharmaceutical Engineering Science

www.pharmaceutical-
engineering.brad.ac.uk/
School of Life Sciences

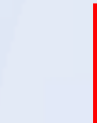
Pharmaceutical
structuring for
enhanced
bioavailability/ drug
delivery



Advanced Materials Engineering

www.brad.ac.uk/research/
rkt-centres/advanced-
materials-engineering/

Advanced materials for
**Healthcare
Technology &
Resource Efficiency;**
including solid phase
&
fibre orientation
processing



Polymer Micro & Nano Technology

www.polymer-
mnt.brad.ac.uk/
www.ukmig.com

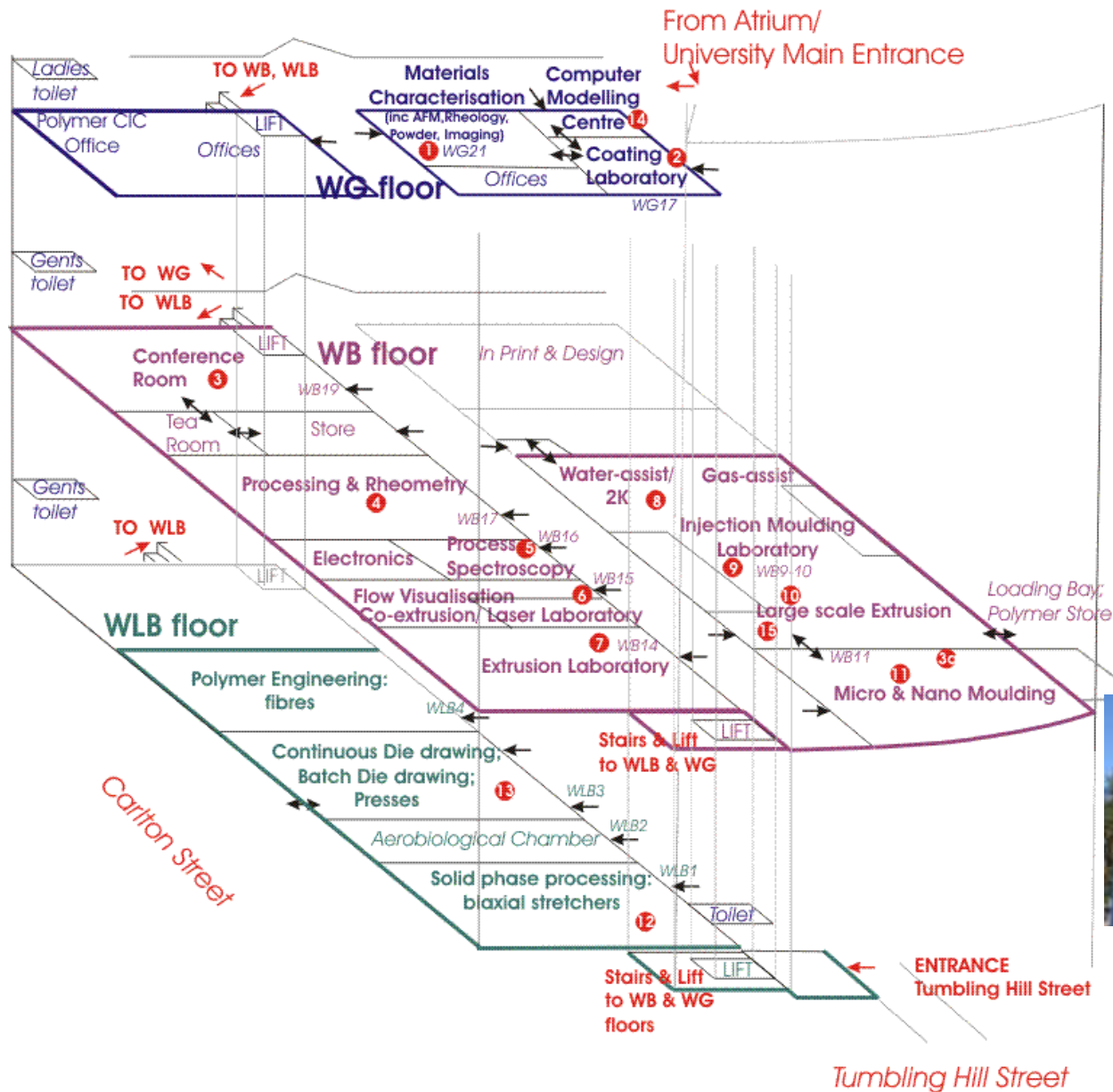
Micromoulding &
surface structuring
for Healthcare &
Telecommunications



UK:
QUB, Warwick,
York, Oxford,
Cambridge,
Huddersfield,
Swansea,
Sheffield Hallam,
Nottingham,
Loughborough;

International:
(inc. RCUK
Science Bridges
China, EPSRC
Global, and Joint
international
laboratory with
Sichuan
University)

Polymer IRC Laboratories, Bradford



**Welcome
to the
Polymer IRC/
Polymer CIC Bradford
- a science tour**

R & KT output delivery

- Academic outputs:
 - > 400 Journal papers published
 - > 15 books published
 - Strong RCUK grant track record
- Industry collaboration
 - >100 companies live contracts/ co-operations
- Leader of various national and international networks, including
 - RCUK Bradford Science Bridges China
 - EPSRC Global Engagements
 - DIUS - In process measurements (also EPSRC);
 - UK MNT polymer manufacturing [MNT KTN];
 - international Micromoulding Interest Group;
 - Previously: EPSRC Computer modelling network

Polymer IRC Bradford, 2012

Vision:

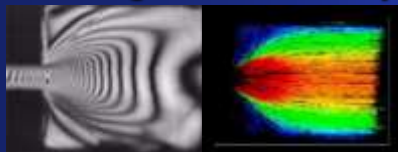
To maintain our leading position in polymer engineering and associated research areas, further developing and increasing:

- academic excellence
- industrial application
- international leadership and
- collaborations – inside and outside the university

with

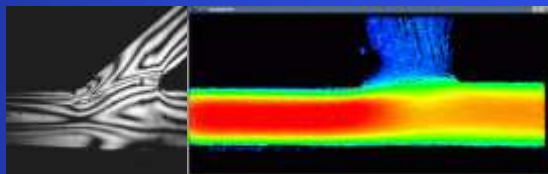
- promotion of the wellbeing and development of our team members

Rheo-optics: stress
birefringence & velocity



σ, V

co-extrusion

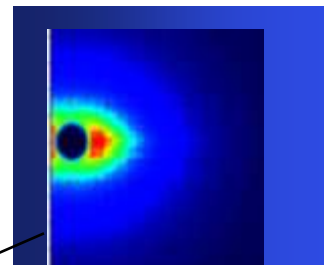


σ, V

Solid phase
deformation

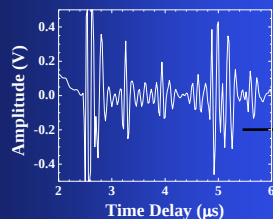


$\sigma, X, V, \epsilon, \epsilon$

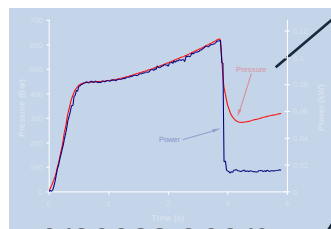


Neutron scattering

Process Imaging Metrology



ultrasound



process energy



In-barrel viewing



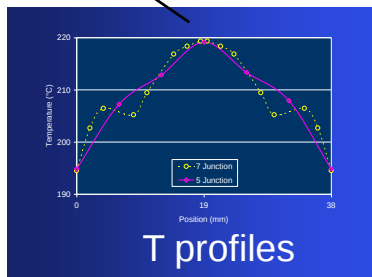
film blowing



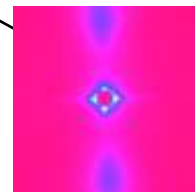
die swell



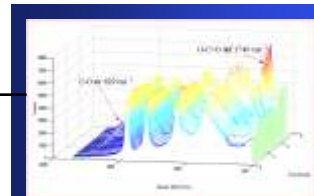
flaw detection/
Surface features



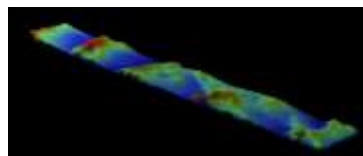
T profiles



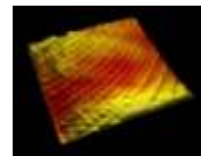
Xray scattering



spectroscopy



profilometry



AFM

+ process tomography

Carlton Street



Main machine hall

Dr Adrian Kelly, Dr Leigh Mulvaney Johnson, Dr Mike Martyn, Prof H Benkreira, P D Coates



- larger scale processing:
injection moulding, including gas and water-assisted injection, and
extrusion, including twin screw compounding, scCO₂, single screw

- Process & machine parameter monitoring;
- Process rheometry
- ultrasound
- Thermocouple meshes
- Process Energy

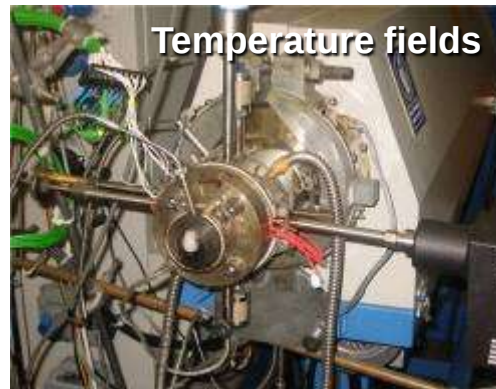


Main machine hall

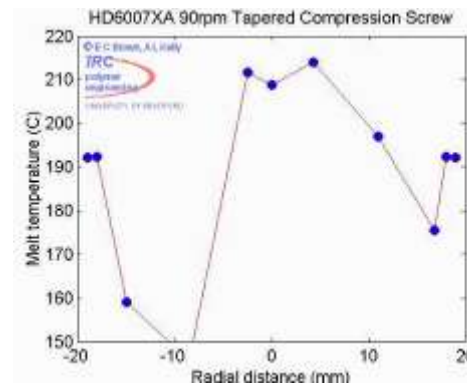
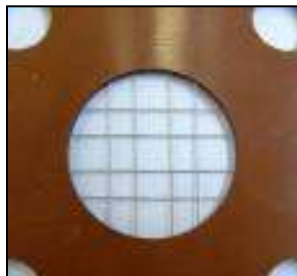


In-process measurement studies

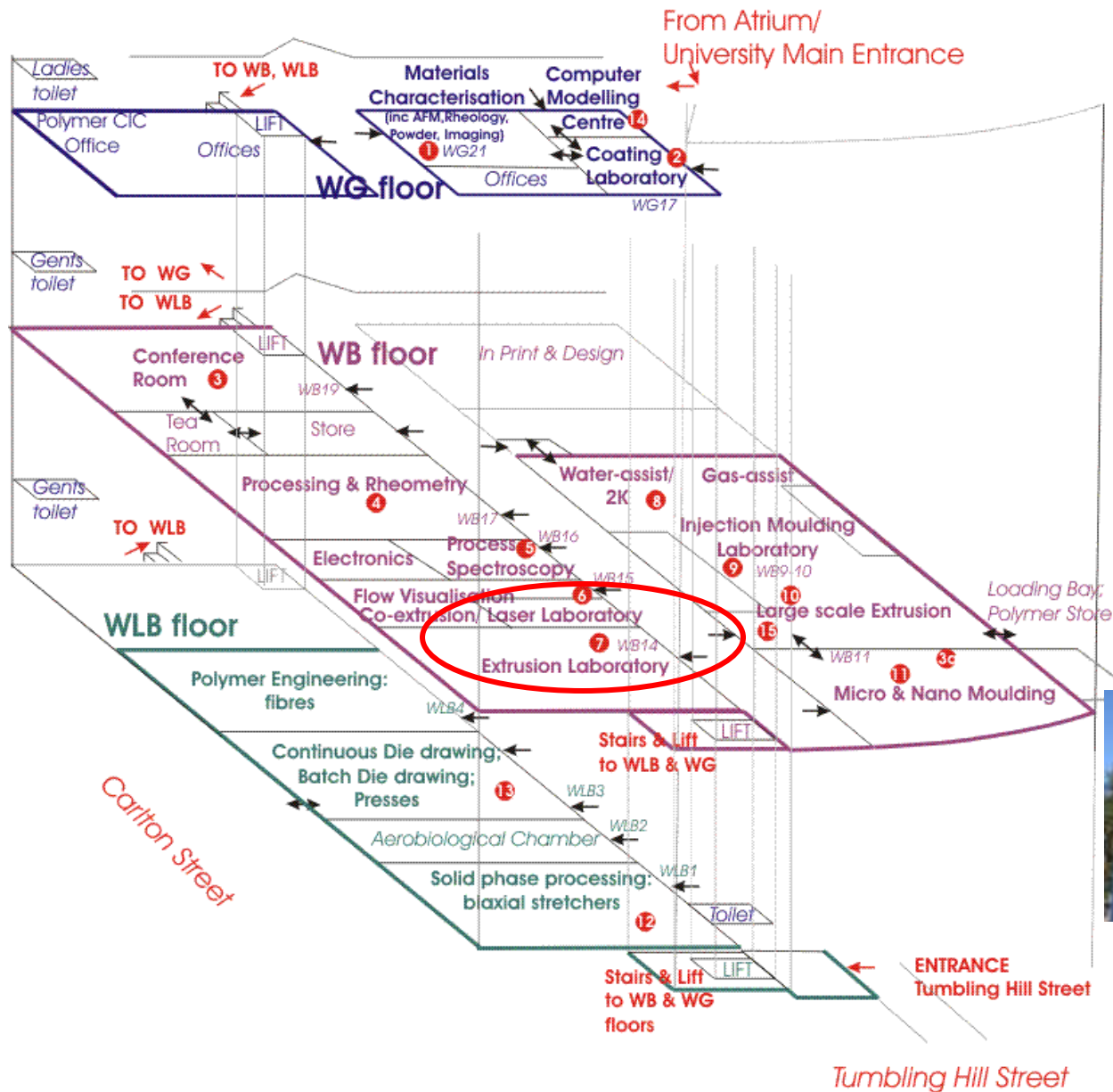
Dr Adrian Kelly, Dr Elaine Brown, Dr Mike Woodhead, P D Coates



- P, T, & machine parameter monitoring;
- ultrasound
- Thermocouple meshes
- Process Energy



Polymer IRC Laboratories, Bradford



Extrusion – films laboratory

Dr Adrian Kelly, Dr Mike Martyn, Dr Rob Spares, P D Coates



- Video imaging of film blowing, film casting,
- Extruded films and profile quality assessment by imaging



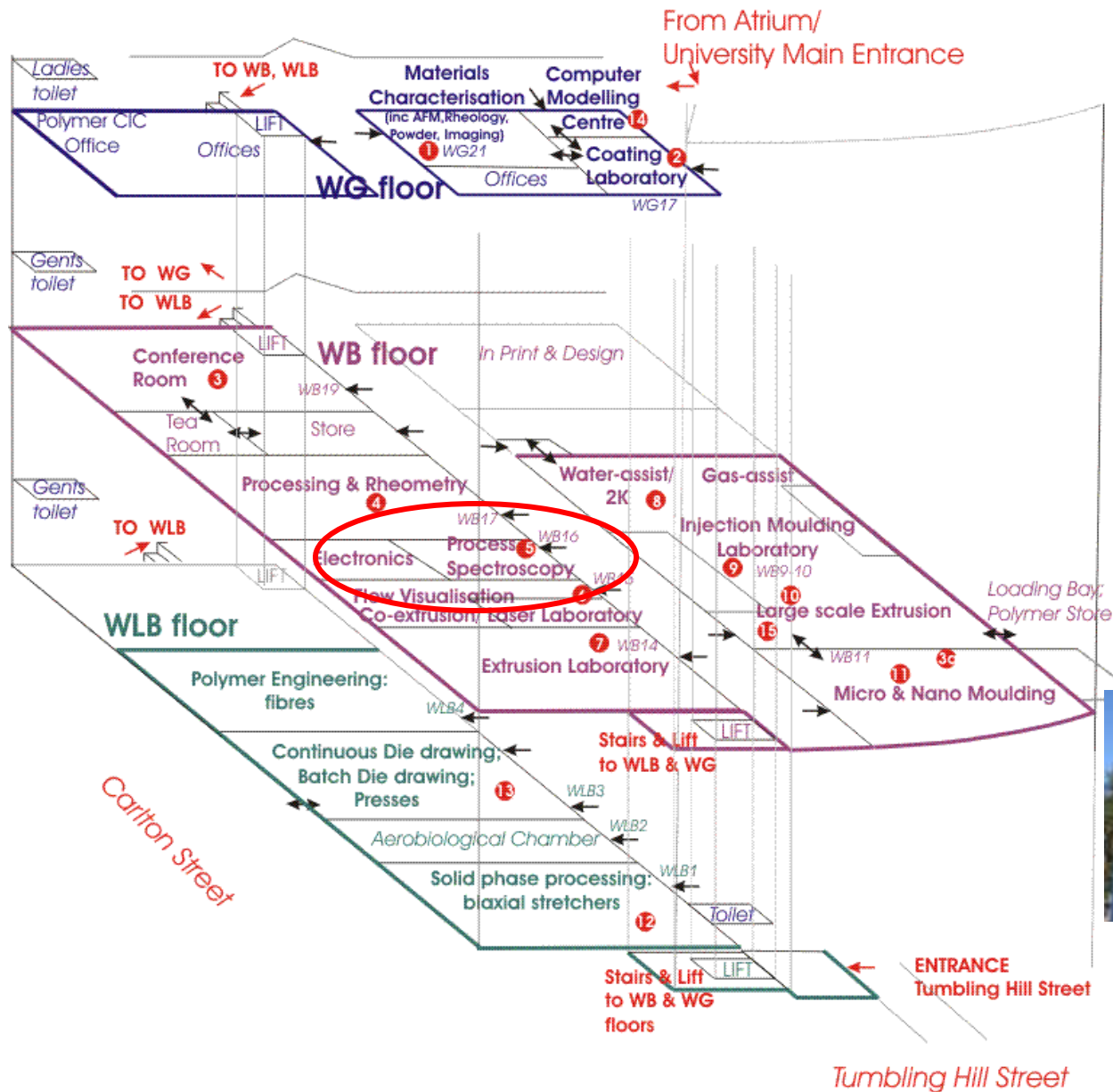
Pharmaceutical Engineering Science – Extrusion of drug formulations

Prof Anant Paradkar, Dr Adrian Kelly, Dr Tim Gough, Prof P York, Dr N Blagden, P D Coates

- Twin Screw extrusion of drug formulations
 - confidential programmes
- Pharmalab stainless steel 16mm twin screw extruder (40:1)
 - Process rheometry
 - Process spectroscopy



Polymer IRC Laboratories, Bradford



Coextrusion/rheo-optics laboratory

Dr Tim Gough, Dr Mike Martyn, Dr Adrian Kelly, P D Coates



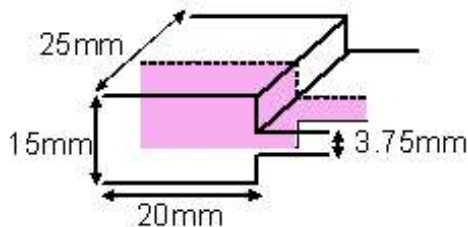
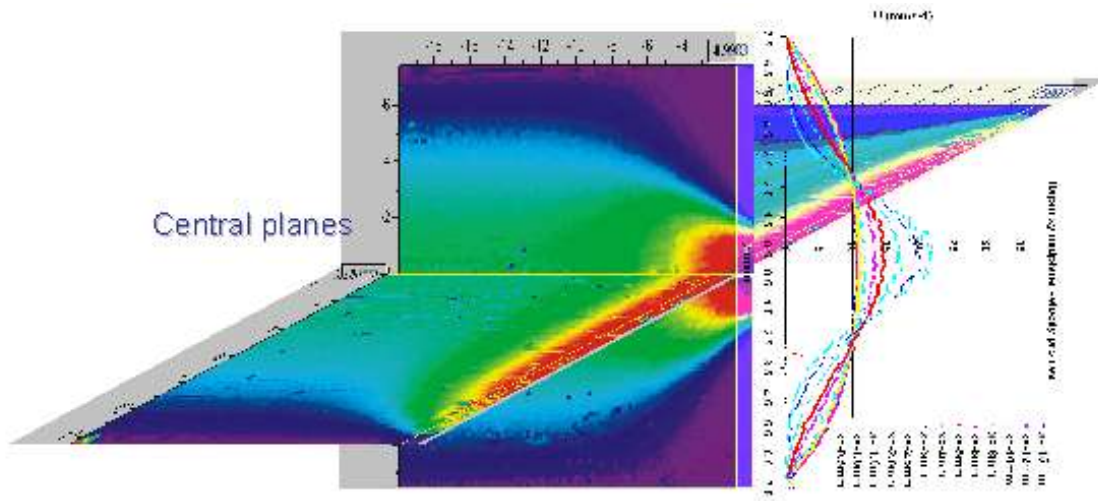
- 3-d particle velocimetry,
- stress birefringence
- SANS*
- WAXS **



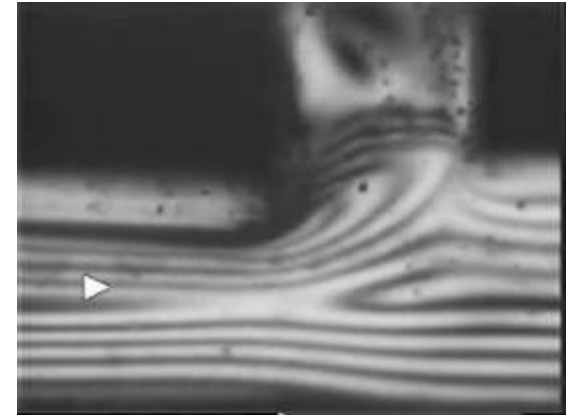
*ILLS Grenoble
** Grenoble, & Brookhaven

Coextrusion/rheo-optics laboratory

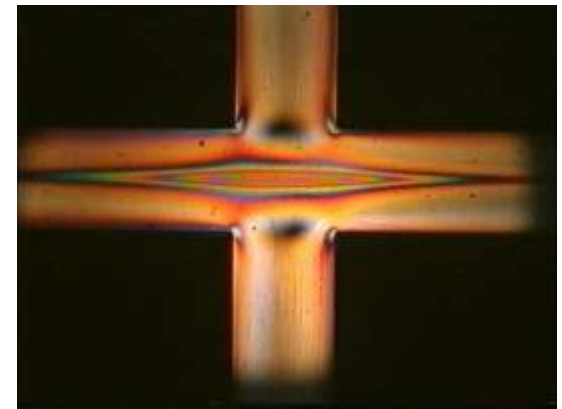
Dr Tim Gough, Dr Mike Martyn, P D Coates



Velocity fields measured for contraction flow, using laser sheet lighting and particle velocimetry



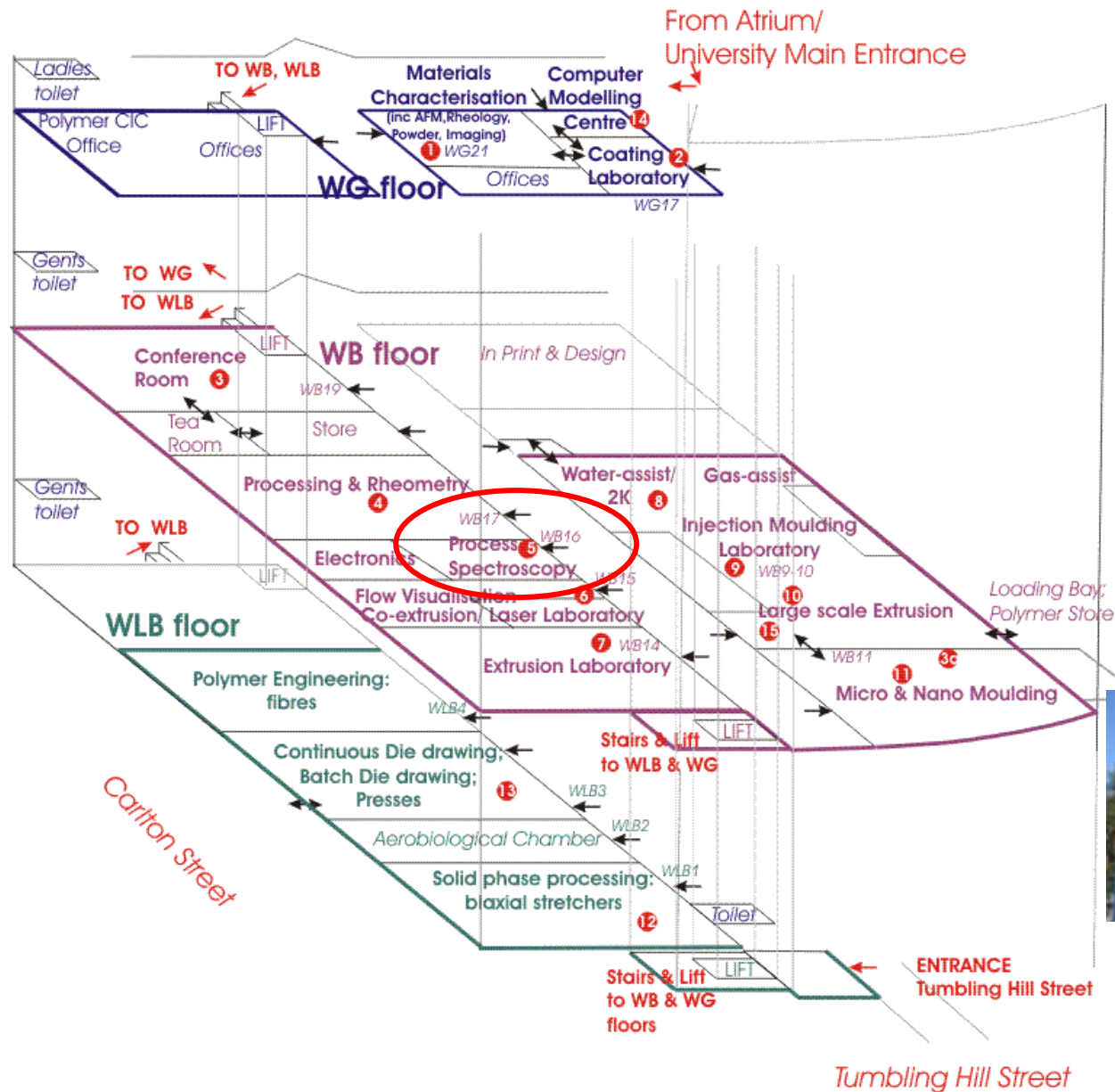
Flow birefringence



Cross-slot for extensional flow

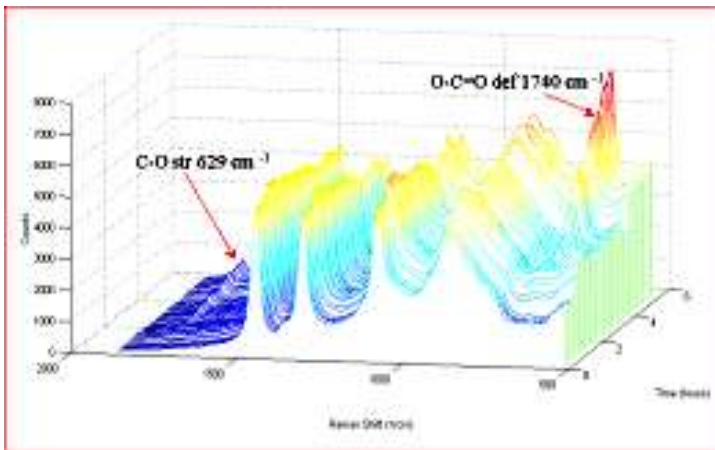
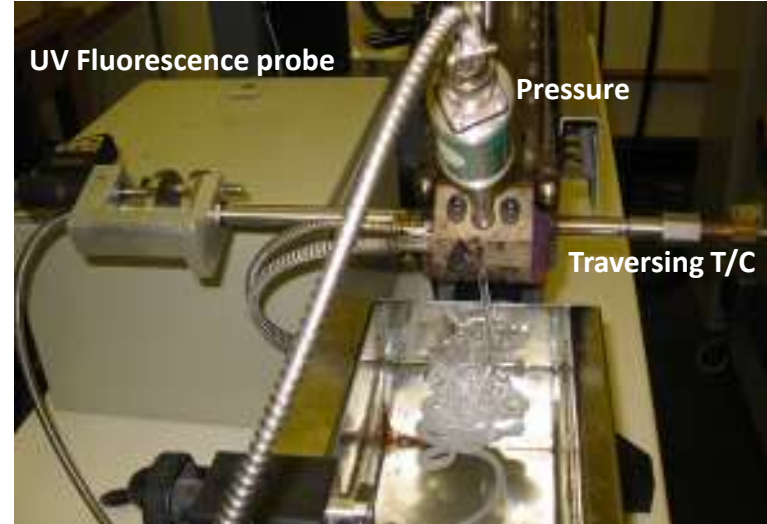
Part of the EPSRC 'MuPP2' programme, plus SANS and crystallisation studies

Polymer IRC Laboratories, Bradford



Reactive Extrusion & at-process spectroscopy

Dr Tim Gough, Dr Adrian Kelly, Dr Emma Burton, Prof H Edwards, P D Coates



Raman spectroscopy



NIR, UV, Raman, colour

Polymer IRC Laboratories, Bradford



Process development/ capillary rheometry laboratory

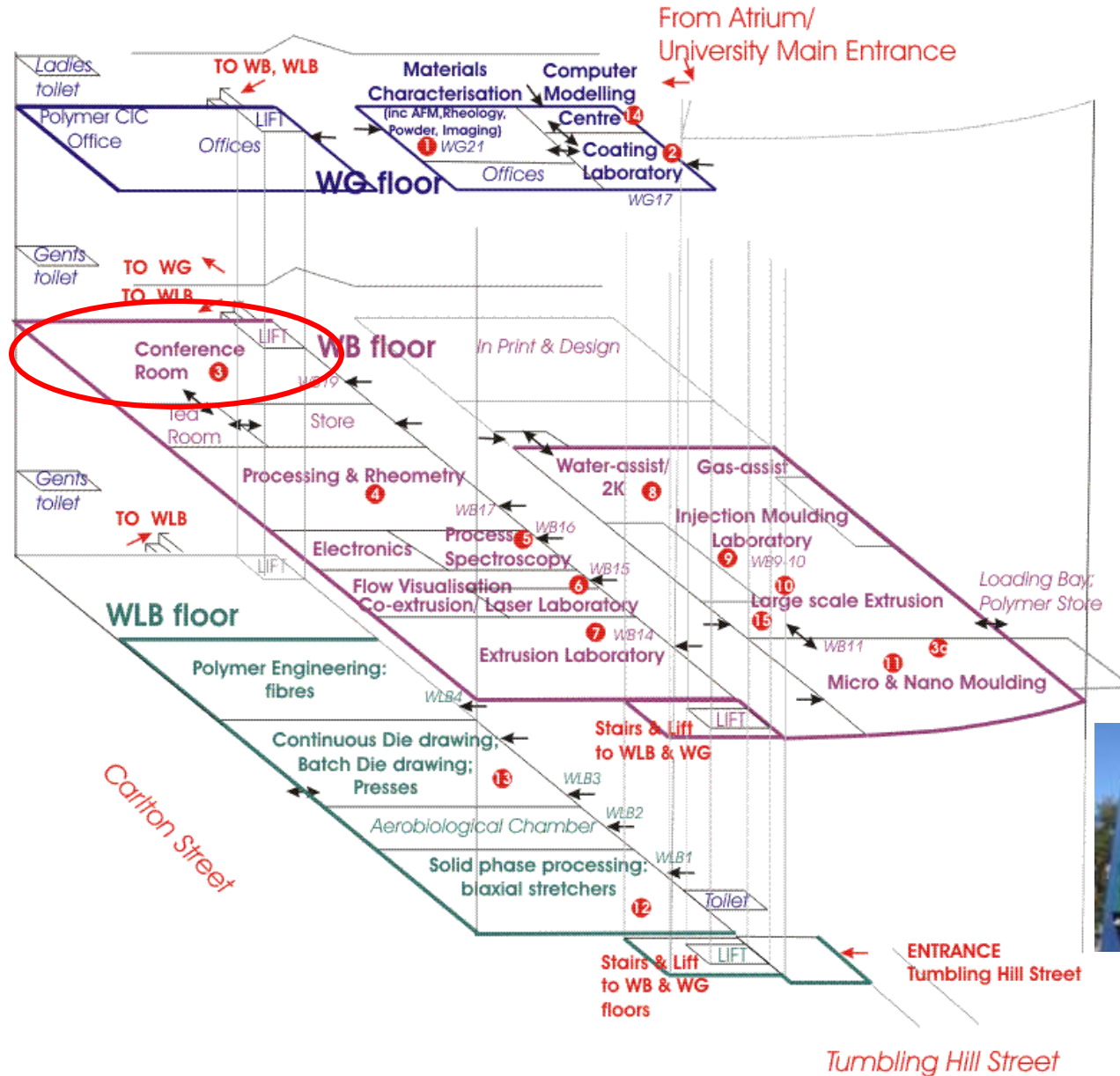
Dr Adrian Kelly, Dr Mike Martyn, Dr Ben Whiteside, Dr Mike Woodhead, J Wyborn, P D Coates



High force capillary rheometry
with hauloff;
16mm & 19mm twin screws;
MiniLab twin screw (5g);
mini single screw



Polymer IRC Laboratories, Bradford



Conference Room

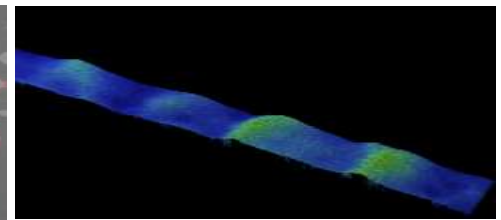
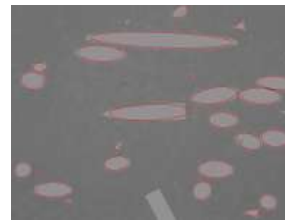
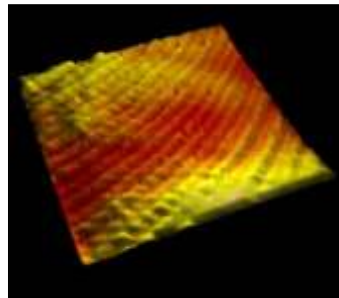
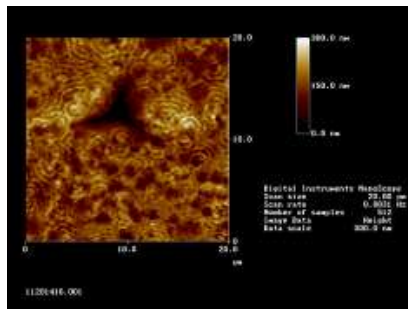


Polymer IRC Laboratories, Bradford

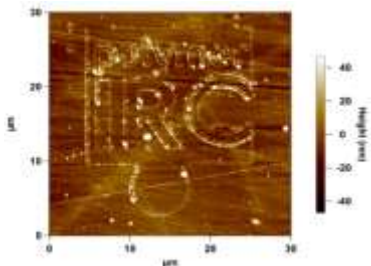


Advanced Materials Characterisation laboratory

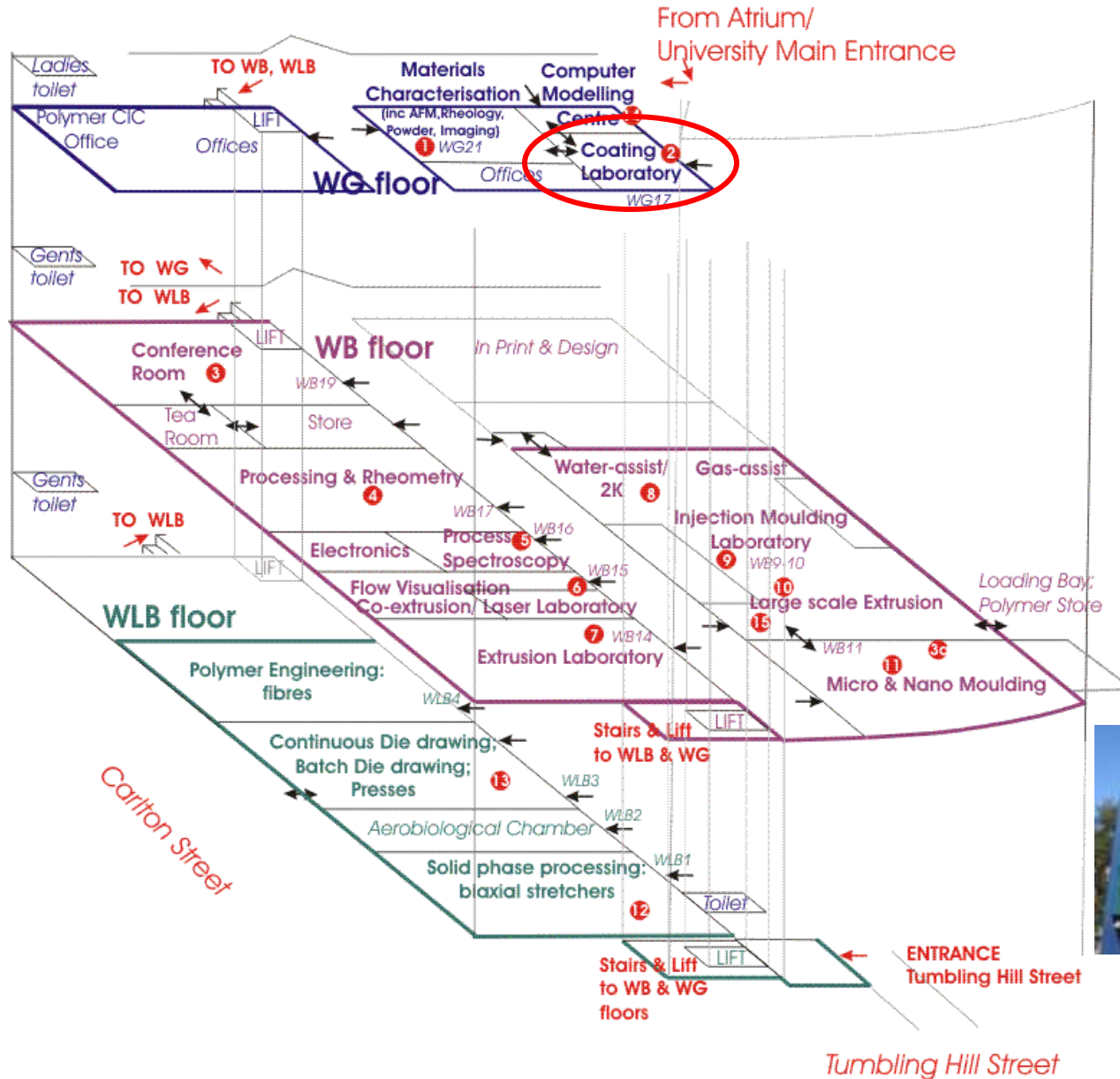
Dr Tim Gough, Dr Ben Whiteside, Dr Colin Grant, Dr Raj Patel, Prof Hadj Benkreira, Dr Fin-Caton-Rose, PDC



AFM, surface profiler, laser scanning,
rotational & extensional rheometry



Polymer IRC Laboratories, Bradford



Coating Laboratory (Prof H Benkreira, Dr R Patel)

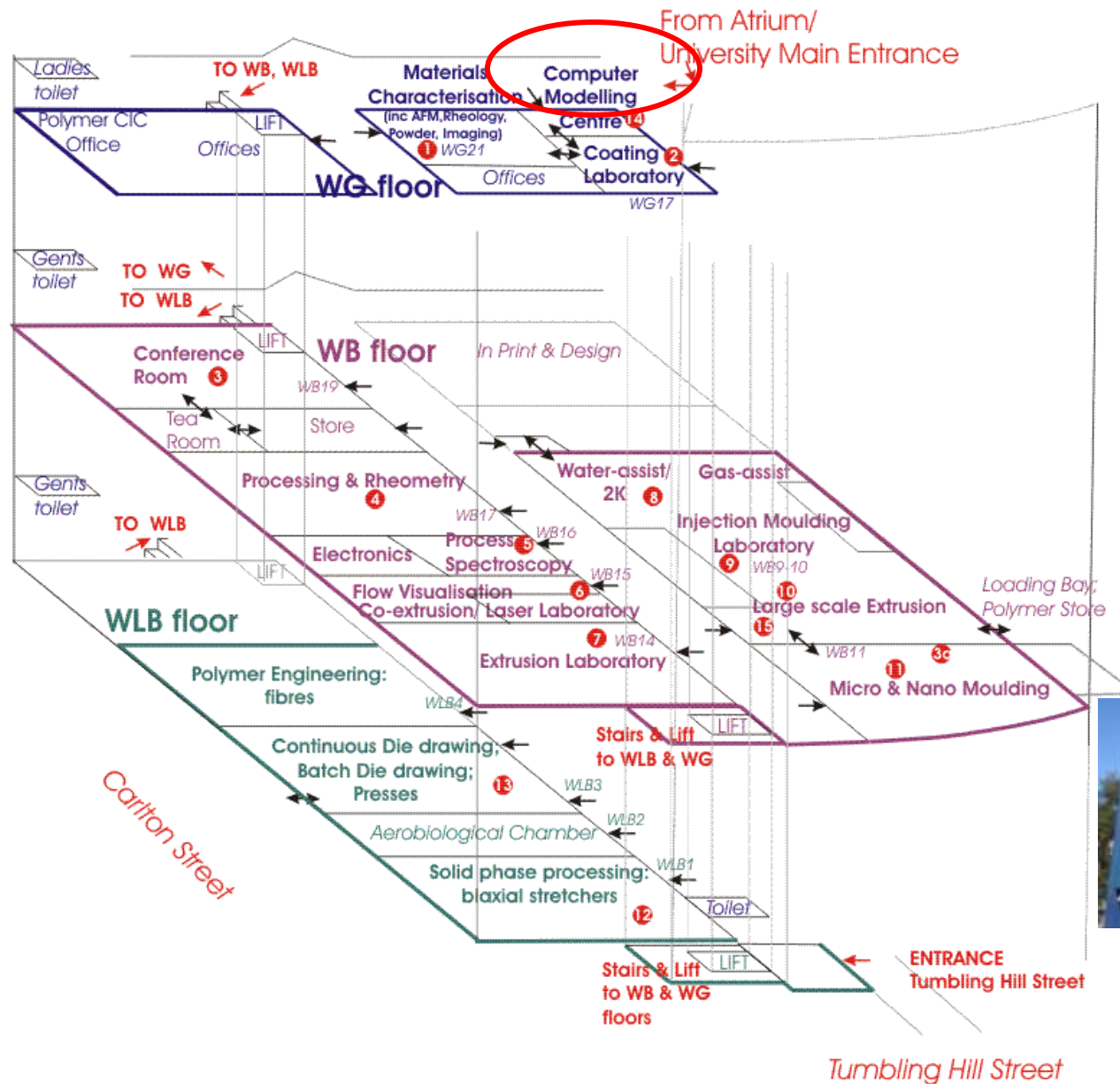


- Video imaging of coating
- small scale mixing/film blowing

Emphasis on rheology of coating flows



Polymer IRC Laboratories, Bradford



Computer modelling research centre

Dr Fin Caton-Rose, Prof John Sweeney, Dr Pete Olley, Dr Tim Gough, Dr Adrian Kelly, PDC

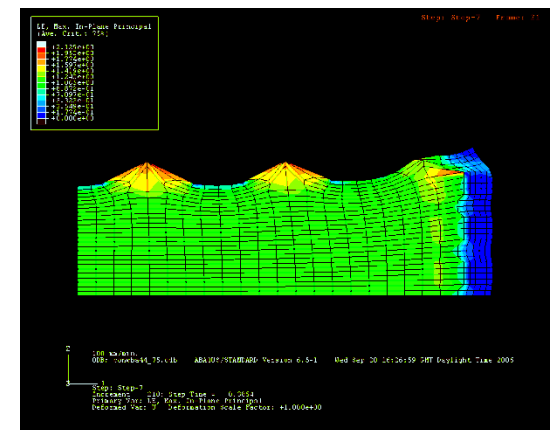
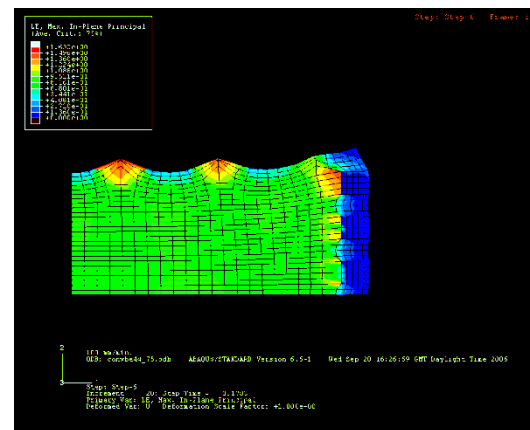
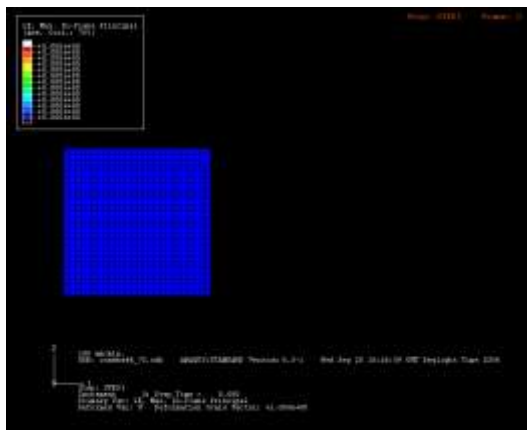
Includes:

- Moldflow
- Polyflow
- Compuplast
- Abaqus
- Ansys
- Matlab

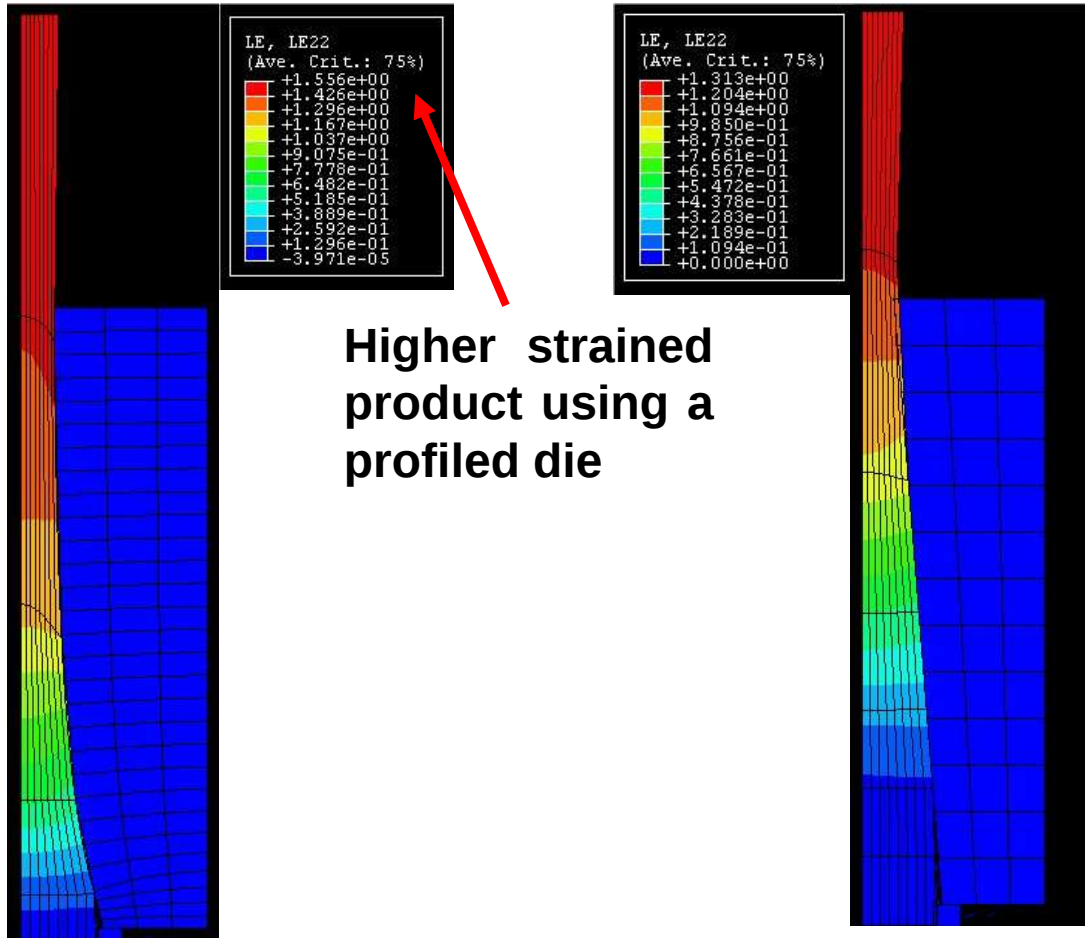


Computer Modelling Research Centre

Material tests such as constant width and biaxial deformation are analysed using finite element analysis and novel constitutive theories.

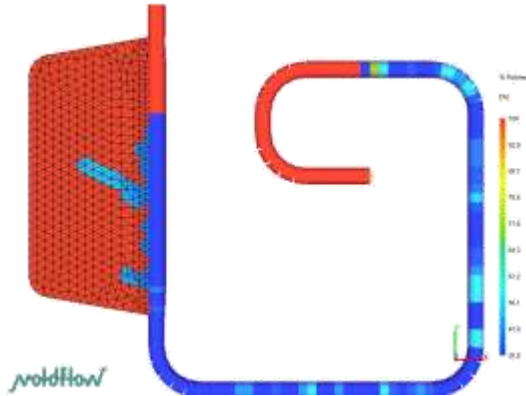


Computer Modelling Research Centre



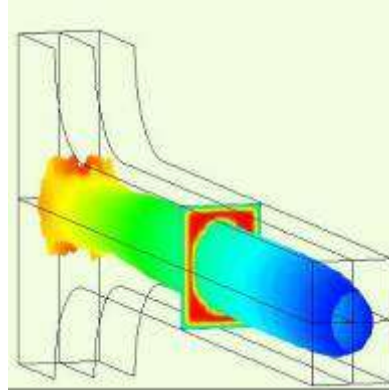
Theories developed during material characterisation stages are used to analyse polymer processes such as die drawing in order to optimise the process.

Computer Modelling: examples



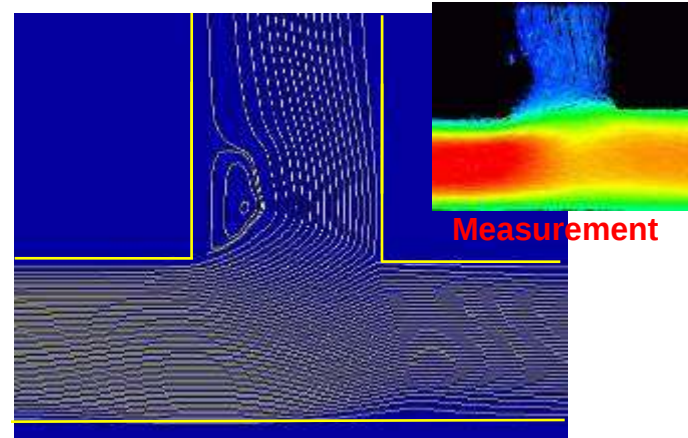
Gas injection: Moldflow

Dr L Mulvaney-Johnson



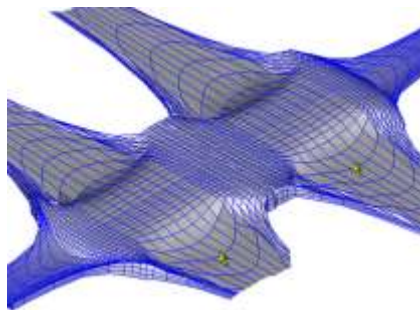
Fluid-assisted injection

Dr P Olley



Viscoelastic Calculation:

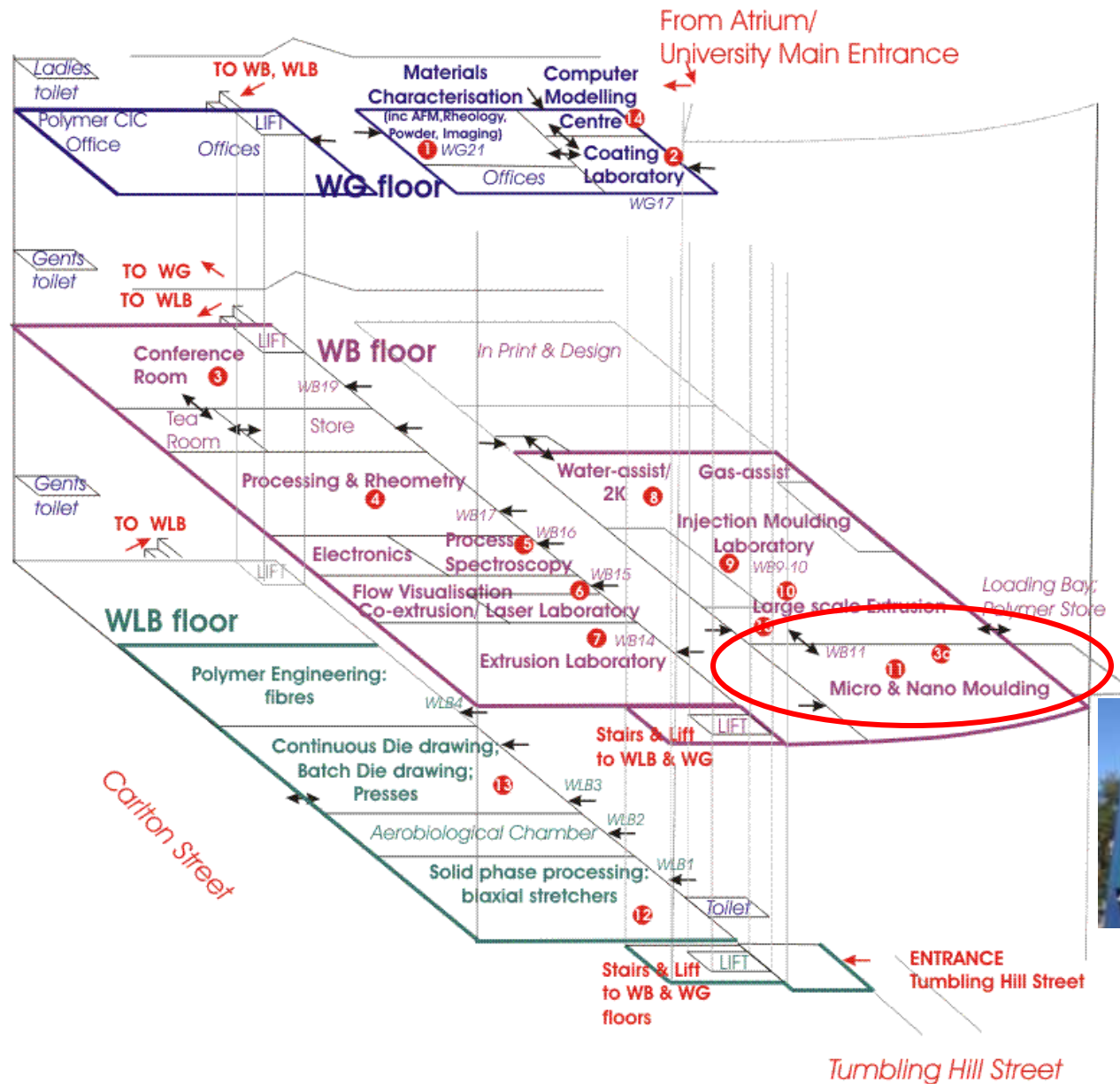
Compuplast; Dr M Zatloukal



**Solid phase processing,
with constitutive equation
development**

Drs J Sweeney, P Caton-Rose

Polymer IRC Laboratories, Bradford



Micro & Nano Technology Laboratory



Micro & Nano Technology laboratory

Dr Ben Whiteside, Dr Mike Martyn, Dr Tim Gough, Dr Rob Spares, PD Coates

- in-cavity high speed video imaging
- machine parameters
- in cavity P, T, rheo-optics, shrinkage
- high strain rate rheometry



MiG
www.ukmig.com



Polymer MNT lab

- in-cavity high speed video imaging (linescan to 150k l.p.s)
- machine parameters
- high speed thermal imaging, to ~2500 f.p.s



Micromoulding & novel Micromoulding In Line Compounding



Micro&Nanomoulding – some products

0.34mg gear blank



~200mg stepped plaque

~180mg strip

HAPEX™ – HDPE + Hydroxyapatite bone substitute with IRC Biomaterials

micro-gears

~1 µg
*Juken

~10 µg

surgical clip†

micro-filter††

micro-actuator††

deuterated-PE for SANS (orientation)

†BMicrosystems

††Battenfeld

Nanocomposite mouldings:

Hapex™ for cochlear implant surgery

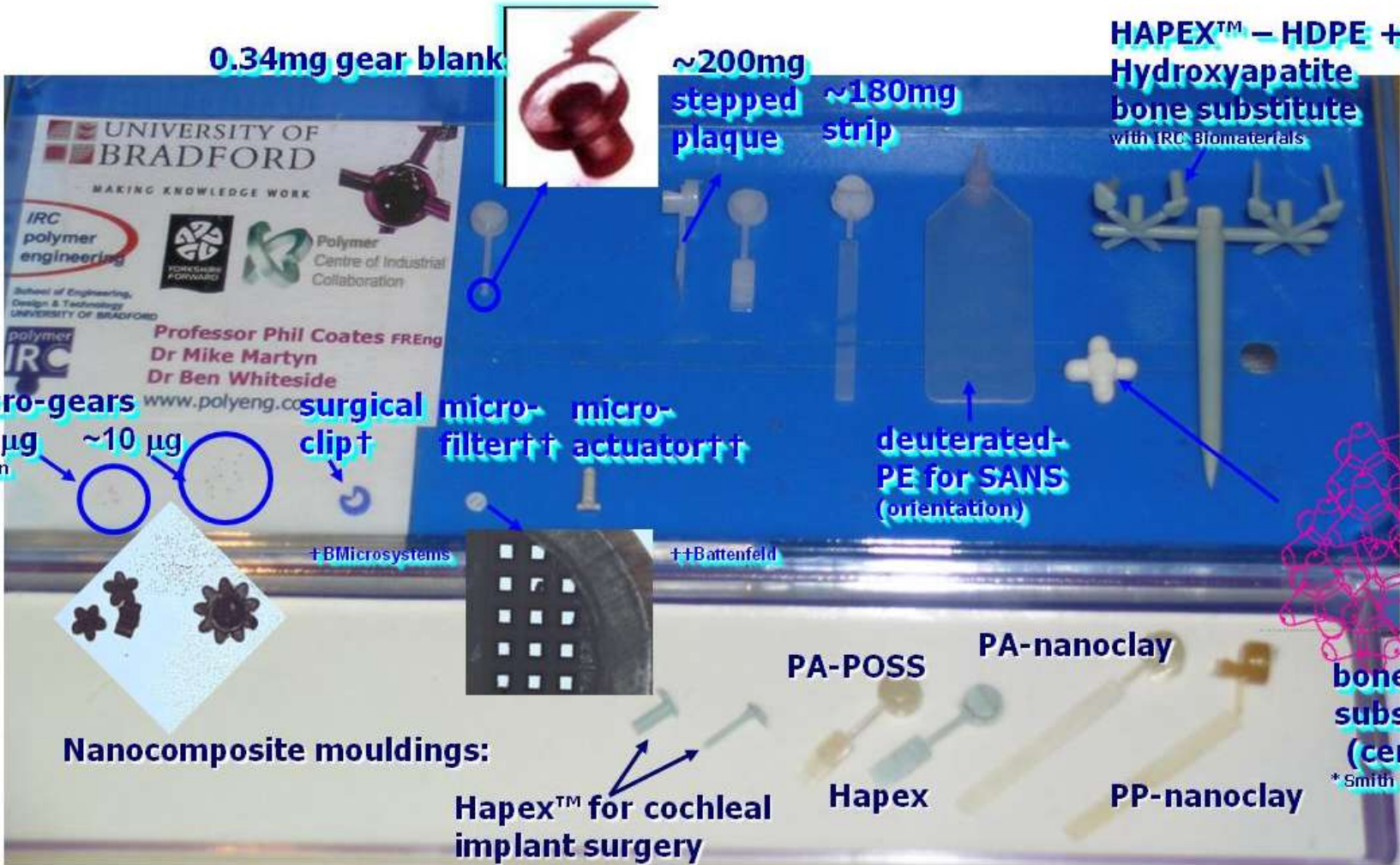
PA-POSS

PA-nanoclay

Hapex

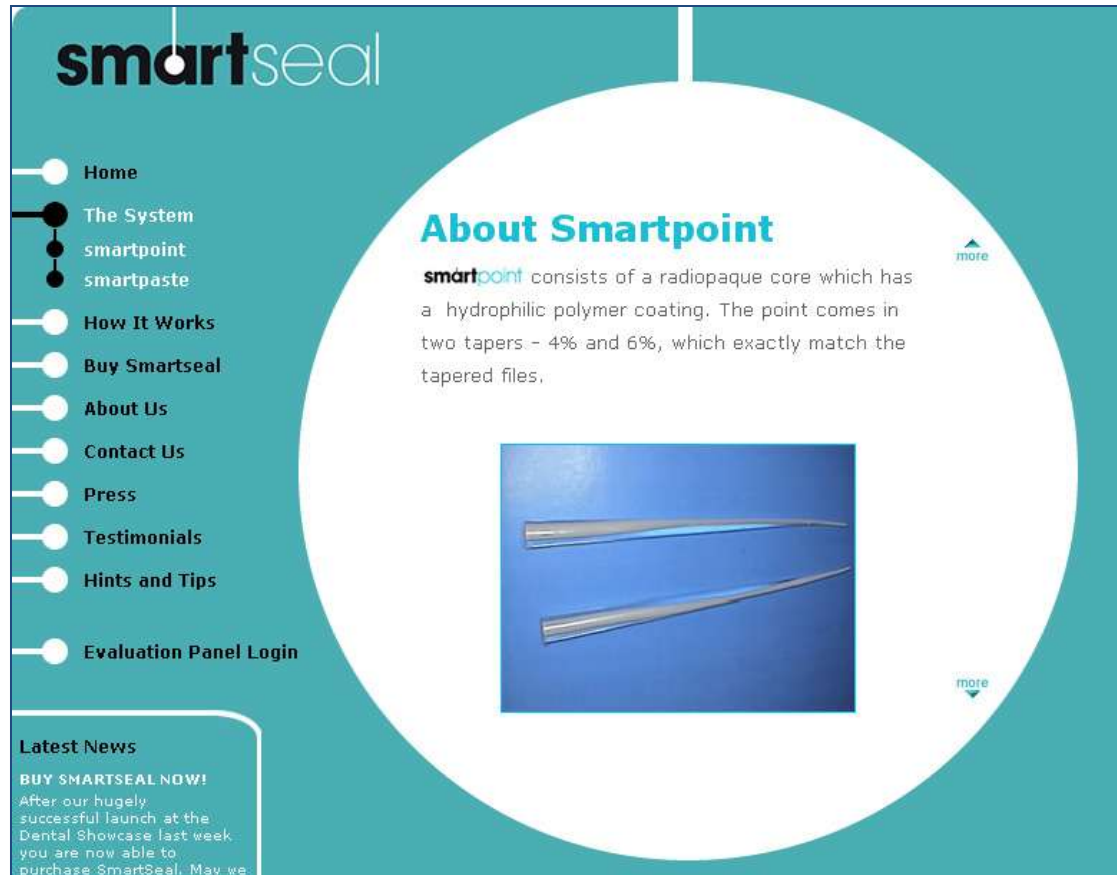
PP-nanoclay

Jax* bone graft substitute (ceramic)
*Smith & Nephew



DRFP – a case study

- Product launched October 2007 at UK NEC
- Currently >200,000 products manufactured at the centre in a fully automated process
- Winner Plastics Industry Best Technology award 2008
- Winner Medical Excellence award, US 2011



The screenshot displays the SmartSeal website interface. On the left, a vertical navigation menu lists: Home, The System (with sub-items smartpoint and smartpaste), How It Works, Buy Smartseal, About Us, Contact Us, Press, Testimonials, Hints and Tips, and Evaluation Panel Login. The main content area features a large white circle containing the heading 'About Smartpoint'. Below this, text describes the smartpoint as a radiopaque core with a hydrophilic polymer coating, available in 4% and 6% tapers. An image shows two dental files against a blue background. A 'more' link with an upward arrow is positioned to the right of the text, and another 'more' link with a downward arrow is at the bottom right of the circle. A 'Latest News' section at the bottom left contains a promotional message about the product's launch at the Dental Showcase.

smartseal

- Home
- The System
 - smartpoint
 - smartpaste
- How It Works
- Buy Smartseal
- About Us
- Contact Us
- Press
- Testimonials
- Hints and Tips
- Evaluation Panel Login

About Smartpoint

smartpoint consists of a radiopaque core which has a hydrophilic polymer coating. The point comes in two tapers – 4% and 6%, which exactly match the tapered files.



more

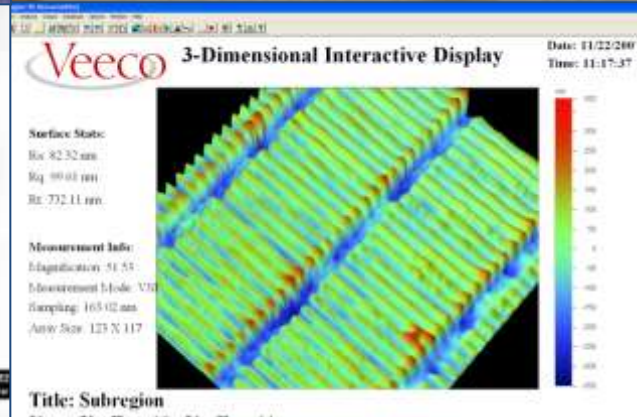
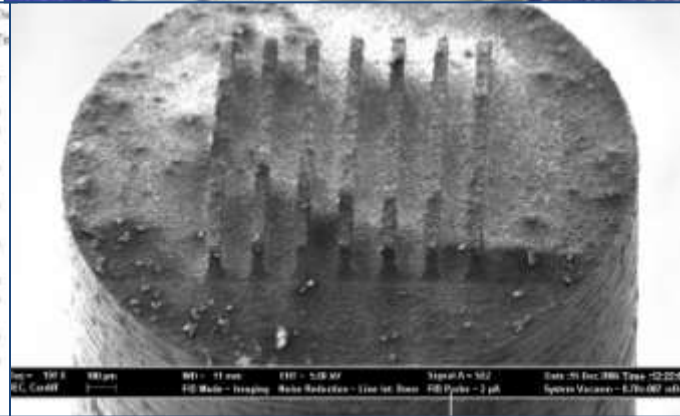
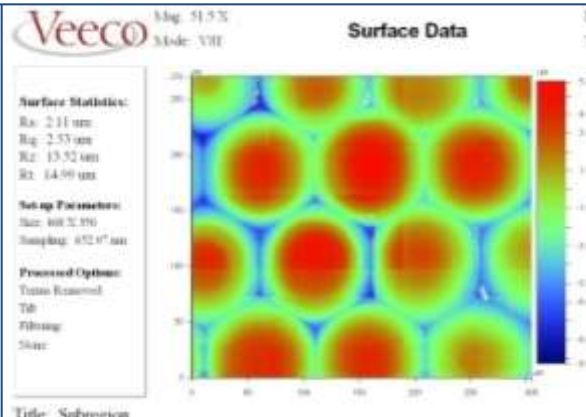
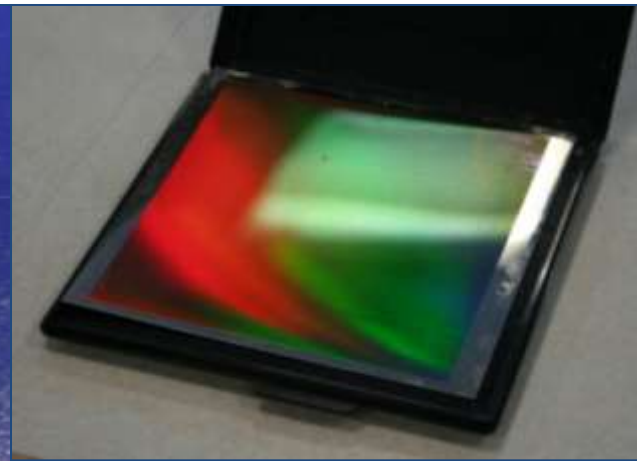
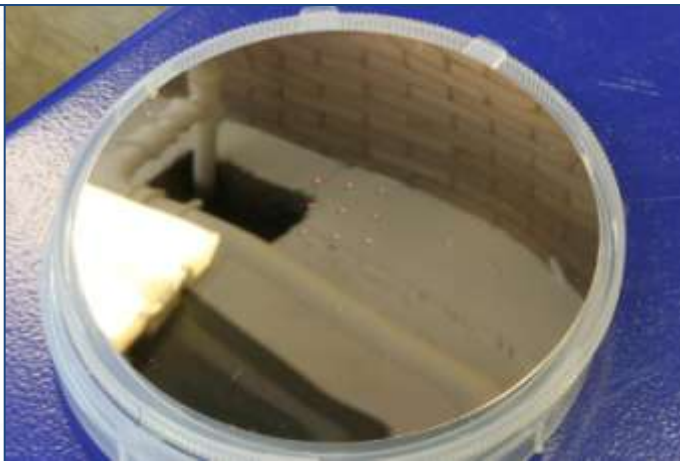
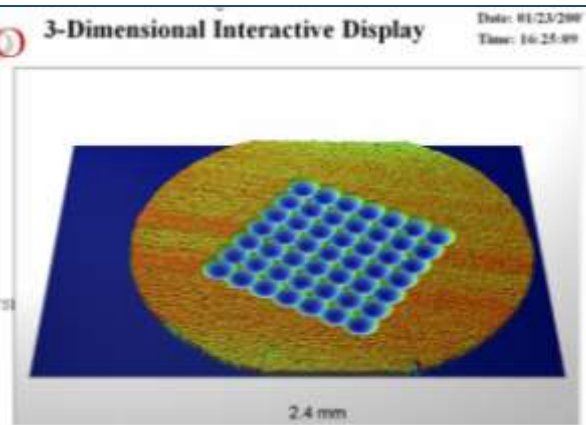
more

Latest News

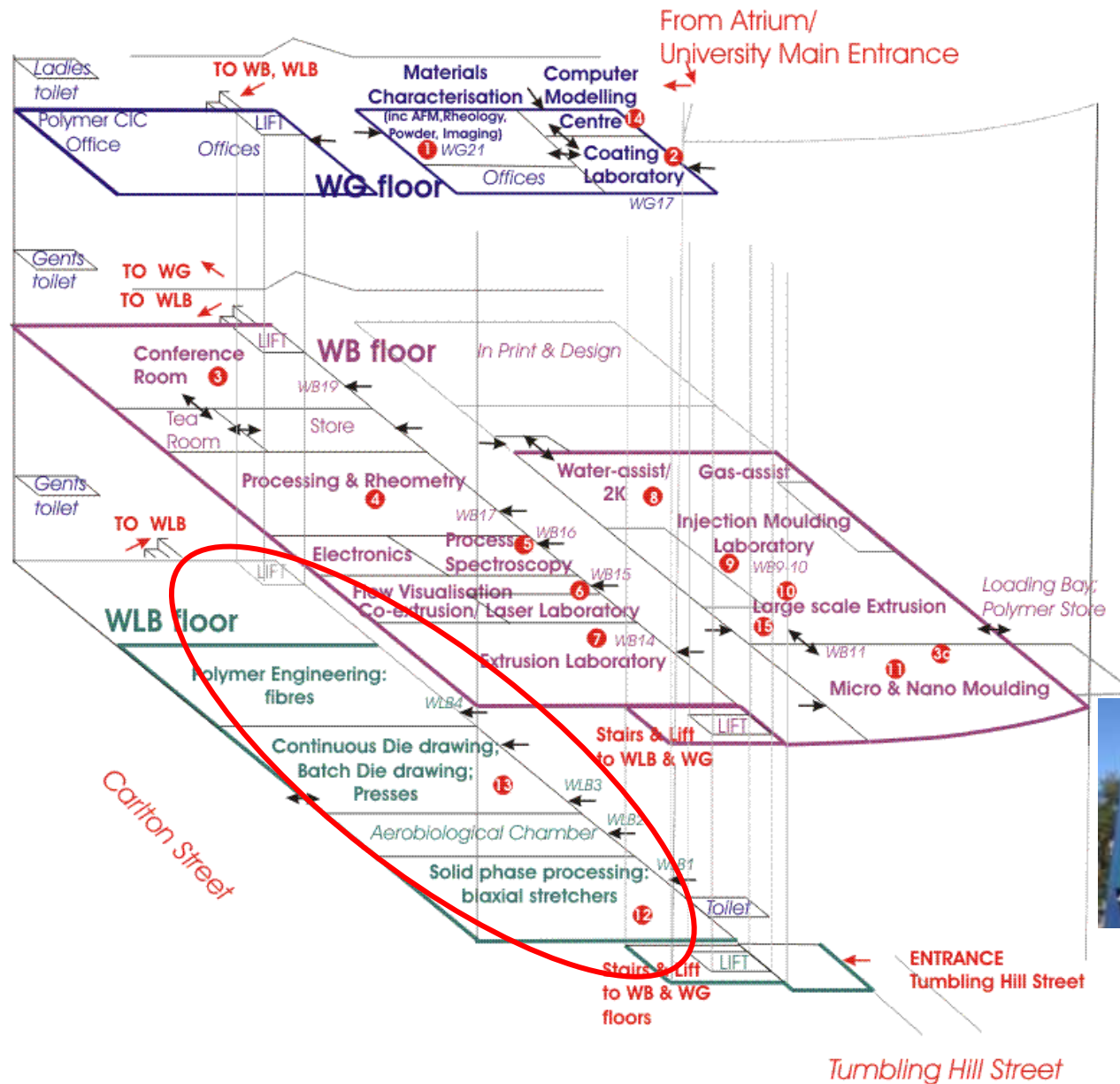
BUY SMARTSEAL NOW!
After our hugely successful launch at the Dental Showcase last week you are now able to purchase SmartSeal. May we

Surface feature studies:

Including Thermal contact resistance; surface structuring



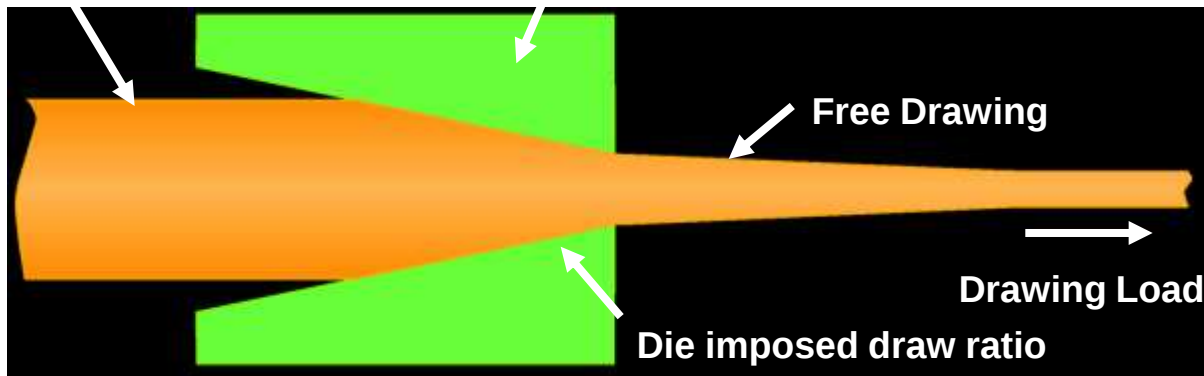
Polymer IRC Laboratories, Bradford



Solid Phase Processing

Dr Fin Caton-Rose, Dr John Sweeney, Dr Mike Martyn, Prof Ian Ward FRS, PDC

The IRC Solid Phase Processing has close links with the Computer Modelling Research Group and investigates the solid phase deformation behaviour of polymeric materials during processes such as die drawing.



**Stress, strain and strain-rate fields are crucial !
Can be used to form oriented sheet, rod and tube**

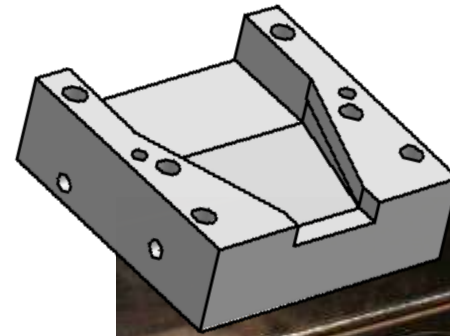
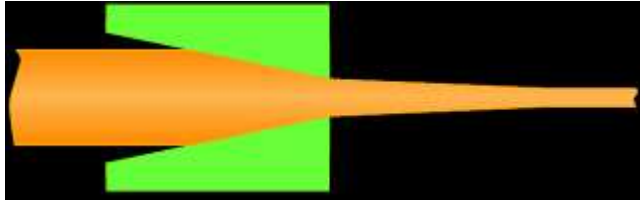
Die drawing laboratory

Large scale batch and continuous processes, to >1 m/min



Solid Phase Processing

Exploits molecular orientation and anisotropic property changes



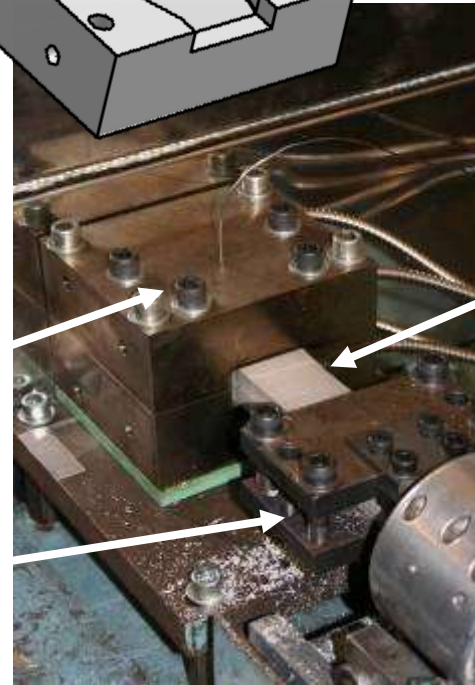
Oven

Chain
drive



Die

Clamp



Oriented
polymer
product

Solid Phase Processing

Deformation processes such as uniaxial, biaxial and constant width are employed for material characterisation.



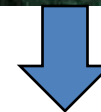
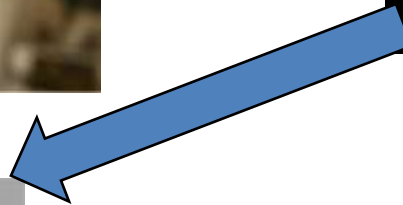
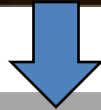
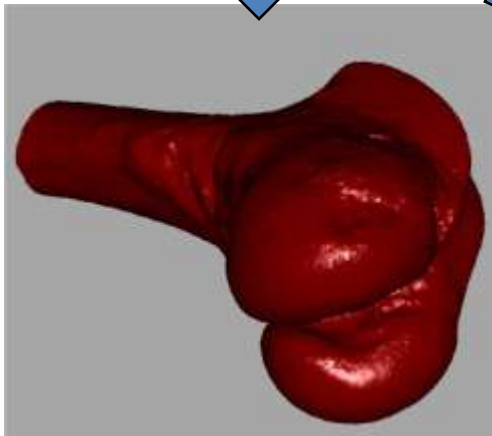
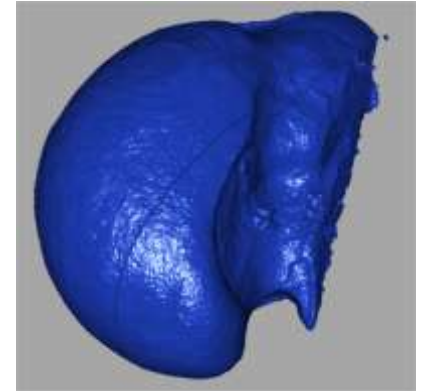
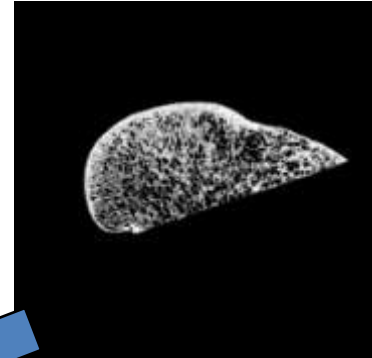
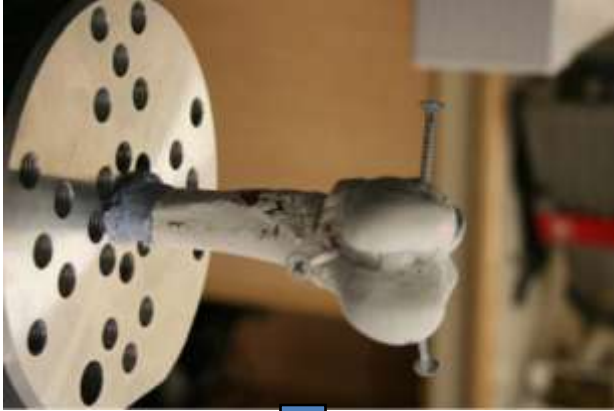
Biaxial and constant width testing

Fatigue/ Tension/compression facilities

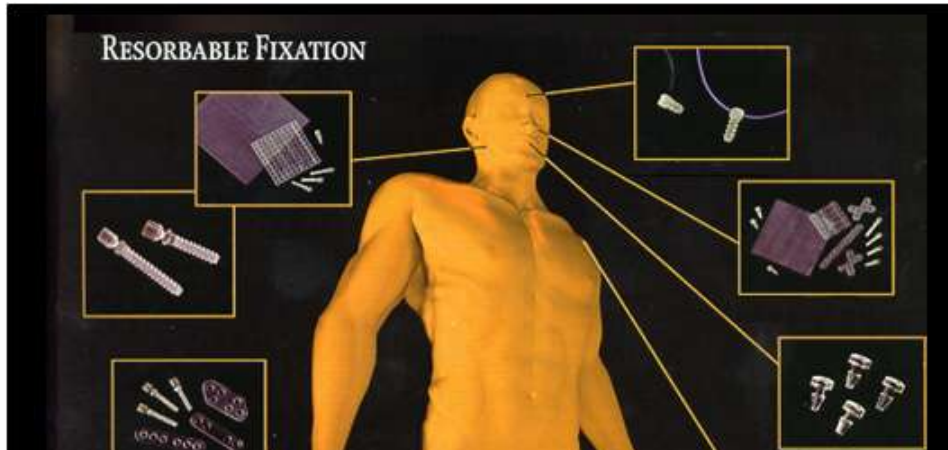


Orthopaedics – biomedical applications research – articulating surface repair

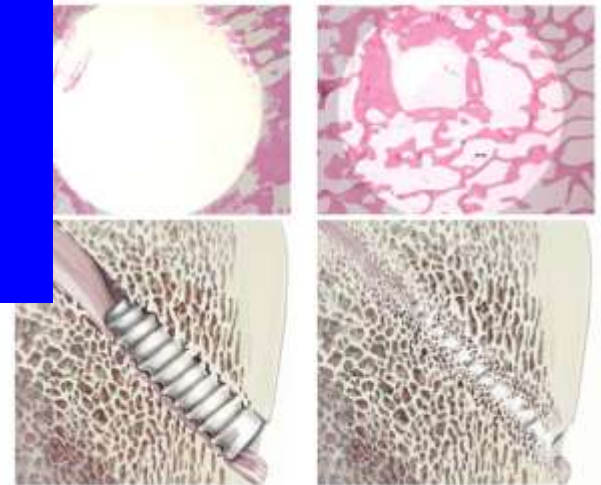
Dr Fin Caton-Rose, Dr Mike Martyn, PD Coates



Bioresorbable bone & soft tissue fixation – shape memory polymers (PLAs)



Polymer	Tensile Strength (MPa)	Tensile Modulus (GPa)
PGA	65	3.5
Oriented PGA	300	12
PLLA	70	4
Oriented PLLA	250	8



The end of the tour, for today..

- Some – by no means all - of the extensive range of our facilities and programmes have been shown on this tour; please contact us for more details;
- All visitors are welcome in person!

www.polyeng.com; www.polymerirc.org

Polymer IRC, 2012

- The Polymer IRC (Leeds, Bradford, Durham & Sheffield) is an international 'brand' – founded in 1989, it maintains a high level of recognition
- PDC is now Executive Chair of the Polymer IRC Directors,
- www.polymerirc.org web site now resides with us – and is being updated
- the IRC Spring meeting was held at Bradford on 2 April 2012

Academic involvement - 1

- We maintain **excellent relationships** with many universities – e.g. in the UK (Leeds, QUB, Sheffield, Durham, York, Huddersfield, Sheffield H; ‘MuPP’ group); Europe; China (esp. Sichuan, BUCT, ICCAS, Changchun; ongoing Science Bridges China programme) and other international groups
- **academic drive** is still associated with the polymer processing steps, particularly structuring materials via processing, and has developed into associated areas in advanced materials for healthcare, resource efficiency, micro & nanotechnology and pharmaceuticals. Where next? – much opportunity at the engineering-life sciences interface, but we are also alive to other opportunities.

Academic involvement - 2

- continue to develop Advanced Materials Engineering (~Feb13), Polymer Micro & Nano Technology (~July 12) and Pharmaceutical Engineering Sciences RKT Centre (~Feb 13)
- a range of good investments and appointments made.

Our Themes include:

- healthcare technologies – advanced materials, pharmaceuticals
- MNT and precision processing; structuring?
- solid phase orientation
- resource efficiency, inc. upcycling, fuel cells
- biophysics

Industry involvement

- Our lab currently has ~100 companies associated with us!
- The Polymer Centre of Industrial Collaboration (CIC) brand name is worth maintaining, under the umbrella of the Polymer IRC
- Renew the Industry Group technical/business meeting, perhaps 2 or 3 p.a., with ~ half day meetings – aim for up to 50 companies attending.
- many exciting collaborations ongoing, new ones arising
- potential for spin-out companies



2011-12 – *some* events

- Science Bridges China (SBC) Research Workshop, Beijing 14-15 Nov 2011
- Autodesk University, Las Vegas Nov 2011
- PPE'11, 6-7 Dec 2011
- SBC Open Innovation Workshop, Guangzhou March 2012
- SPE Antec 2-4 April 2012
- IRC Spring Meeting 2 April 2012
- SBC 2nd Research Workshop, Chengdu ~ 20-22 April 2012
- PPS Americas 21-24 May 2012
- IUPAC, Virginia Tech, 24-29 June 2012
- July China visits
- October China visits
- PPS 28, Thailand 10-15 Dec 2012

Examples of large projects following on:

- National/international:
**EPSRC Microscale Polymer Processing
programme (MuPP1 and MuPP2)**
- International:
**RCUK Science Bridges China &
EPSRC Global Engagements programmes**

Microscale Polymer Processing Consortium

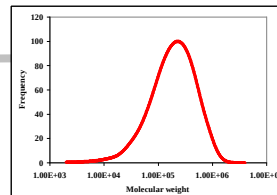
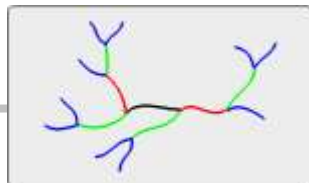
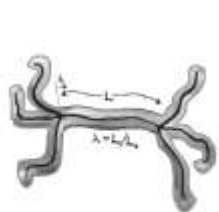
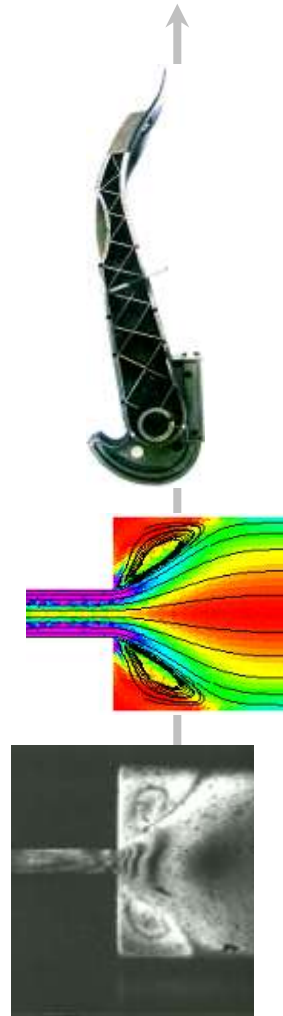
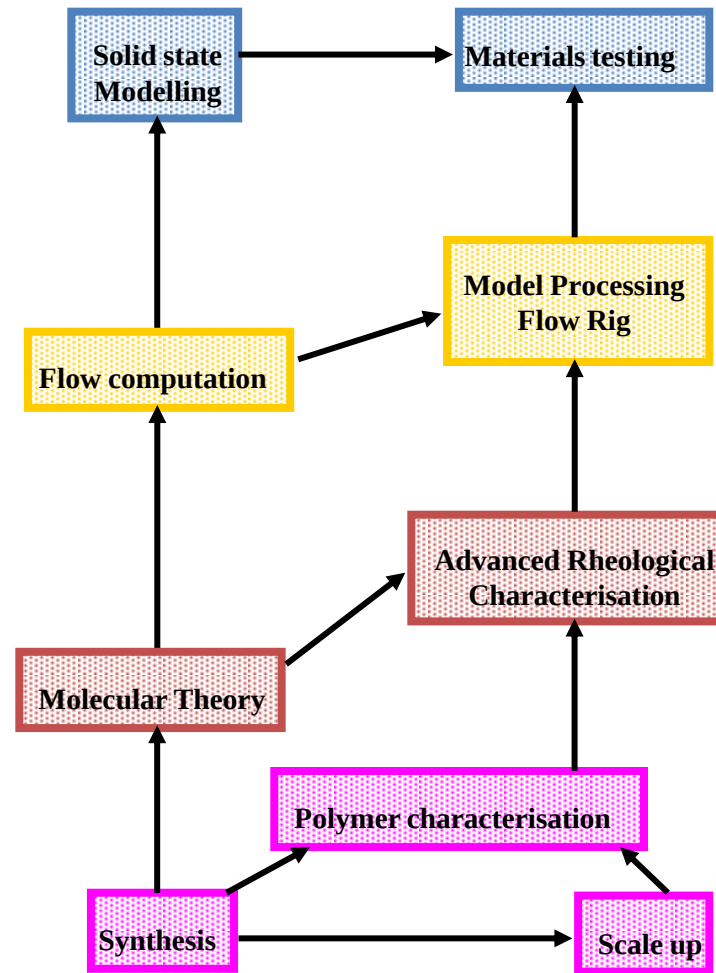


TuE

*BASF, Innovene, Mitsubishi, Dow,
Du Pont, DSM, ICI, Lucite*

Microscale Polymer Processing Consortium

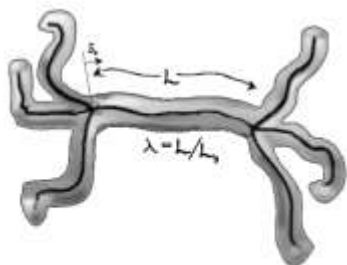
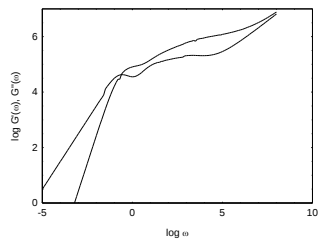
"Follow the processing path of well characterised polymers from synthesis through processing and property evaluation combined with the parallel development of a mathematical and computational protocol."



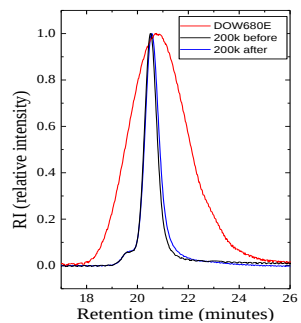
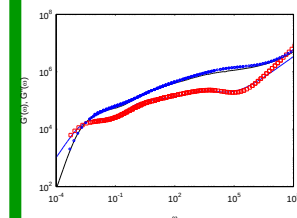
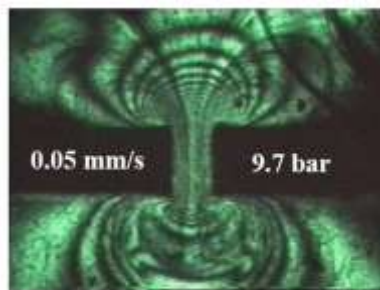
$$\frac{d\sigma}{dt} = -\frac{1}{\tau_d}(\sigma - IG_0) + \kappa\sigma + \sigma\kappa^t - \frac{\left(1 - \sqrt{\frac{3G_0}{tr\sigma}}\right)}{\tau_R} \left(\sigma + \beta \left(\frac{tr\sigma}{3G_0} \right)^\delta (\sigma - IG_0) \right)$$

Microscale Polymer Processing Consortium

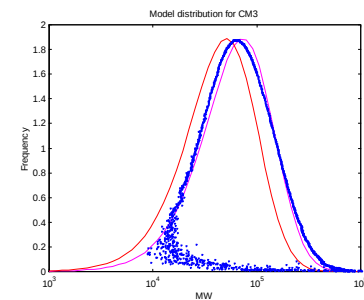
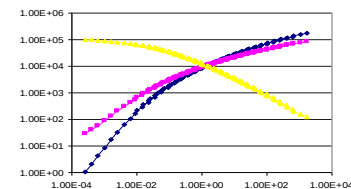
THEORY



MODEL MATERIALS



INDUSTRIAL RESINS



The UK Polymer Interdisciplinary Research Centre Bradford – international dimension

- EPSRC Virtual Institute (with 10 Chinese Universities)
www.polymervip.com
- Micromoulding Interest Group (>40 organisations worldwide) www.ukmig.com
- International Polymer Processing Society excellence centre
- academic links with > 30 overseas universities
- industrial contracts with US, Japanese, European and Australian companies
- Science Bridges China award, with IPI
- Prof Coates Honorary Professor at Sichuan and Beijing University of Chemical Technology; Molecular Sciences Forum Professor, ICCAS Beijing; also Chief Editor of the international journal of the Institute of Materials, Minerals and Mining



Science Bridges China

- Home
- What is Science Bridges China?
- Science Bridges at 2010 Shanghai Expo
- Meet the Science Bridges Team
- Gallery

You are here: Science Bridges China

Welcome to Science Bridges China

The University of Bradford has a range of international research (over 80% of our research was recognised to be of international standing) and international education programmes.

Over the past decade we have partnered with Chinese Universities, initially in collaborative teaching provision but increasingly across the range of research, open innovation and teaching provision. We are firm believers in 'People Bridges' – establishing friendly links between key academics in Bradford and our Chinese partners, and building up a range of co-operations based on these bridges.

Bradford's Science Bridges China, a £1.3m RCUK programme, is the latest and largest platform for such activities, and has already led to further funding support in China for collaborative research through MOST, MOE and NNSFC and for open innovation in healthcare technologies initially through Changzhou City Government, with other programmes under development.

We welcome the expansion of these collaborations!



[Science Bridges China Brochure \(pdf, 1766KB\)](#)

Follow our blog

"Science and technology are primary productive forces."

Xiaoping Deng, former leader in China, "The Chief Architect of China's Economic Reforms" 1988

Science Bridges China - an introduction

by UniversityOfBradford

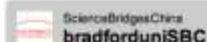


Contact us

Dr Qun Shao

China Programme Manager
Institute of Pharmaceutical
Innovation, School of Life
Sciences

E: q.shao@bradford.ac.uk



bradforduniSBC very proud to have won the Interdisciplinary Working Award from the KT Awards at @BradfordUni as part of the @BradUniReshKT event.

322 days ago · reply · retweet · favorite

bradforduniSBC Getting ready for this afternoon Research & Knowledge Transfer Showcase! Come see what's going on @BradfordUni yfrog.com/h8afipqj

321 days ago · reply · retweet · favorite

bradforduniSBC We're shortlisted for the Interdisciplinary Working Award! Winners to be announced after the showcase. Fingers Crossed! <http://bit.ly/dGbx5G>

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bradforduniSBC Science Bridges China is on the University's Research Showcase today! <http://bit.ly/hMBdmo>. Come over to have a look!!

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Join the conversation





Bradford RCUK Science Bridges China

Bradford EPSRC Global Engagements

&

UK-China Advanced Materials Research Institute



MOST/ NSFC/ RCUK China meetings covered:



- Our RCUK **Science Bridges China** platform continues to thrive, with
 - (i) EPSRC Global Engagements grant, in Advanced Materials for Healthcare with China ,
 - (ii) Yorkshire Cancer Research support for Open Innovation workshops in China.



- **UK-China Advanced Materials Research Institute** – launched April 2012 - a more substantial and coherent activity than just the 'one to one' collaborations.



- **RCUK-MOST Joint Call** project bids (3 healthcare bids from Bradford + Chinese partners)
- **Research Workshops** in the UK in September 2012 and in China in March 2013

- Potential involvement of Chinese partners such as MOST or NSFC, including **sponsoring activities** in the period after March 2013 - *advice please?*

- further **Chinese industry involvement** in our platform - how Chinese government funders might assist with more industry involvement. We have established very good links with Science & Technology Bureaus in Chengdu, Changzhou and Guangzhou. - *advice please?*

- **Bradford University's office** is being set up in central Beijing (Cofco Plaza)



fuller details

- RCUK Science Bridges China platform – outcomes to date
- EPSRC Global Engagements grant
- UK-China Advanced Materials Research Institute
- RCUK-MOST Joint Call project bids
- UK meeting/ Research Workshops in September 2012 and the one due in China in March 2013
- potential for Chinese partners such as MOST or NSFC to be involved, or sponsor in the period after March 2013
- Bradford University's office being set up in central Beijing.

Research strengths from leading UK Institutes

三个先进的英国研究所拥有领先的研究实力:

Drug discovery



Drug formulation, Drug delivery



Advanced Polymer Biomedical Materials

先进的高分子生物医药材料

- Biomedical materials & devices;
- Polymer Micro & Nanotechnology;
- 100 companies collaborate



+ RKT Centres in Pharmaceutical Engineering Science, Advanced Materials Engineering, Polymer Micro & Nano Technology

Bradford RCUK Science Bridges China People:

The Bradford Team:

Prof Phil Coates FEng – Director & Academic Lead, Advanced Materials Engineering

Dr Qun Shao – Programme Manager;

Paul Thorning - Leader, Open Innovation China;

Prof Peter York, Pharmaceutical Innovation

Prof Laurence Patterson; Academic lead, Life Sciences

Xiao Lei Wang – External Relations Officer



Prof Anant Paradkar, Pharmaceutical Engineering Sciences, and Prof Richard Greene, Dean of Life Sciences and Prof Alastair Wood, Dean of Engineering, Design & Technology join this core team to form our Management Group.

Academic co-applicants: Prof Jamshed Anwar, Prof Clive Beggs, Prof Hadj Benkreira, Dr Rob Falconer, Prof Tiho Obrenovitch, Dr Klaus Pors.

Other key researchers: Prof Anant Paradkar, Prof Vladimir Botchkarev, Dr Fin Caton-Rose, Dr Mike Martyn, Dr Tim Gough, Dr Adrian Kelly; Dr Leigh Mulvaney-Johnson, Dr Pete Twigg, Dr Raj Patel, Dr John Buckley, Dr Kamyar Afarinkia, Dr Marina Bloj, Dr John Sweeney, Dr Elaine Brown. Administration support: Sarah Womersley + colleagues from Durham (Dr Junjie Wu, Dr Lian Hutchins), Sheffield (Prof Steve Rimmer, Prof Paul Hatton, Dr Aileen Crawford), Leeds (Prof Peter Olmsted, Prof Ian Ward FRS, Dr Pete Hine, Dr Ceri Williams)

Science Bridges China runs in association with the Polymer IRC, and the School of Engineering, Design & Technology and School of Life Sciences, University of Bradford, and with the following Research & Knowledge Transfer Centres in Bradford:

Advanced Materials Engineering (inc. Infection Control & Biophysics), Centre for Skin Sciences, Pharmaceutical Engineering Science, Polymer Micro & Nano Technology, Visual Computing

Bradford RCUK Science Bridges China - Advisory Board:

UK members:

- Patrick Cantrell, *Partner, Walker Morris;*
- Dr Futao Chen, *Minister Science Counsellor, Chinese Embassy, London;*
- Chris Cotton, *China Britain Business Council (CBBC);*
- Dr Jiangshen Du, *UKTI Life Science Specialist;*
- Dr David Farrar, *Smith & Nephew Ltd;*
- Alastair Gardiner, *UKTI;*
- Kevin Kiely, *MD Medilink Y&H Ltd;*
- Peter O'Donovan, *Consultant, Bradford NHS Hospitals.*

Chinese members:

- Professor Jiwen Zhang, Shanghai Institute Materia Medica Chinese Academy of Sciences
- Professor Qi Wang, State Key Laboratory of Polymer Materials Engineering, Sichuan University
- Professor Liqun Zhang, Head, Key Laboratory of Beijing City on Preparation & Processing of Novel Polymer Materials, Beijing University of Chemical Technology
- Professor Jinliang Qiao, Director of BRICI Sinopec, Beijing
- Professor Guangxian Li, Vice President Sichuan University, co-chair China Materials Society
- Professor Quan-Ming Zou, Director of the Biopharmaceutical Research Institute, Third Military Medical University, Chongqing
- Professor Xiuwu Bian, Director, Institute of Pathology and Southwest Cancer Center, Third Military Medical University, Chongqing
- Professor Weishuo Fang, Institute of Materia Medica Chinese Academy of Medical Sciences, Beijing
- Professor Yi Feng, Shanghai University of Traditional Chinese Medicine, Shanghai
- Professor Hongjuan Cui, State Key Laboratory of Silkworm Genome Biology, Southwest University
- Professor Jingkai Gu, Jilin University
- Professor Guoan Luo, Tsinghua University, Beijing

Bradford RCUK Science Bridges China Programme: ADVANCING SCIENCE & INNOVATION IN PHARMACEUTICAL & HEALTHCARE TECHNOLOGY

- building joint strengths in fundamental research
- translating research for the benefit of society
- creating new technologies and companies through open innovation



A £1.27m RCUK grant, 2009-12, meeting aligned strategic needs of the UK and China in Healthcare Technologies, currently leveraging ~£3.9m support (with >£9m in negotiation)

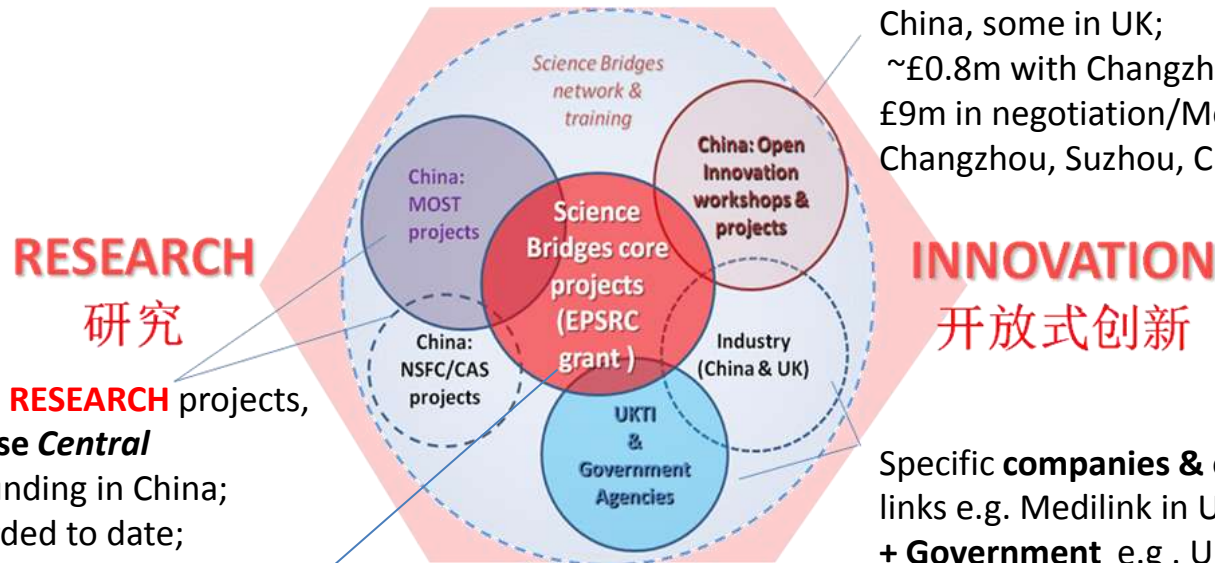
FUNDERS:

UK: RCUK (Medical Research Council; EPSRC); White Rose; UoB

China: MOST, NSFC, MoE; City Governments: Changzhou; Guangzhou
others in discussion

UK ACADEMIC COLLABORATORS: Leeds, Sheffield, York, Durham, Nottingham.

UK AGENCIES – Medilink Y&H Ltd, UKTI, Health Tech & Medicines KTN



Pure & applied RESEARCH projects, leveraging Chinese **Central government** funding in China; ~ £0.75m awarded to date; link with RCUK Beijing; £0.6m bids

OPEN INNOVATION projects, leveraging Chinese **Local government** funding mainly in China, some in UK; ~£0.8m with Changzhou; ~£2m Guangzhou; £9m in negotiation/MoU –[Guangzhou, Changzhou, Suzhou, Chengdu]

Specific **companies & organisation** links e.g. Medilink in UK, CAMDI China; + **Government** e.g. UKTI, Chinese Embassy & Consulate, Science & Innovation Network, Health KTN



CORE PROJECTS:

Pharmaceutical Sciences:

Drug development & delivery for diabetes, cancer, malaria;
Traditional Chinese Medicine data mining & therapies;

Key Collaborators: SIMM CAS, Tsinghua University, IMM CAS, Jilin University, TMMU Chongqing, Zhejiang TCM University, Nanjing University, XiangXue

Advanced Materials - Medical technology:

Polymer biomaterials/ bioresorbables/ nanocomposites for medical devices & drug delivery;

Key Collaborators: Sichuan University (SKLPME and NERCB); BUCT Beijing; ICCAS Beijing, Changchun IAC CAS



Science Bridges Chinese Collaborators & People Bridges (人与人的桥梁)

Other UK partners

We have expanded to involve other UK academic in SBC research and OI programmes, including Nottingham University and the White Rose Universities (Leeds, Sheffield, York), and the Polymer IRC (Bradford, Leeds, Durham and Sheffield).

Various industrial partners from the UK and China are involved in the OI programmes.



We gratefully acknowledge the support of:



RKT Centres in Advanced Materials Engineering, Polymer Micro & Nanotechnology, Pharmaceutical Engineering Science, Visual Computing, Skin Sciences

BENEFITS to the UK and CHINA include:

- better medicines and medical devices
- improved national and global healthcare provision
- joint IP, commercialisation of research
- company growth, spin outs, quality employment, export income
- effective use of resources - Chinese capital investment + UK KT skills
- increased understanding, trust and cooperation
- new cross-disciplinary and cross-cultural opportunities

Bradford RCUK Science Bridges China provides a successful, growing platform for extending collaborations to other UK and Chinese partners - universities, companies, hospitals and government agencies.

Bradford RCUK Science Bridges China forms a platform for the University of Bradford's ongoing and developing China activities.

Bradford RCUK Science Bridges China forms a platform for the University of Bradford's ongoing and developing China activities.



The Bradford Core Team: Prof Phil Coates FREng – Director; Dr Qun Shao – Programme Manager; Prof Peter York, Prof Laurence Patterson, Paul Thorning; Xiao Lei Wang
Prof Anant Paradkar

+ RKT Centres in Pharmaceutical Engineering Science, Advanced Materials Engineering, Polymer Micro & Nano Technology

Science
Bridges
China
Core
Projects
(RCUK
support):

Life Sciences
(£50k)

Advanced Materials/
Life Sciences
mini-projects
(£5k-£20k)

Project Title	UoB	Partner	Running Period
Identification of Key Ingredients in Complex Chinese Medicines, to Develop New Therapies for Global Markets	Dr Qun Shao	Prof Guan Luo and Dr. Liangqiong Lin, Tsinghua University	Oct 2009 – June 2012
A Mechanistic Investigation of TCM Therapies for Type 2 Diabetes October 2010 – June 2012	Dr Qun Shao	Prof Jiwen Zhang , Shanghai Institute of Material Medica, CAS Prof Luwei Xiao , Zhejiang Chinese Medicine University Prof Jingkai Gu , Jilin University	Oct 2010 – June 2012
Improved Anti-Malarial Treatment through Enhanced Bioavailability of Artemisinin December 2010 – June 2012	Prof Laurence Patterson , Dr Wendy Hulse	Jiwen Zhang , Shanghai Institute of Material Medica, CAS Prof Jingkai Gu , Jilin University Prof Peter York , Crystec Ltd	Dec 2010 – June 2012
Project Title	UoB	Partner	Running Period
Ultrasound-assisted Physical or Chemical Interaction from Melts	Prof Anant Paradkar, Dr Adrian Kelly, Dr Elaine Brown and Prof Phil Coates	Dr Hong Wu, Prof Shaoyun Guo , Sichuan University	Oct 2010 – Oct 2011
Electrically Conductive Polyurethane/Carbon Nanotubes Composites for Medical Microdevices	Prof Phil Coates , Prof Hadj Benkreira, Dr Raj Patel, Dr Ben Whiteside, Dr Fin Caton-Rose	Prof Hesheng Xia , Dr Guoxia Fei, Sichuan University	Oct 2010 – Oct 2011
Poly(vinyl alcohol)-based Composite Products for Drug Delivery	Prof Phil Coates , Dr Leigh Mulvaney-Johnson, Dr Ben Whiteside	Prof Qi Wang , Dr Ning Chen, Dr Li Li and Prof Jie Zhang, Sichuan University	Oct 2010 – Oct 2011
Solid Phase Processing of Polymer Blends and Nanocomposites	Prof Phil Coates , Dr Fin Caton-Rose, Dr Michael Martyn	Dr Xiaowen Zhao, Prof Lin Ye , Sichuan University	Oct 2010 – Oct 2011
Seeding of plug flow crystalliser using a micro channel reactor	Dr Nicholas Blagden, Dr Qun Shao	Prof David Wei , Tianjin University	Aug 2011 – July 2012
The Development of Agents Targeting the Hypoxic Tumour Cell Phenotype	Prof Laurence Patterson , Dr Klaus Pors	Prof Weishou Fang , Institute of Material Medica, Chinese Academy of Medical Sciences & Beijing Union Medical College	Nov 2010 – Oct 2012
The development of FormylPeptide Receptor antagonists as a New Class of Antiproliferative Agents	Prof Laurence Patterson , Dr Kamyar Afarinkia, Dr Viqui Vinader, Dr Rob Falconer	Prof Xiuwu Bian , Southwest Hospital, Third Military Medical University	Nov 2010 – Oct 2012
Targeted polymeric micelles for anti-cancer drug delivery	Dr Kamyar Afarinkya, Prof L Patterson, Prof Phil Coates	Prof Zhongwei Gu , Dr. Yu Nie, Sichuan University	June 2011 – June 2012
Investigation of polymer micro-needles by micro-injection molding	Dr Ben Whiteside, Prof Anant Paradkar, Dr Adrian Kelly, Prof Phil Coates	Prof Dongyun Ren , Prof Yajun Zhang, Mr Xiang Lin, Mr Ling Xue, Beijing University of Chemical Technology	Aug 2011 – Aug 2012
Precise Microfabrication and Micro-Nanoscale Combination of Polymeric Microspheres for Promoting Cell Growth	Prof Phil Coates , Dr Colin Grant, Dr Ben Whiteside	Prof Zhihua Gan , Dr Xudong Shi, Institute of Chemistry, CAS	Aug 2011 – Aug 2012
Structure and Properties of Micro-moulded Poly(ϵ -caprolactone) and its miscible blends	Dr Tim Gough , Dr Ben Whiteside, Prof Phil Coates	Prof Yongfeng Men , Dr Ying Gao, Dr Yuqing Lai, Dr Zhiyong Jiang, Dr Lingzhi Liu, Changchun Institute of Applied Chemistry, CAS	Aug 2011 – Aug 2012
Toughening of Polylactide with Bioelastomer for Biomedical Application Research Team	Dr Mike Martyn, Dr Tim Gough, Prof Phil Coates	Prof Liqun Zhang, Hailan Kang, Prof Dongmei Yue , Beijing University of Chemical Technology	Aug 2011 – Aug 2012
Epigenetic Mechanisms of Tissue Development and Regeneration	Prof Vladimir Botchkarev	Dr. Guo-Liang Xu, The State Key Laboratory of Molecular Biology, Shanghai Institutes for Biological Sciences, Chinese Academy of Sciences	Nov 2011 - Jun 2012

Chinese Government funded internationally collaborative projects

Project Title	UoB	Partner	Running Period	Funding Body	Amount
Enhance the Bioavailability of Artemisinin by Combined Drug Delivery Techniques to Limit the Emergence of Malaria Resistance	Prof Laurence Patterson	Jiwen Zhang, Shanghai Institute of Materia Medica, CAS	May 2010 – Dec 2012	MOST	1m RMB
Development of methods for the assessment of TCM's disease/syndrome and efficacy as well as data mining	Dr Qun Shao	Prof Guoan Luo, Tsinghua University	May 2010 – Dec 2012	MOST	1m RMB
Preparation and Micromolding of Polymer Nanocomposites for Medical Applications	Prof Phil Coates	Qi Wang, Sichuan University	May 2011 – Dec 2013	MOST	1m RMB
				Sichuan Province	1m RMB
Fundamental studies on the preparation and micro-processing of polymer functional micro-devices	Prof Phil Coates, Prof Hadj Benkreira, Dr Ben Whiteside, Dr Michael Martyn, Dr Adrian Kelly, Dr Tim Gough	Prof Qi Wang, Prof Hesheng Xia, Prof Jie Zhang, Dr Yan Liu, Dr Ning Chen, Dr Shibing Bai, Dr Guoxia Fei, Ms. Zhengkun Hua, Sichuan University	Jan 2011 – Dec 2013	NSFC	1.6m RMB
Overseas Famous Scholar	Prof Phil Coates	Sichuan University	2010 -2015	MOE	1m RMB
High-End Foreign Professor	Prof Phil Coates	Sichuan University	1 July 2010 – 30 June 2013	Sichuan University	100k RMB
China Scholarship Council awards	Prof Phil Coates	Prof Yinghong Chen, Sichuan University	Jan 2011- Jan2012	MOE	~150k RMB
China Scholarship Council awards	Prof Phil Coates	Prof Qi Yang, Sichuan University	March 2011-March2012	MOE	~150k RMB

Open Innovation programme

We believe this is a unique feature in China.

We have run three highly successful Science Bridges China Open Innovation Workshops, two in Changzhou (focussing on drug delivery) and one in Guangzhou (focussing on medical diagnostics) – the latter ran in November 2011, with more in development with Guangzhou (the next, supported by **Yorkshire Cancer Research** is due in July 2012). Total support leveraged from city governments is around £2.8m, with ~ £8m in negotiation.



First open innovation workshop in Changzhou



Open innovation workshop in Guangzhou

Open Innovation programme

	Project Title	UoB	UK partner(s)	Chinese Partner 1	Chinese Partner 2	Chinese Partner 3	Running Period	Amount
Changzhou 1 Dec 2009	Repair of Oral and Periodontal Defects using Regenerative and Antimicrobial Strategies Delivered by Novel Tissue Scaffold	Dr Richard Telford, Dr Qun Shao		Prof Jiwen Zhang, Shanghai Institute of Materia Medica, CAS	Dr Juan Du, Changzhou Sanwei Industry Institute	Prof Jingkai Gu, Jilin University		~£200k
	The Development of Nanoparticulate Curcumin with Enhancers from TCM for Treatment of Cancer and Alzheimer's Disease	Prof Anant Paradkar		Prof Yihu Qiao, Nanjing University	Dr Zhifeng, Changzhou City Hospital			~£200k
	A Suite of Platform Technologies for Masking the Undesirable Taste of TCM and Western Medicines in Liquid Form	Prof Laurence Patterson, Dr Qun Shao	Dr Stefan Ogrodzinski, Biostatues	Prof Yi Feng, Shanghai University of Traditional Chinese Medicine	Changzhou Yabang Pharmaceuticals Co Ltd			~£200k
Changzhou 2 April 2011 (announced Sep 2011)	Development of new material applied to artificial disc replacement	Dr Pete Twigg	Ionbond Ltd	Mr Jianxing Liu, Trauson Holdings Company Ltd	Dr Hao Liu, Sichuan Huaxi Hospital			~£200k
	Development of new hydrocolloid for improved wound treatment	Prof Anant Paradkar	Prof Kadem Al-Lamee, Arterius Ltd; Mr Richard Snell, Altrika Ltd	Ms Ping Li, Changzhou Nanfang Medical Application Factory Co. Ltd	Prof Huayu Tian, Changchun Institute of Applied Chemistry, CAS			~£200k

Guangzhou I – November 2011 (announced April 2012, final value being resolved, but in the range £120k-£200k, with potential further match funding expected from Chinese industrial collaborators):

Development of Candidate Vaccines Against Viral Disease using Advanced Adjuvant Technology	South China United Vaccine Institute (UK: Jon Sayers, University of Sheffield)
Development of cancer biomarker immunoassay using novel antibody mimetics	Raybiotech, Inc. Guangzhou (UK: Darren Tomlinson, Leeds University)
Multi-Analyte-Virus-Chip (MAVIC)	Guangzhou IRD Medicine Co., Ltd (UK: Tom Gibson, ELISHA Systems Ltd)
Biosensor Systems for Cancer Biomarkers and Bacteria	Guangzhou Wondfo Biotech Co., Ltd (UK: Tom Gibson, ELISHA Systems Ltd)
Development of Novel Reagents for Virus Detection and Antiviral Therapeutics	Guangzhou Institutes of Biomedicine and Health (UK: Darren Tomlinson, Leeds University)

NETWORKS

Substantial Networks of leading Chinese academics and organisations, industry and government funding agencies (central, regional and local) have been developed:

- **Research Workshops** (Beijing, Nov 2011 and Chengdu, April 2012 – joint with EPSRC Global Engagements programme) – both with extensive Researcher Profile and presentation outputs (ongoing access via web site) and **Open Innovation Workshops** (Changzhou, Dec 2009 and April 2011, Guangzhou November 2011) - typically ~ 60 attendees at each workshop - have built our capability platform (in both China and the UK), to help identify collaboration teams, formulate projects and bids and deliver projects;

- **Shanghai Expo** – Science Bridges China Life Sciences Event (23 Sept 2010) at the invitation of and with support from UKTI and the Science & Innovation Network;

- our latest development is the launch of the **UK-China Advanced Materials Research Institute** (April 2012) – founder members with Bradford and the Polymer IRC universities in the UK are Sichuan University, ICCAS, CIAC CAS, SIMM CAS, BUCT;

Science Bridges China
www.sciencebridgeschina.com
中英科技桥



Networks: Science Bridges China Event co-hosts in China

- **Sichuan University** - Prof Qi Wang/Prof Guangxian Li (Vice President) – State Key Laboratory Polymer Materials Engineering and National Engineering Research Centre for Biomaterials visits & formation of the International Centre for Polymer Microprocessing;
Second Research Workshop, Chengdu, April 2012 & Chengdu High Tech Zone meetings, April 2012.
- **Shanghai Institute Materia Medica Chinese Academy of Sciences** – Prof Jiwen Zhang, Prof Huliang Jiang (Associate Director) – Open Innovation events with Changzhou; *Shanghai Expo* Science Bridges China Life Sciences Event - co hosted by UKTI, Science & Innovation Network, British Consulate Shanghai;
- **Changzhou Science & Technology Bureau** team – first and second Open Innovation Workshops (Dec 2009, April 2011);
- **Guangzhou Science & Technology Bureau** team – third Open Innovation Workshop (Nov 2011);
- **Beijing University of Chemical Technology** – first Research Workshop, Beijing November 2011.

TRAINING

Technical and capability-based for Chinese research staff is undertaken in association with funded projects:

Researcher visits to Bradford included:

Sichuan University: **2010** - Prof H Xia Dr Li Li, Dr Qi Yang (3wk), **2011** - Dr Hong Wu, Dr Xiowen Zhang, Dr Guoshua Fei, Dr Ning Chen (4 wk); Prof Qi Yang (10 months – Chinese Scholarship Council), Prof Yinghong Chen (12 months - Chinese Scholarship Council);
Changchun IAC CAS: 2012 – Dr Zhiyong Jiang (4 wk), Dr Ying Gao (4 wk);

Senior staff visits to Bradford included: Prof J Zhang (SIMMCAS), Prof Q Wang, Prof H Xia (Sichuan)

UK Researcher visits to China included:

Prof Coates (various lectures, supervision, mentoring - Sichuan, BUCT, ICCAS, CIACAS); Prof A Paradkar (Sichuan, SIMMCAS); Prof P York (SIMM CAS); Prof L Patterson (TMMU);
Sep 2010 (Shanghai Expo event - team); Research Workshops Nov 2011 – Prof A Paradkar, Dr P Caton-Rose, Dr P Twigg, Dr K Pors, + Dr A Crawford (Sheffield Uni), Dr Junjie Wu (Durham Uni);
April 2012 - as Nov 2011 plus Prof L Patterson, Dr B Whiteside, Prof S Rimmer (Sheffield Uni);

Acknowledgements:

We are grateful for the support of Research Councils UK, including the Medical Research Council and EPSRC, and the University of Bradford, and for Chinese support to date from MOST, NSFC, MoE, Sichuan University and Chinese local governments in Changzhou and Guangzhou. We are also grateful for the collaborative support of the UKTI, SIN, Health Technologies & Medicines KTN, Materials KTN and Medilink Y&H Ltd.



New EPSRC Global Engagements grant

- **£0.5m** research grant for 12 months to develop our Science Bridges China platform
- From EPSRC VIPps , then RCUK Science Bridges China, to this new Global Engagement programme, our cooperation is building strength!
- runs from 1 April 2012 to 31 March 2013
- highly competitive, one bid per university – Bradford was in the **top 2**, of 47 UK universities bidding
- the grant will allow:
 - a range of **research projects** to build on our current Science Bridges ones,
 - **researcher exchanges**,
 - **research studentships**, and
 - **Workshops/ conferences**
- this offers much **synergy** with our UK-China AMRI proposed activities

2012 RCUK-MOST Joint Call for Healthy Ageing Populations:

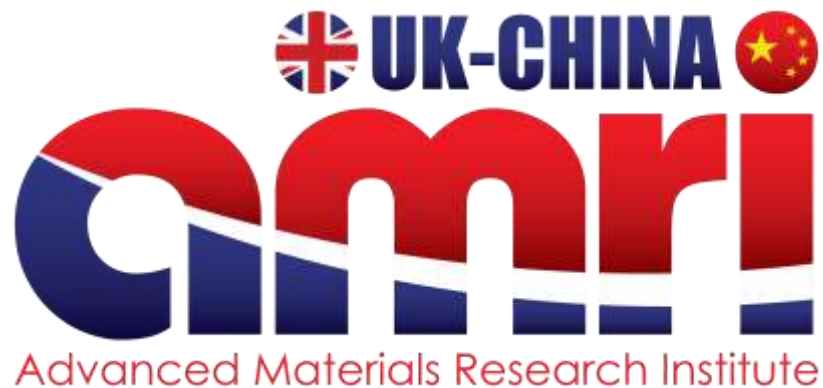
April 2012, **we submitted 3 bids** :

- *Elderly specific transdermal patch design to improve patient compliance in dementia patients:* University of Bradford/ Shanghai Institute of Materia Medica, Chinese Academy of Sciences/ Jilin University/ Peking University First Hospital/ The First People's Hospital of Changzhou. [?]

- *Biomaterials for Joint Soft Tissue Repair - Improving Health in Older Age:* University of Bradford/ State Key Laboratory of Polymer Materials Engineering, Sichuan University / Institute of Chemistry, Chinese Academy of Sciences Beijing/ Sheffield University/ Durham University [Sichuan have been invited to submit a full proposal]

- *An exploration of chemopreventive TCM and tumour targeted novel ultrapotent chemotherapeutic agents in tissues from UK and China cancer patients:* University of Bradford/ Southwest University Chongqing / Southwest Hospital, Third Military Medical University, Chongqing/ Huaxi Hospital, Sichuan University, Chendgu), St James' Hospital, Leeds University/ Bradford Royal Infirmary.

A further project is under development (*Microneedles* – Bradford, Beijing University of Chemical Technology and General Hospital of Beijing Military Region).



Research Institute Board Core Members

Co-Directors:	Professor Phil Coates FREng (University of Bradford & Director, Polymer IRC) Prof Guangxian Li (Sichuan University)
Core Board members:	Prof Qi Wang (SKLPME Sichuan University) Prof Dujin Wang (ICCAS Beijing) Prof Liqun Zhang (BUCT Beijing) Prof Jiwen Zhang (SIMM CAS Shanghai) Prof Yongfeng Men (CIAC CAS Changchun) Dr P Caton-Rose (University of Bradford)
AMRI coordination & liaison	Xiao Lei Wang (University of Bradford) Prof Hesheng Xia (Sichuan University)



RCUK Bradford Science Bridges China

UK-China Advanced Materials Research Institute 中英先进材料研究所

The leading researchers involved in UK-China collaborations in polymer-related materials, brought together by the RCUK Bradford Science Bridges China programme, agree to form the UK-China Advanced Materials Research Institute. This virtual institute will represent the growing UK-China research collaborations in a more coherent and substantial way, linking members together more visibly, for increased impact. We aim to increase our research co-operations and friendship, and create new opportunities for exchanges and funding.

The Research Institute will bring together leading UK and Chinese research groups with Advanced Materials research strengths, especially Polymer-related materials and processing. An initial focus will be on 'advanced materials for healthcare'. This is an area identified by both the UK and China as a priority for research cooperation. This area also includes a range of materials interests, built strongly on our polymers and polymer-related materials expertise, and includes drug delivery and biomaterials aspects. Our approach is genuinely interdisciplinary, across materials science, engineering, physics, chemistry and biomaterials disciplines. Many materials advances offer potential application to healthcare but the Institute will cover other advanced materials 'themes' which are also strategically important, such as advanced materials for Energy/ Resource Efficiency, and more general materials areas such as polymer nanocomposites. We aim to work in harmony with all appropriate Professional Institutions and Societies.

Signed:

P. D. Coates

Professor P D Coates FRSC
Co-Director, UK-China AMRI
Director, Science Bridges China
Director, Polymer IRC
University of Bradford, UK

Guangxian Li

Professor Guangxian Li
co-Director, UK-China AMRI
Administrative Vice President,
Sichuan University,
China

Date:

20 April 2012

20/04/2012



Bradford University's office in central Beijing

Address:

Room 1012, Building B,
Beijing COFCO PLAZA
No. 8, Jianguomennei Dajie
Dongcheng District
Beijing, China

Manager

Rosemary Zhao: Email: f.zhao@bradford.ac.uk, phone: 0086-18600048922

Deputy

Lei Ding: Email: l.ding2@bradford.ac.uk, Phone: 0086-18611744815



Polymer IRC at Bradford

www.polyeng.com

RKT Centres:



Polymer Centre of Industrial Collaboration

Industry facing aspect of our research labs

Bradford Industry Group

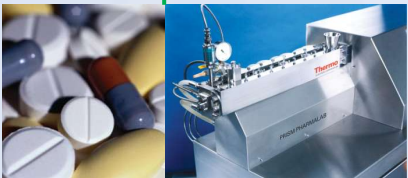
Industry technical/consultation group (>100 companies)

www.polymercic.com

Pharmaceutical Engineering Science

www.pharmaceutical-engineering.brad.ac.uk/
School of Life Sciences

Pharmaceutical structuring for enhanced bioavailability/ drug delivery



Advanced Materials Engineering

www.brad.ac.uk/research/rkt-centres/advanced-materials-engineering/

Advanced materials for **Healthcare Technology & Resource Efficiency**; including solid phase & fibre orientation processing

Polymer Micro & Nano Technology

www.polymer-mnt.brad.ac.uk/;
www.ukmig.com

Micromoulding & surface structuring for Healthcare & Telecommunications



UK:
QUB, Warwick, York, Oxford, Cambridge, Huddersfield, Swansea, Sheffield Hallam, Nottingham, Loughborough;

International:
(inc. RCUK Science Bridges China, EPSRC Global, and Joint international laboratory with Sichuan University)

University of Bradford RKT Centres

Key Research & Knowledge Transfer Centres, which have significant investment from the University, are contributing to the Polymer IRC at Bradford; these include:

- Advanced Materials Engineering - *exemplified in the following slides*
- Polymer Micro & Nano Technology
- Pharmaceutical Engineering Science

Together with strong links/ joint programmes with:

- Skin Sciences
- Visual Computing

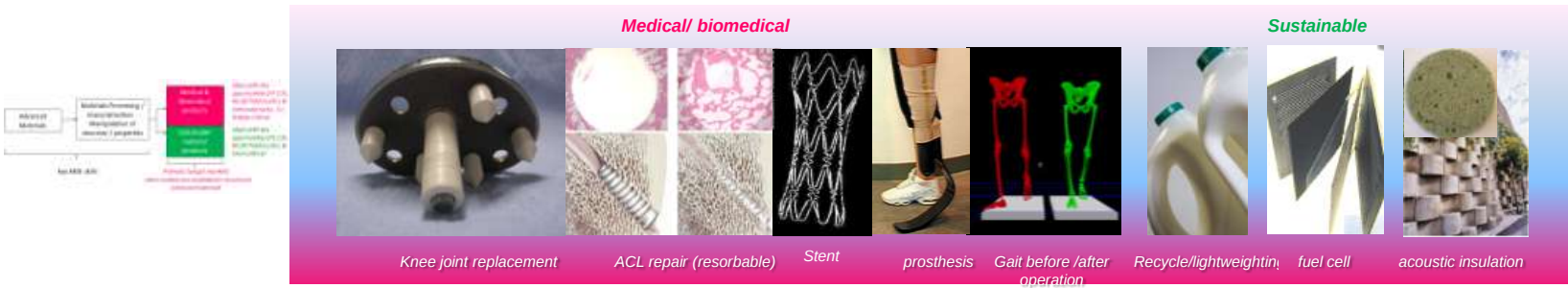
Advanced Materials Engineering RKT Centre

Smart materials for high added-value products for health and wellbeing



AME has important symbiotic relationships and joint grants or contracts with other University RKT Centres, notably Polymer Micro & Nano Technology, Pharmaceutical Engineering, Visual Computing and Skin Sciences

Located in the world-class **Polymer Interdisciplinary Research Centre** at Bradford, AME builds on existing Polymer IRC research and knowledge transfer strengths, and extends the RKT team and leading edge facilities. We now incorporate the Infection Control and Biophysics group.



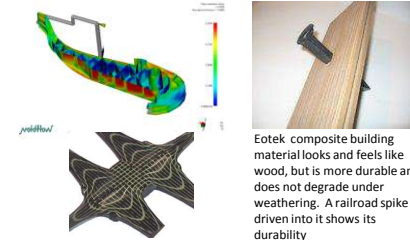
The Advanced Materials Engineering (AME) Centre focuses extensive 'smart materials' expertise associated with the Polymer IRC and beyond, into the growth areas of:

• medical and biomedical products



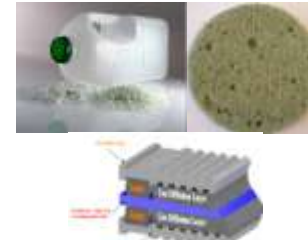
Healthcare technologies Medical/ biomedical products include bioresorbable or non-resorbable orthopaedic components for joint repair or replacement, stents for vascular repair, spinal braces, structured films for wound dressing, precision tubing, medical devices and components including laparoscopic devices, medical packaging; design of artificial limbs/ rehabilitation strategies using biomechanics. (RCUK Science Bridges China; EPSRC, Surgical Innovations; Invibio; Arterius; Blatchfords);

• high added value advanced materials



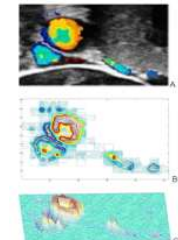
Advanced materials polymers and polymer composites for building, transport, chemical additives, anti-counterfeiting, land reinforcement; Novel materials or composites include bioresorbable and non-resorbable shape memory materials for high-added value products. These may include active pharmaceutical ingredients. (e.g. EPSRC Nanocomposites processing; Gates Inc; Infineum; Nylacast; Autodesk; Master Technologies; Pandrol);

• sustainable materials



Resource efficient materials: - Sustainable material products include novel acoustic materials from recycled polymers; smart incorporation of recyclates into conventional products for lower carbon footprint. supercritical CO2 processing (e.g. FP7 projects [Polysense, COTECH]; TSB programme with Johnson Matthey Fuel Cells; Armacell; Nampak); Green processing - EPSRC Thermal control of extrusion;

• biophysics & infection control



Biophysical Research and Infection Control studies, at the interface between physics and biology/physiology, include decontamination of surgical instruments, air disinfection, simulation of infection transmission in hospitals, modelling of pulsatile blood flow and characterisation of tissue microstructure in compliant blood vessels. (e.g. NIHR hydroxyl radical disinfection)

Key underpinning skills of the AME Centre include:

Acoustic materials (KH, HB)
Advanced Rheology/ materials characterisation (TG, HB, ALK, PDC, KH)
Biophysics modelling (SS, CB, TG)
Composite materials (PCR, PDC, ALK, TG, MTM)
Computer modelling - FEA, solid modelling, CAD-CAM, biomechanical (PCR, JS, PO, HB, PDC, ALK, LMJ, TG, JB)
Melt processing of polymers (ALK, PDC, HB, LMJ, TG, RP)
Microbiology (AS, JF)
Nanocomposites (PDC, JS, ALK, TG, MTM)
Reactive Melt processing (PDC, TG, ALK)
Sensors & monitoring technology, inc ultrasound (KH, ECB), rheo-opt (TG, PDC, MTM), spectroscopy (TG, PDC),
Solid phase orientation processing (PDC, PCR, JS)
Sustainable recycling (KH, HB, PDC, ALK, LMJ)
Thin film coating (HB, RP)

Recent Commercial successes include:

- **Eovations Inc spin out** \$16 million investment in Bay City, Michigan creating 64 jobs with new 'wood' technology (Eotek) - by **Dow Building Products Inc** from our solid phase orientation of polymers research (see above)
- **IP with Smith & Nephew, Dow, Fujiseal, Smartwalker, Armacell, & Sichuan Uni**

International collaborative projects in China, via **Chinese Government funding** through NSFC, MOST, MOE, particularly with Sichuan University and Beijing University of Chemical Technology;
 5 Science Bridges China projects at Sichuan University
 2 fully funded **Chinese Scholarships Council** awards (1 year each) in our lab,
 2011

Academic Team: the core academic staff are: Prof Phil Coates FREng, Director of AME, and Director of the Polymer IRC; Prof. H. Benkreira, Prof. K. Horoshenkov, Dr J. Sweeney, Dr P. Olley, Dr J. Buckley, Dr E. C. Brown, Dr P. Caton-Rose, Dr T. D. Gough, Dr A. L. Kelly, Dr M. T. Martyn, Dr L. Mulvaney-Johnson, Dr P. Twigg; **Infection Control & Biophysics:** Prof C Beggs, Prof S Shepherd, Dr A Snelling, Dr J Fletcher;

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Associated academic staff: a further 12 academic staff are associated with the AME Centre

Leading edge facilities

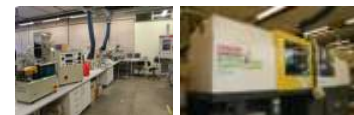
to attract new business, develop directions (in collaboration with the suppliers)

Processing:

- top level extrusion, injection moulding facilities (Thermo; Fanuc);
- unique solid phase processing;

Characterisation:

- at-process spectroscopy (FTIR, Raman) joint with PES RKT Centre/ Thermo Ltd;
- Atomic force microscopy including tissue capability (Asylum Ltd);
- precision rheo-optics (Anton Paar)
- powerful computer modelling enhancements (Autodesk Moldflow, Jaguar)
- infection chamber

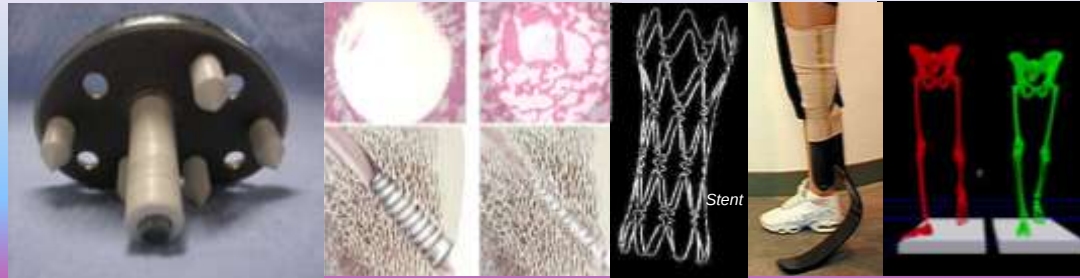


Advanced Materials Engineering RKT Centre

Smart materials for high added-value products for health and wellbeing

AME has important symbiotic relationships, joint grants & contracts with other University RKT Centres: Polymer Micro & Nano Technology, Pharmaceutical Engineering, Visual Computing, Skin Sciences

Medical/ biomedical



Knee joint replacement

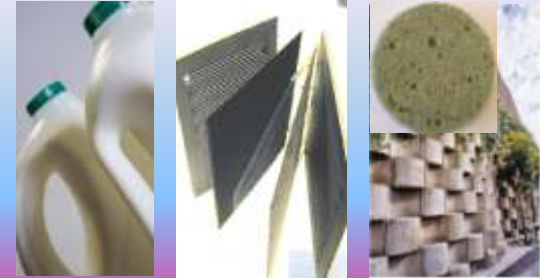
ACL repair (resorbable)

Stent

prosthesis

Gait before /after operation

Sustainable



Recycle/lightweighting

fuel cell

acoustic insulation

The Advanced Materials Engineering (AME) Centre focuses extensive 'smart materials' expertise associated with the Polymer IRC and beyond, into the growth areas of:

- **medical and biomedical products**
- high added value advanced materials
- sustainable materials
- biophysics & infection control



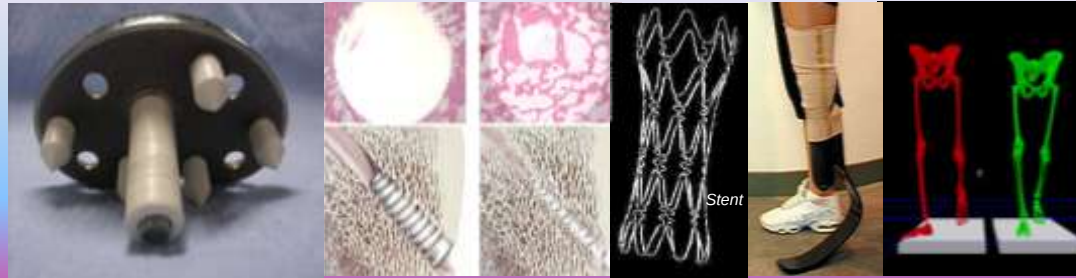
Healthcare technologies Medical/ biomedical products include bioresorbable or non-resorbable orthopaedic components for joint repair or replacement, stents for vascular repair, spinal braces, structured films for wound dressing, precision tubing, medical devices and components including laparoscopic devices, medical packaging; design of artificial limbs/ rehabilitation strategies using biomechanics. (**RCUK Science Bridges China; EPSRC, Surgical Innovations; Invibio; Arterius; Blatchfords**);

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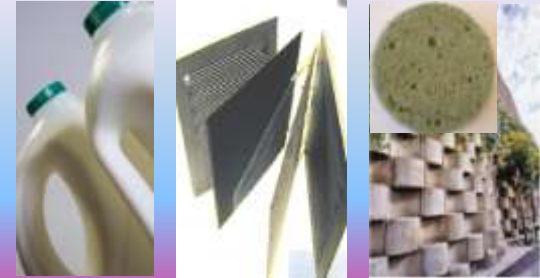
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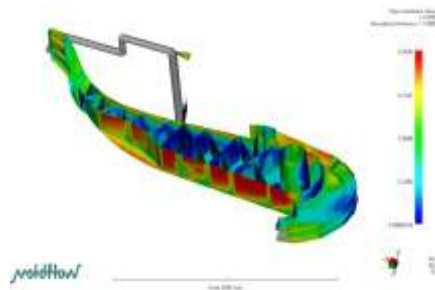
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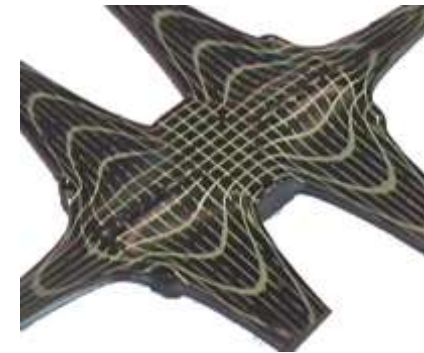
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Eotek composite building material looks and feels like wood, but is more durable and does not degrade under weathering. A railroad spike driven into it shows its durability



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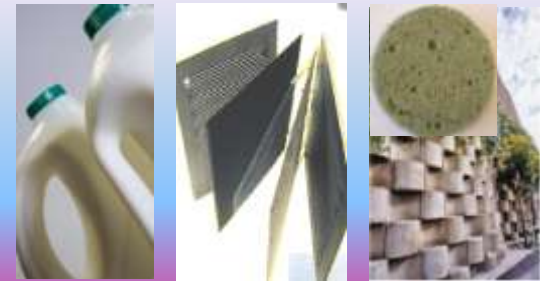
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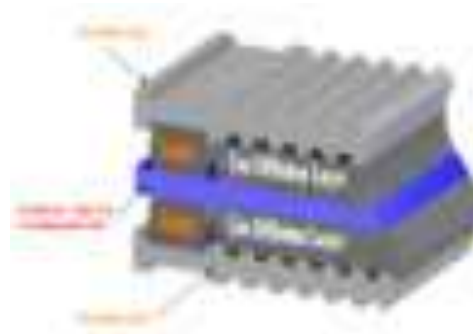
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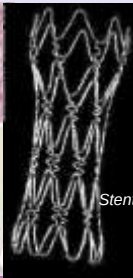
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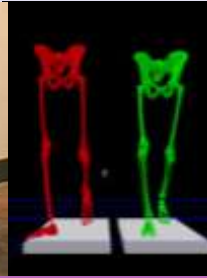
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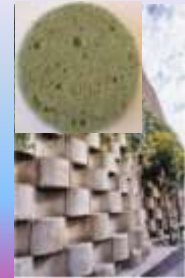
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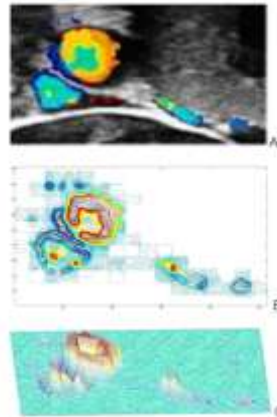


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(A) Colour Doppler ultrasound image of blood flows in the carotid artery (CA) and internal jugular vein (IJV). (B) Encoded image showing the iso-flows in the CA and IJV. (C) 3D rendered image showing the velocity profiles of the flows in the CA and IJV.

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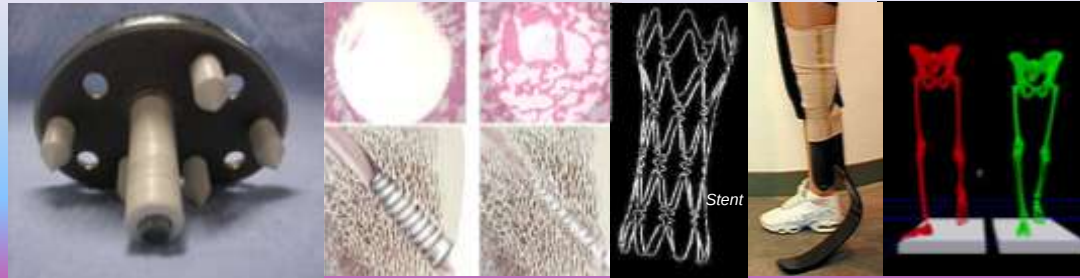
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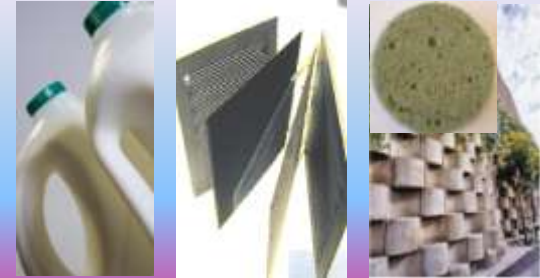
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