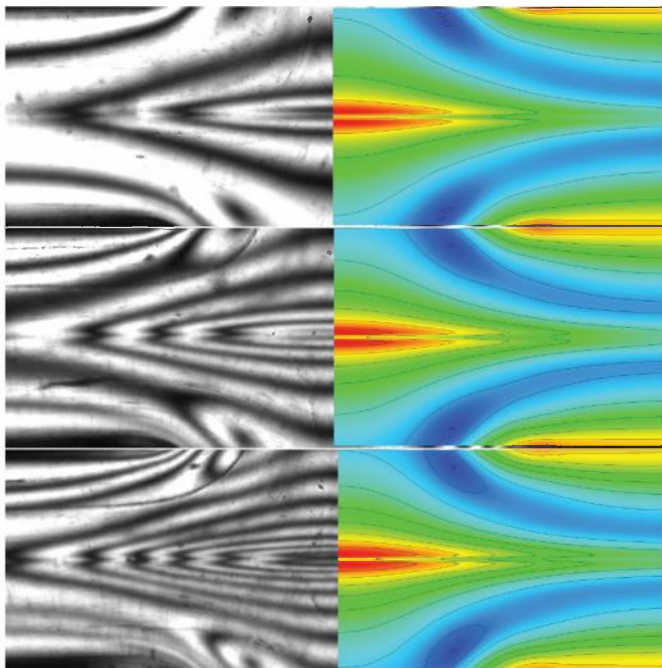

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	Dr. Nick E. Hudson Department of Pure & Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow G1 1XL	T: 0141 548 2162 F: 0141 548 4822 E: n.e.hudson@strath.ac.uk
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Industry/Non-Newtonian Club Coordinator	Mr. Jonathan Harvey Department Computer Science University of Wales, Swansea, Singleton Park, Swansea SA2 8PP.	T: F: E: jharvey@bayviewsystems.co.uk

T: Telephone; F: Fax; E: Email

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THE BRITISH SOCIETY OF RHEOLOGY



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CONTENTS

Editorial	66
Aims of the Society	67
Inventing and Developing Scientific Apparatus – by Malcolm Mackley	68
Vernon Harrison Award 2011 article – by David Hoyle	81
Letter to the Editor	86
Ken Walters Commemorative Symposium at ICR 2012	
Overview – by Tim Phillips	87
Limerick – by Bob Bird	89
Slip Dilemma – by Corneliu Balan	90
With KW Through History – by Roger Tanner	91
BSR News	
BSR Student Travel Awards	97
BSR Membership News	98
Conference reports	99
Commentary on the 336 th Council Meeting	102
Philip Sherman (1922 -2012) – by John Mitchell	103
Conference Announcements	
Extensional flows	106
Industry News	107
Conference & Courses Dairy	Inside back cover

Hon Bulletin Editor:

Dr. Robert J. Poole

The School of Engineering, The University of Liverpool,
The Quadrangle, Liverpool, L69 3GH

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EDITORIAL

Welcome to Volume 53 (issue #3) of the British Society of Rheology Bulletin. For my second issue as Editor – this one is really a bumper – we have a fascinating article from former BSR president, Prof. Malcolm Mackley, regarding the development of a series of scientific instruments he has been involved with during his career; an article from the winner of the 2011 Vernon Harrison, Dr. David Hoyle, giving a brief overview of this doctoral work (and providing the cover illustration for this issue) plus an extended section documenting the recent “Ken Walters Commemorative Symposium” held at the International Congress on Rheology in Lisbon.

Rob Poole, Liverpool October 2012.

SUBMISSIONS TO THE BULLETIN

Submissions to the Bulletin are welcomed. Electronic submissions by email to the Editor (bulletin@bsr.org.uk) are preferred in word format (e.g. .doc or .docx). Please always provide a contact name, address, e-mail, or telephone number in case of problems. The deadline for submission is Feb. 15th, June 15th and Oct. 15th, respectively, for three issues annually. As always, all contributions are gratefully received. Late copy can sometimes be accommodated, however the facilities of the BSR and ESR web sites may also be appropriate. Please contact the Editor for details.

COVER ILLUSTRATION

The front cover image is discussed in this issue's article by the Vernon Harrison Award winner, Dr David Hoyle. The image shows a comparison between experimental flow induced birefringence (left) in cross-slot flow and 2D simulations of the overshoot Pom-pom model (right) for a long chain branched HDPE, HDB6. The black lines in the simulations represent the black contours of the experimental principle stress difference for initial strain rates of 0.70/s, 1.74/s and 3.48/s from top to bottom. More details about this image can be found in David's article and will appear soon in the Journal of Rheology (Hoyle et. al).

We are always looking for appropriate images for the front cover of the Bulletin and Rheology Abstracts (preferably of a rheological nature!). Please contact either Rob Poole (bulletin@bsr.org.uk) or Nick Hudson (n.e.hudson@strath.ac.uk). Contributions are always welcome!

AIMS OF THE SOCIETY

The way liquids flow and solids deform affects all aspects of life.

Extraction and processing of crude oil, moulding of plastics, use of toothpaste, spreading of margarine, painting and the lubrication of joints in the human body are all examples of processes depending upon rheological behaviour. Rheology is defined as the science of the deformation and flow of matter.

If your work is concerned with rheology in any way, then you have much to gain by joining the British Society of Rheology, including

- advance your knowledge by attending our conferences
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Inventing and Developing Scientific Apparatus

Malcolm Mackley

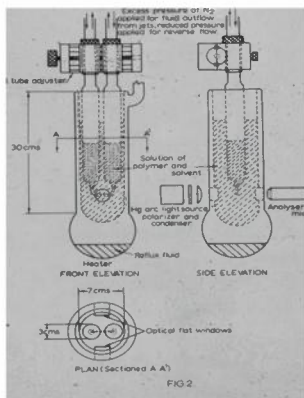
This article gives a brief account of various scientific apparatus that I have invented and or developed over the last forty years. All the apparatus described have rheological connections although some are not, in the classical sense “rheometers”. There was no grand master plan in terms of the way it happened; it just happened!

On reflection I now see that going to Technical High School (Gravesend, Kent) and not a Grammar or Public School for my secondary education was an important factor in the way I went about my future science. I was educated in the noble arts of woodwork, metal work and also engineering drawing. Sadly I missed out in relation to languages and how I now struggle with my French! My physics and maths teaching was pretty good; but it is the making of metal and wood components that I remember most, coupled with the training for sketching in 3D and preparing engineering drawings of components.

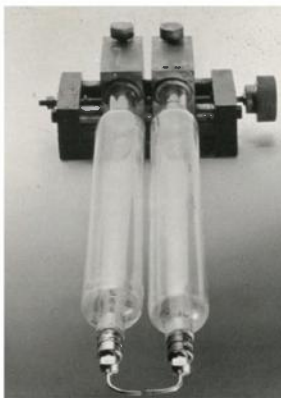
Extensional Flow; Opposed Jets

The first apparatus I designed and had built was not invented by me. It was the inspiration of the late Sir Charles Frank with input from the late Andrew Keller. Both were total scientists of the highest calibre and I happened to be the fortunate PhD student at Bristol University Physics Department in 1970 tasked with the job of turning their ideas into experimental reality. Sir Charles had been reading papers by Pennings et al. (1970) and Peterlin (1966) on the polymer chain stretching power of extensional flows and Sir Charles proposed an untried geometry of firing polymer solution into the faces of each other using two opposed jets. High strain rates were required and the whole thing needed to be at elevated temperature with optical windows if flow induced fibrous crystallisation of polyethylene was going to be observed. Andrew Keller suggested using a glass reflux bath arrangement and with the combined skills of a superb glassblower in Physics, Mr Colin Burrows and Andrew Keller’s talented but feisty technician Terry Owen, an apparatus was constructed that could blow and suck fluid into opposed jets. I discovered the sucking flow was far more stable than blowing and the apparatus is shown in figure 1 with the resulting observed localised flow birefringence, Frank et al. (1971),

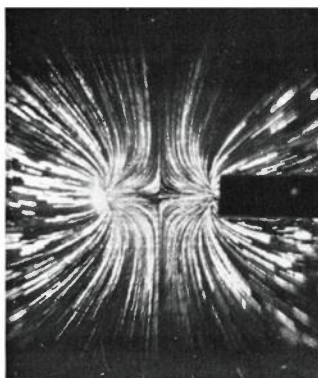
Mackley et al. (1975). Chain extension and fibrous crystallisation was achieved, but at the time of writing up my PhD an explanation as to why the extension was localised on the exit symmetry axis of the geometry was not clear.



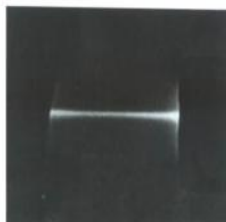
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Figure 1 a) Schematic of Opposed Jet apparatus. b) Photograph of Opposed jets. c) Streamline photograph of uniaxial extension flow. d) Photograph of localised centre line birefringence for PE/Xylene solution. (Mackley et al. 1975)

Two, Four and Six Roll Mills

The reason for the observed localised birefringence only became “obvious” after a series of further experiments were carried out using other centro symmetric flow geometries, namely the Two and Four Roll Mill. The Four Roll Mill was the invention of G.I Taylor (1934) where he had used the apparatus to follow the stretching of drops in pure extensional flows. My observations using the Four Roll Mill were carried out as a combined student final year research project at Bristol using polyethylene oxide/water solutions, which were very much more benign than elevated temperature polyethylene/xylene solutions, (Crowley et al. 1976). Localised birefringence was again observed in the Four Roll Mill as shown in Figure2. On seeing the results, Charles Frank immediately realised that in order to stretch chains in solution, not only was a high strain rate required, but also a high strain too and in the opposed jet and mill geometries this was only achieved very close to the exit symmetry axis or plane of the flow. The conclusion, once appreciated was obvious and goes a long way to explaining why there were so many reports of different extensional rheometers apparently giving different extensional viscosities, see for example James et al. (1994), Petrie (2006). Very few extensional rheometers reach anywhere near high enough strain levels to obtain full chain extension and or a steady state. Most extensional rheometers measure some form of transient extensional viscosity.

The Two Roll Mill, (Frank et al. 1976) which was one of my own inventions for flow birefringence experiments, is shown in figure 2 and added a touch of rotation to the flow. The Six Roll Mill (Berry et al. 1977) was the inspiration of Sir Michael Berry and is also shown in figure 2. The Six Roll mill literally took the multi mill story to catastrophically high levels!

The “Linkam” Cambridge Shear System

In the late 1970s a well known British Rheologist, Neil Cogswell introduced me to Liquid Crystal Polymers (LCPs) and provided me with a precious 500g sample of Eastman Kodak thermotropic LCP material to play with. Optical observations of the complex microstructure were complicated by the need to carry out observations at elevated temperature and the material was also very shear sensitive. In the early 1980s I tasked one of my first Cambridge PhD students, Diane Graziano to study the

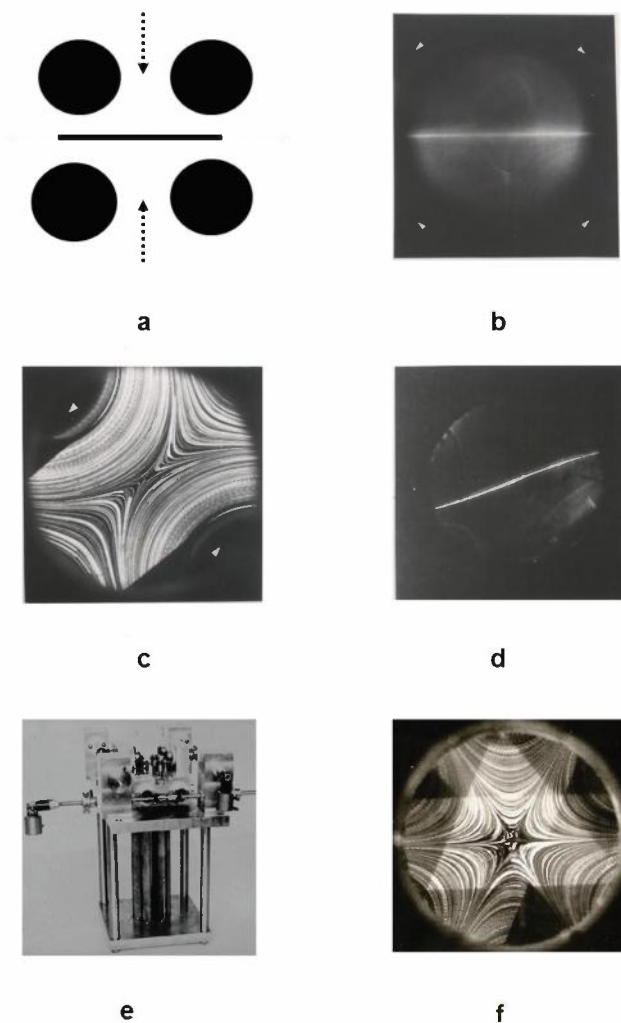


Figure 2 a) Schematic of Four Roll mill. b) Localised birefringence for PEO/water solution in Four roll mill. c) Photograph of streamline flow for Two Roll mill. d) Photograph of localised flow birefringence for PEO/water solution. e) Photograph of Six Roll Mill. f) Photograph of streamlines for six Roll Mill.

(Crowley et al. (1976), Frank et al. (1976), Berry et al. (1976))

rheology and microstructure of thermotropic LCPs. The rheology was straightforward as we had a nice Rheometrics RDS machine and with the help of a fellow American, Kurt Wissbrum, Diane did a good job on characterising and understanding the rheology, Graziano et al. (1983). Optical observations were more challenging experimentally and our optical shear cell went through three sequential design and build stages before it worked in a sensible fashion, Graziano et al. (1984). The design centred around a neat way of heating both a stationary top glass plate and a rotating bottom glass plate. Working with Diane and a stalwart, patient and able technician in Chemical Engineering, Alan Butcher, we eventually got an apparatus that worked. A post Doc, Tim Nicholson then added computer software to complete an apparatus where controlled shear experiments could be carried out at elevated temperature. The apparatus and an example of later optical observations are shown in figure 3. After demonstrating the apparatus viability, Linkam Scientific, <http://www.linkam.co.uk> owned and managed by Arnold Kamp, took over the basic design and they have steadily improved the concept. The apparatus is now marketed as the Linkam CSS and several hundred units have been successfully manufactured by Linkam with sales throughout the world.

The Cambridge Multipass Rheometer

The Cambridge Multipass Rheometer (MPR) has true rheology measuring capacity as well as the ability to perform multiple processing functions. For a review see Hassell et al. (2011). It is the technically most ambitious apparatus I have been involved with and is the one that has produced the most challenges. The MPR was conceived from a long standing relationship with BP and Steven Aldhouse in particular. In the early 1990s there was the recognition that standard viscosity flow curves were not enough to characterise molten polymers. Linear viscoelastic properties were more powerful at differentiating one polymer from another and could be used for both characterisation and describing processing behaviour.

The MPR was initially conceived as an online rheometer that could measure both standard capillary flow and oscillatory LVE measurements for a polymer melt at the ex reactor extruder head. An EPSRC grant application was rejected; however Sir Sam Edwards came to the rescue by obtaining a DTI “pot of gold” for the study of soft matter at Cambridge.

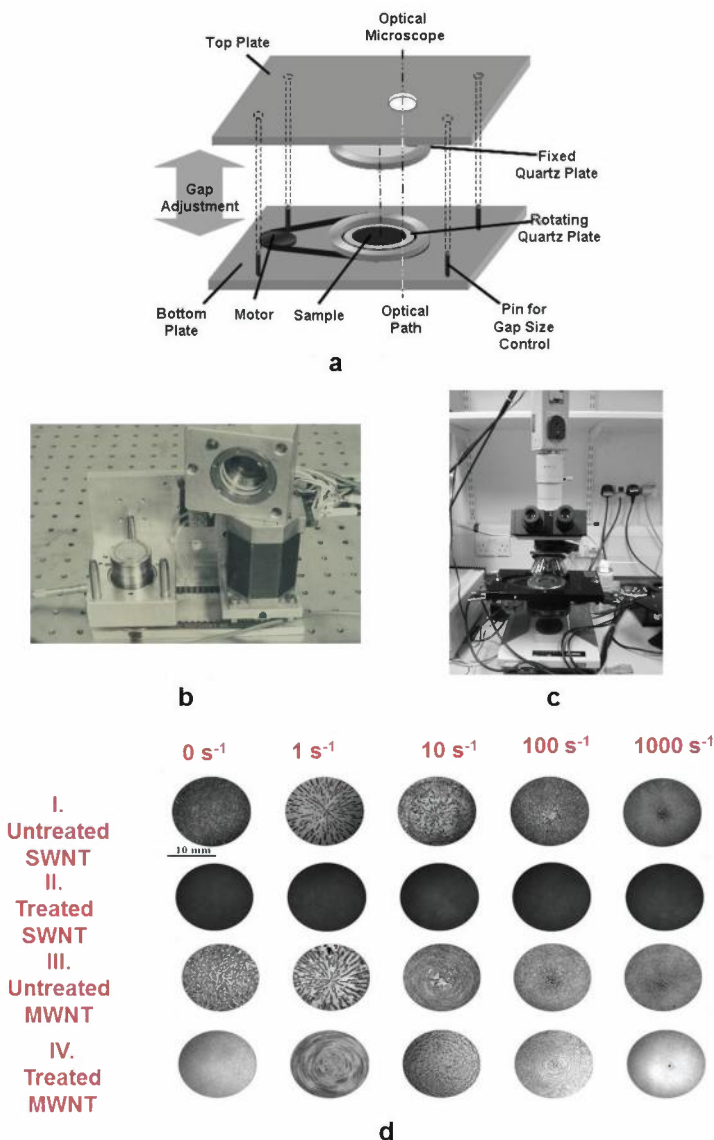
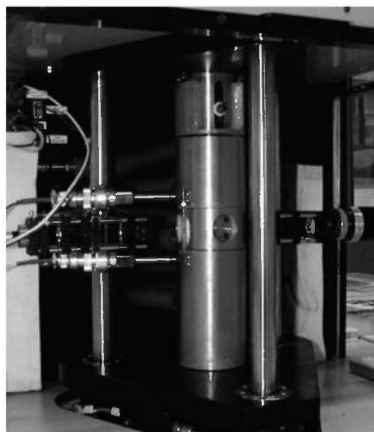


Figure 3 a) Schematic of Linkam CSS. b) Photograph of a prototype. c) Photograph of an early Linkam unit. d) Photograph of different optical microstructures for different Carbon Nanotubes (CNTs) at different shear conditions. (Graziano et al. (1984), Ma et al. (2008))

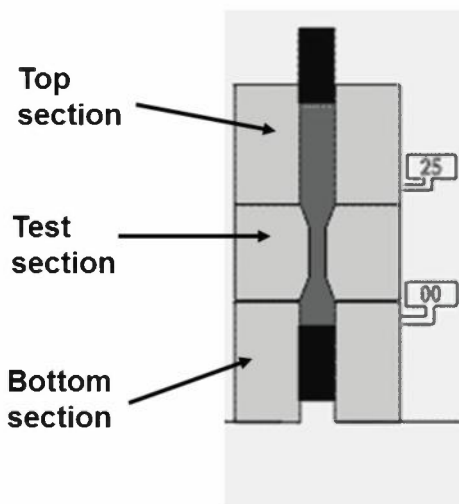
Although a theoretician, Sam was a loyal and active supporter of experimentalists and I was a beneficiary of his generosity in now having enough funding to design and build our first MPR.

The MPR is a two piston servo hydraulically driven device that can perform single or multi passes within a “test section” shown in figure 4. The test section insert could be a capillary or a more complex geometry such as a pure shear cross slot (Coventry et al. (2008)). The MPR was my own invention with very valuable input from the Polymer Fluids Senior Technical officer, Robert Marshall and an able Post Doc, Dr Bas Smeulders (Mackley et al. (1995)). The detailed servo hydraulic design and construction was put in the hands of Peter Watcham and the Company Eland Test Plant. The Mk1 device worked well and from a period in the 1990s and early 2000s we moved on to Mk 2 and Mk3 machines. At the point when Eland had 5 Mk4 machines completed or under construction, Eland went into liquidation leaving several poorly completed and incomplete machines. Fortunately two Companies came to the rescue. Strata Technology <http://www.stratatec.co.uk/> took on the engineering side of the MPR and Omiga Technology <http://www.omigatech.co.uk>, the delicate control issues for the two pistons. Some damage was done to the reputation of the MPR during the period of Eland collapse, however Strata and Omiga have together now produced an excellent product with superb piston control and resolution.

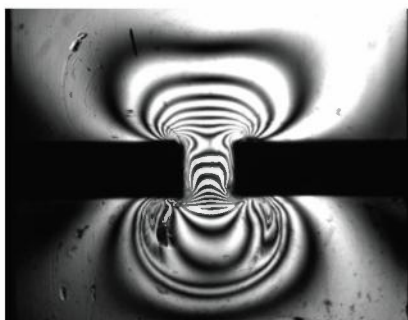
One of the strengths and also weaknesses of the MPR is its multi-function ability. Yes it can be a capillary rheometer with independent pressure control. Yes it can measure G' , G'' in an enclosed environment. Yes it can perform flow birefringence studies in both complex slit or Cross slot geometries and yes it can even perform sophisticated mechanical tests on solid samples. Whilst all these options are potentially attractive, most people seem to want a rheometer to perform in a particular familiar way and the MPR does not really satisfy this criteria. As a research platform the MPR has provided a fantastic diversity of controlled experiments in different geometries for very different fluids and materials. On looking back at the MPR, I have few regrets, although saddened that the full potential of the machine has yet to be exploited.



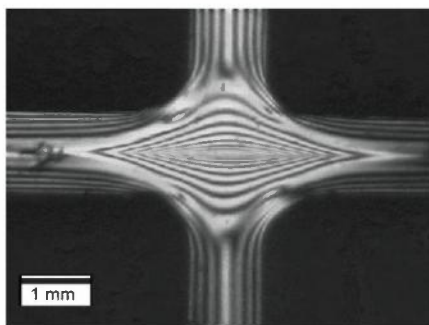
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Figure 4 a) Photograph of Mk4 Cambridge MPR. b) Schematic of MPR configuration. c) Flow birefringence photograph of Slit flow for LDPE. d) Flow birefringence photograph of Cross Slot flow for HDPE. (Mackley et al. (2011))

The Cambridge Trimaster

My final apparatus development has been the Cambridge Trimaster. Initial experiments were carried out by another of my Post Docs, Dr Tri Tuladhar using the MPR as a two piston Mk1 Trimaster filament stretch device, Tuladhar et al. (2008). We were interested in the stretching and break up of low viscosity fluids in relation to ink jet printing and so there was a requirement to stretch fluids with millisecond time scales for relatively short distances. Filament stretching has been around for some time and has mostly been used as a way of measuring extensional viscosities (See for example Shridhar et al. (1991)). In addition filament thinning has provided useful rheological data following pioneering experiments by Bazilevsky et al. (1990) and later others (see review by McKinley (2005)). The use of high speed mutually opposed pistons in the Trimaster has the advantage that the centre of the filament remains at the centre of field of view which in turn makes optical interrogation of the filament thickness easier.

The Mk 2 device is shown schematically in figure 5 with an example of the optical output it achieves. The important thing for low viscosity fluids is that the pistons must move precisely and fast and that a high speed camera is necessary to follow all thinning and break up events. The Trimaster has been challenging but fun to develop and we are now working in conjunction with a Cambridge based Company, Huxley Bertram, www.huxleybertram.com on a Mk4 design that will achieve even higher separation velocities using a cunning engineering design conceived by Stewart Huxley.

Conclusion.

There can be three stages in the genesis of a new scientific instrument. The inventive step; potentially the easiest step, but of course a risk, as by definition the inventor is doing something new and therefore uncertain. The development stage; requires time and almost certainly the evolution of several trial units. Very rarely can you expect the Mk1 version to be the final instrument. It is true; we learn by our mistakes. Unfortunately it is also true that sometimes we do not learn from our past mistakes!

A commercialisation step is a final option and this should be done with extreme caution, if at all. None of the apparatus I have described were

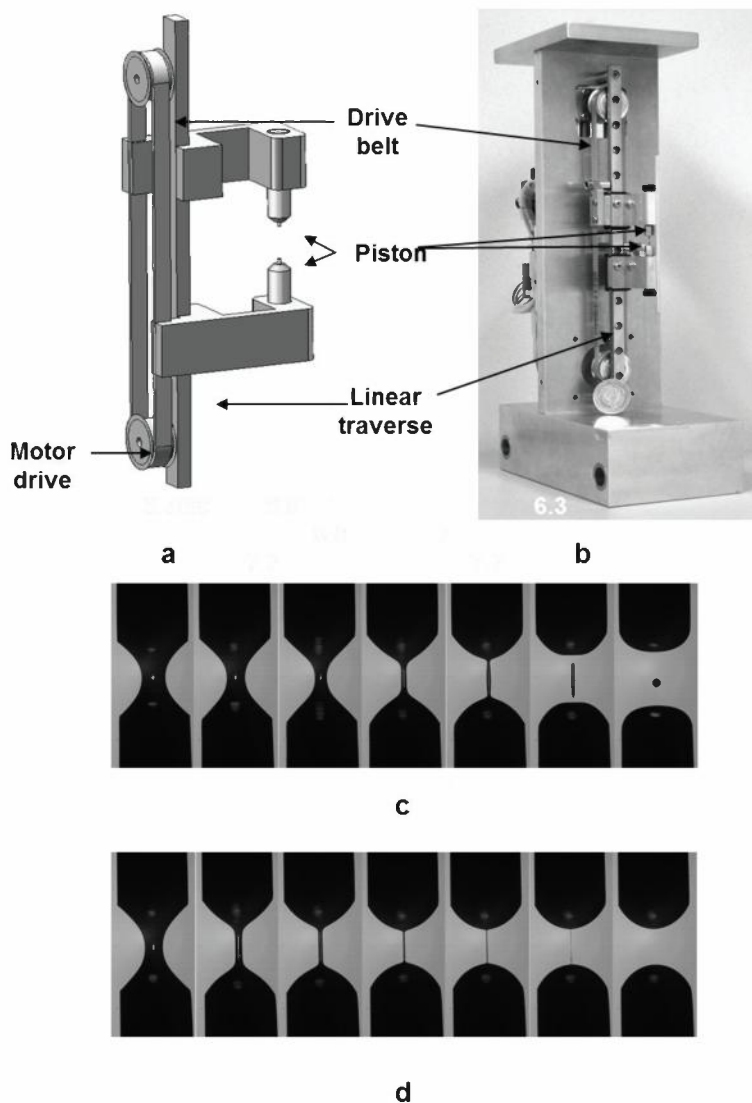


Figure 5 a) Schematic of Mk2 Cambridge Trimaster. b) Photograph of Mk2 Trimaster. c & d) Example of filament stretch, thinning and break up, c) DEP solvent. d) 2.5% polystyrene in DEP. (Vadillo et al 2010)

developed with commercialisation in mind. If commercialisation is the key driver, it is perhaps better to work backwards. Ideally identify the commercial need and then invent an instrument to fulfil that need.

My experiences in Scientific Instrument development on the whole has been a lot of fun; although with every instrument that I have described there have been set backs, dramas and hurdles to overcome. People of course are the key and I do not believe there are many or any people currently on this planet that have the complete tool kit to invent, develop and market a new scientific instrument on their own. Finding a team of able people is essential. In addition finding the financial resources to see a new instrument from invention to final product is not easy. Initially everything is an act of faith and then there is the marketing uncertainty of whether you will be able to sell any, one, ten, a hundred or a thousand units. I remember a long time ago Sir Charles Frank once said to me, “stick to science and don’t go commercial”. I have done a bit of both and so have not strictly followed his advice. Today I see more and more “academics” going or being forced to go essentially fully commercial. What a pity; we still need some true scientist as well as commercially active “academics”.

September 2012 Antibes. France

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Vernon Harrison Award Winner 2011

David Hoyle

[\(d.m.hoyle@durham.ac.uk\)](mailto:d.m.hoyle@durham.ac.uk)

Department of Physics
Durham University

Department of Mathematics
Leeds University

My PhD research was focused on the characterisation of long-chain branched polymer melts through differing rheometric measurements. I chose to focus on the mathematical parameters used in constitutive modelling of branched polymers. I investigated differing flow types both in shear and extension to ascertain their sensitivity to each parameter.

Over the past decade a class of constitutive models known as ‘Pompom’ models have been developed to capture the rheology of branched polymer melts. A Pompom molecule is the simplest molecule to contain multiple branch points. The molecule consists of a backbone between two branch points with each branch point linking to q arms. The presence of two branch points causes the backbone to become stretched during an imposed deformation. This stretched backbone provides a strain hardening stress response in extensional flow. My PhD research was concerned with the modelling of long chain branched polymer melts using the McLeish and Larson Pompom constitutive equations.

Although in principle a precise knowledge of molecular structure should give a complete prediction of its rheology, in practice this information is not available for commercial polymer resins and so even constitutive equations derived from molecular theory will contain unknown parameters that must be quantified by fitting the model to experimental data. However, by correctly parameterising a material it is possible to infer molecular detail about the material as well as providing an accurate description of its rheology for modelling complex flow situations.

A multi-mode version of the Pompom model is needed to characterise real branched resins. The multi-mode model has many parameters that represent the polydispersity over both relaxation time scales and branching architectures. The fitting of a multimode Pompom parameter space to a material’s rheological response is an ill-posed problem with multiple fitting

solutions. The current practice is to fit the two non-linear Pompom parameters to extensional data due to its sensitivity to levels of long chain branching, however this has two weaknesses. First, fitting two parameters simultaneously can provide ambiguous characterisation and it would be far better to investigate parameters individually. Second, extensional measurements are difficult, in particular the extensional stress steady state cannot be measured through standard stretching experiments since the sample breaks and this leads to uncertainty when fitting the Pompom model. In my thesis I studied a number of other non-linear flows using this model to investigate if the non-linear Pompom parameters can be otherwise probed. For each flow the results were compared to experiments on a set of polyethylene melts with differing branching levels and we will see if a particular flow can discriminate between materials.

The first flow types examined were simple shear flows. In a shear step-strain flow the stress relaxation of polydisperse branched polymers is observed to be time-strain separable, whereby the relaxation modulus can be separated into the product of separate functions of time and strain. Conversely, the relaxation modulus for a melt of ideal H-polymers is not time-strain separable. As we expect the single mode Pompom model is not time-strain separable due to the separation of relaxation processes. However, there exist sub-sets of parameter values for the multimode Pompom model where time-strain separability is valid. For these sets a branched damping function was derived which is analogous to the Doi-Edwards damping function for linear polymer melts. The conditions for time-strain separation are not met by real long chain branched polymer melts, but they are approximated closely enough for time-strain separation to be observed in both experiments and in general by the Pompom constitutive model. We also observed that shear step-strain was able to discriminate between the two types of PEs investigated, LCB-HDPE and LDPE, however, it was hard to ascertain precise knowledge of the branching structure as the flow did not sufficiently probe the material. This means we were unable to uniquely characterise it with Pompom non-linear parameters [4].

The other simple shear flow I examined was oscillatory shear. Commonly, oscillatory shear is probed at low strain amplitudes over a range of frequencies to measure the usual dynamic moduli of linear viscoelasticity. The effect of strain amplitude was explored up to absolute strains of order

unity. The non-linear stress response is analysed from the higher harmonics in the Fourier series. In particular it was found that the low-strain asymptote of the third Fourier harmonic depends on only one of the two non-linear parameters in the Pom-pom model, the non-linear stretch relaxation time. This tells us about the microstructure of the fluid since the stretch relaxation time is proportional to the entanglement level between branch points. Therefore, these low strain asymptotes can be used to parameterise the stretch relaxation time and then the remaining parameter, the branching number, can be found from extensional experiments. In my thesis I investigated Pom-pom spectra derived from modelling the synthesis of the polymers [3]. Modelling the synthesis generates thousands of Pom-pom modes and the asymptotic solutions are ideal for comparing the model to experimental data without having to perform lengthy computer simulations. Furthermore, the spectra derived from synthesis showed excellent agreement with the experiments, helping to demonstrate the accuracy of modelling polymers this way.

Subsequently, my thesis focused on the stagnation point flow generated in cross-slot flow. The stress calculated from the Pom-pom constitutive model was compared to experimental flow induced birefringence images. It was shown for linear and lightly branched materials that the Pom-pom model predicts both the form of the birefringence pattern and stress values obtained from the stress-optical law. However, for more highly branched polymers the Pom-pom model fails to predict the change to birefringence patterns. I confirmed using 3D simulations that three-dimensional effects were negligible for the experimental geometry used and so 2D simulations were compared to experiments. In this situation the Pom-pom model failed to capture the correct rheology downstream of the stagnation point. To examine this discrepancy further, flow induced birefringence images from the cross-slot were used to determine the steady state extensional viscosity. Subsequent analysis showed that there exists a transient overshoot in extension which the Pom-pom model does not capture. This has been confirmed by recent stretching experiments from Hassager's group at DTU [2]. Using stagnation point flow allows the measurement of the steady state extensional stress which should allow good characterisation of the Pom-pom model. However, the Pom-pom model does not capture non-monotonic extensional stress growth [1].

In the final part of my thesis I proposed a modification to the Pompon constitutive model to capture this transient extensional overshoot, which is able to resolve the differences between experimental flow induced birefringence images and theoretical simulations [5] (c.f. cover image). Although there is only limited data of transient extensional overshoots, a combination of uniaxial stretching experiments and flow induced birefringence images can be used to fully capture the extensional rheology of a material. The model I used was not derived from a micro-structural basis and does not capture all the rheological features associated with this extensional overshoot, for example, the stress relaxation following a cessation of flow. Since the extensional stress in non-monotonic you can choose to stop the flow at an equal value of extensional stress on either side of the transient overshoot and there is an important difference in the relaxation depending on which side of the overshoot you start from. If the flow is stopped before the overshoot, the stress relaxation has been modelled and the Pompon equations capture this relaxation well. If the flow is stopped after the transient overshoot then the stress relaxation occurs much faster and neither the original Pompon model nor the modified Pompon model adapted to exhibit an overshoot can capture this relaxation effect. So the Pompon model is capable of capturing the stress response in various rheometric flows in the linear and non-linear regime up to a point. Furthermore, using a combination of oscillatory shear with Fourier transform rheology and extensional flow we can experimentally probe both non-linear Pompon parameters individually.

Finally, I would like to acknowledge my PhD supervisors Oliver Harlen and Tom McLeish, the MuPP research group, Manfred Wilhelm and Ole Hassager and their research groups, and my current employers, Durham University. I would like to thank the EPSRC for the funding they have provided and I would also like to thank the BSR for awarding me the Vernon Harrison Annual Doctoral Prize.

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Letter to the Editor

Congratulations on taking up the editorship of the Bulletin. I have fond memories of my stint (1990-1994) working with a computer typesetter, when such people were highly sought after. Now, we can do it all ourselves on a PC!

I am writing to ask, through the readers of the Bulletin, if anyone could offer a good home to my collection of Journal of Rheology (from 1997 to 2011). For reasons of pressure on space, I am having to clear some things out of my office and would rather they were used by someone than were simply recycled. Having been supplied to me as an individual member, they are stamped with “Member subscription copy – library or institutional use prohibited until...” (5 years from publication), which means that the 2011 issues are embargoed until 2016.

Professor PFG Banfill
Director of Research
Institute of Building and Urban Design
School of the Built Environment
Heriot-Watt University
Edinburgh
EH14 4AS
(+44) 0131 451 4648
p.f.g.banfill@hw.ac.uk



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Thermo Scientific HAAKE RheoScope module: image acquisition at (very) high shear rates using a stroboscope light source

Key words

Thermo Scientific HAAKE MARS, Thermo Scientific HAAKE RheoScope module, Stroboscope light source, Data acquisition at high shear rates, Emulsions, dispersions

The optionally available stroboscope light source extends the capabilities of the HAAKE RheoScope module, facilitating on the one hand an investigation of rheological phenomena on a structural level also at (very) high shear rates and providing on the other hand an improvement of the quality of the microscopic images at lower shear rates due to a shorter exposure time and a higher light intensity.

Thanks to the stroboscope light source, e.g. the behavior of paints and inks during the coating process can be investigated with the RheoScope or the coalescence of emulsion droplets under high shear rates. Shear-induced orientation and deformation in a sample as well as the structural disaggregation and recovery under defined temperature and shear conditions are further examples.

Instead of using a cold light source, a stroboscope (model BVS-II Woran, Polytech GmbH) can be connected to the RheoScope module using the same light guard. This modification can be made done by the user within seconds without any tools. The stroboscope light source is equipped with a Xenon flash lamp and has a maximum flash frequency of 200 Hz. In order to synchronize the microscopic data acquisition with the flash light of the stroboscope, only the integration time of the camera in the HAAKE RheoWin software needs to be adapted.

High quality images can be obtained up to a shear rate of 44 000 s^{-1} using the HAAKE RheoScope camera in combination with the stroboscope light source. Based on experience and depending on the individual sample, images up to a shear rate of 2000 s^{-1} can be taken with a cold light source. This means, that the use of a stroboscope light source with the HAAKE RheoScope module extends the measuring range by factor of 20.



Thermo Scientific RheoScope module

In Fig. 1 microscopic images of a dispersion of mineral oil in silicone oil are depicted at three different shear rates using a cold light source (Fig. 1a - c) and a stroboscope (Fig 1e - f). A plate/plate measuring geometry with a diameter of 35 mm and a polished surface using a measuring gap of 50 μm was used. Significant differences are already visible at a shear rate of 1290 s^{-1} (Fig. 1b and 1e):

Images taken using a stroboscope have a much higher quality than those obtained with a cold light source.

Fig. 2 shows, that high quality images up to a shear rate of 44000 s^{-1} can be taken using a stroboscope light source.

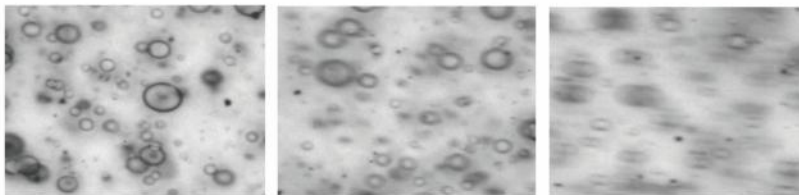


Fig. 1a - c: Images taken using a cold light source at different shear rates: 630 s⁻¹ (1a), 1290 s⁻¹ (1b) and 2520 s⁻¹ (1c)

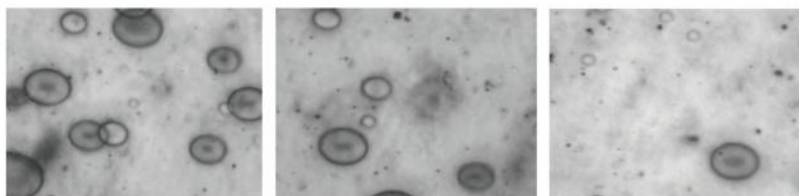


Fig. 1d - f: Images taken using a stroboscope light source at different shear rates: 630 s⁻¹ (1d), 1290 s⁻¹ (1e) and 2520 s⁻¹ (1f)

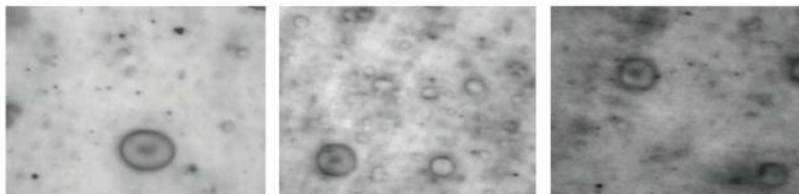


Fig. 2a - c: Images taken using a stroboscope light source at higher shear rates: 5670 s⁻¹ (2a), 12600 s⁻¹ (2b) and 44000 s⁻¹ (2c)

Order information

222-2050 Optional accessory for HAAKE RheoScope module: Stroboscope light source with Xenon flash lamp with maximum flash frequency of 200 Hz (85 V – 265 V / 50 Hz – 60 Hz)

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Material Characterization

Benelux

Tel. +31 (0) 76 579 55 55
info.mc.nl@thermofisher.com

China

Tel. +86 (221) 68 65 45 88
info.mc.china@thermofisher.com

France

Tel. +33 (0) 1 60 92 48 00
info.mc.fr@thermofisher.com

India

Tel. +91 (20) 6626 7000
info.mc.in@thermofisher.com

Japan

Tel. +81 (45) 453-9167
info.mc.jp@thermofisher.com

United Kingdom

Tel. +44 (0) 1606 548 100
info.mc.uk@thermofisher.com

USA

Tel. +1 603 436 9444
info.mc.us@thermofisher.com

International/Germany

Dieselstr. 4
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Report on the Ken Walters Commemorative Symposium at ICR 2012

Tim Phillips
Cardiff University
October 2012

A special symposium was held during the XVth International Congress on Rheology held in Lisbon, Portugal, 4-10 August 2012 to reflect on the contribution of Professor Ken Walters to the subject of rheology and international collaboration. The 23 speakers in the symposium included collaborators, colleagues and former research students. Many representatives from national rheology societies also recounted the encouragement they had received from Ken over the years and the key role that he played in the formation and formative years of the European Society of Rheology.

The symposium started in style with a feature length talk by David Boger on ‘Ken Walters in focus or, what you wanted to know but were afraid to ask’. David provided an entertaining potted biography of Ken from his very early years to the present time interspersed with many photographs from every phase of his life. Apart from describing the many books, awards and collaborations, David focussed on the social side of collaborating with Ken over the years and the hospitality that Ken and Mary have shown to generations of rheologists.

There were some literary contributions to the symposium. Jeff Giacomini conveyed greetings from Bob Bird and recited a limerick that Bob had written for the occasion (reprinted here on the following pages). Ken had spent an enjoyable sabbatical at Madison. Corneliu Balan had been inspired by Shakespeare to write an ode to the Slip Dilemma (also reprinted here on the following pages).

Gerry Fuller in his talk ‘Extensional Viscosity and the Art of Do the Dishes’ reminded us that Ken doesn’t do the dishes, a possible explanation for his predilection for fast food. He then proceeded to give Ken an ice cream from a famous major fast food chain. In his talk he described how viscoelasticity can be used to create soft adhesives for removing particles from silicon wafers without damaging them.

Bamin Khomami spoke on ‘Sedimentation of a sphere in a viscoelastic fluid: a multiscale simulation approach’. Using a multi-bead-spring FENE model and employing the method of Brownian configuration fields he was able to obtain quantitative agreement with experiments on PIB/PB dilute polymer solutions. Although the method is extremely CPU intensive, the influence of the drag on Weissenberg number was captured accurately.

Evan Mitsoulis began by saying how pleased he was to be speaking in this symposium. He told us that in the economic crisis that is enveloping Greece only those who are rich enough or evade taxes are able to travel abroad to participate in conferences. He didn’t tell us which group he belonged to! His talk was concerned with the accurate prediction of the Bagley correction in capillary flows of polymer melts. The punch line in his talk was that the pressure dependence of viscosity was crucial in order to capture the Bagley correction for an LDPE melt.

Rhodri Williams spoke on ‘ A rheometrical study of the modification of incipient blood clot microstructure by exposure to steady shear flow’. He presented a technique that used the notion of fractal dimension to link the ‘structure of a blood clot’ to ‘mechanical properties’.

The second day began with a talk by Roger Tanner who had also written a book with Ken on the history of rheology. Roger described what it was like to work with Ken on this venture and what it is was like to come to an agreement on writing styles and punctuation as well as the more serious aspects of book writing.

The symposium was a fitting tribute to Ken. Many of the leading rheologists on the global stage had accepted the invitation to speak at the symposium. Ken enjoyed the personal reflections on over half a century of involvement in world rheology and the presentation of ‘state-of-the-art’ research on problems that were close to his scientific heart.

Mary had a husband, Ken,
Whose hair was white as snow.
And everywhere that Mary went
Ken was sure to go.
When Ken went off to Dairyland
To visit Madison
Then Mary tagged along, of course,
She knew it would be fun.
They'd climb the cliffs at Devil's Lake
And go in for a swim
And then they'd snack on rich ice cream---
That pleased both her and him.
From time to time, while Mary shopped,
Then Ken would oft be free
To have a chat with "rheo" friends
About "rhe-o-lo-gee."

Bob Bird
University of Wisconsin - Madison

Slip Dilemma¹: Monologue of a Rheologist

Inspired by Hamlet's Tragedy²

by Corneliu Balan

To slip, or not to slip, that is the question³;
Whether or not a simple or complex flow
Is sliding near the wall⁴;
To adhere, to slip it doesn't matter,
Navier-Stokes solution to say we end
The simulations, how useful they might be
To dream reality in virtual experiments,
Without too much thinking of slip and adherence.

To slip a length is natural,
For Navier⁵ the lack of confidence may come,
Must give us pause of run,
The molecules will wait in timeless loops,
Continuum⁶ lost in discrete world.

The undiscovered adherence condition,
No traveller returns in theory of Stokes⁷,
An open puzzle is the flow; to yield in myth⁸
Than fly to other models that we not know of?

Is the fluid stick on solid
A native consequence of resolution,
Or the turning current is the rule
In name of action conservation;
The neighbourhood of both is self understood.

Soft you now! and let the mind free,
In future knowledge the truth is,
Be all scientists' sins remembered.

¹ Dedicated to Ken Walters FRS, at his 80th birthday

² Shakespeare W. (1599-1602) *The tragedy of Hamlet, Prince of Denmark*, act III, scene 1.

³ Day M. (1990) *The no-slip condition of fluid dynamics*, Erkenntnis 33, 285-296.

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With KW Through History

Roger I. Tanner
University of Sydney, Sydney 2006 Australia
Email: roger.tanner@sydney.edu.au

At the XVI International Congress on Rheology (Lisbon August 2012) an interesting and well-deserved session honouring Ken Walters's work in Rheology occurred. I spoke in the session about my experience of writing a book with Ken on the History of Rheology, and this note is a variation on that talk.

About 20 years ago, at or soon after the Brussels International Congress of 1992, Ken suggested we write a book on the History of Rheology and I agreed.



At the 1992 Congress in Brussels: from left to right, the late Art Metzner, Ken Walters (presumably thinking about what to say next), Pino Marrucci in full flight, and me.

Setting up the general outline was not difficult- since we were both interested in phenomena that could be quantified. In fact, the book begins in antiquity and proceeds more or less along the time axis until the 1990s. As a coincidence, Ken's life (1934-) spans most of the time since the invention of the word Rheology in 1929.

We divided up the writing of the proposed Chapters between us, and Ken had the idea that we should not only narrate the history of the subject, but we should also include short biographies of prominent rheologists separately from the main text. I think Ken had seen this idea in a book where the biographies were those of saints. Well, some of our rheological bios were of people who were definitely not saints. However, we adopted the plan, which I believe is a good one, but there are obvious drawbacks. Potential complaints were of two kinds:

- a) Non-inclusion in a separate, full bio causes angst;
- b) Inclusion but with a less than a 'worthy of a Nobel Prize 'write-up also can cause angst.

In fact, we received less complaints than I expected, and less compliments than I hoped.

The first Chapter was mainly written by me and is entitled "Introduction-the Ground is prepared". It begins in antiquity-Heraclitus (540-475 BCE) and Confucius both thought about flow-"Panta Rhei" -everything flows-is now the logo of the Society of Rheology, following Heraclitus.

The Middle Ages saw the development of kinematics and then Newton discovered dynamics. The first quantitative model for elasticity was proposed by Robert Hooke in 1676 and published as an anagram. We wanted to include a picture of Hooke in a biographical note, but we could find none even though he is known to have been painted four times. It is quite possible that Newton, when he was President of the Royal Society of London, had these portraits destroyed after Hooke's death. I was told by a colleague that the Internet was the answer, and sure enough one finds there many pictures which are alleged to be of Hooke. However, close inspection shows that they were all created long after Hooke's death, even hundreds of years after, and are not necessarily likenesses; some are vicious cartoons.

Lisa Jardine in her book about Hooke thought she had found a true likeness but subsequent research showed it to be van Helmont, the Dutch chemist.



A caricature of Hooke



This is Jan Baptista van Helmont, not Robert Hooke.

My conclusion - don't believe everything you find on the Net.

After I had written Chapter 1 and sent the draft to Ken we had a major difference of opinion, as follows. We write the possessive as in “Tanner’s tough life”. However, when the name ends in s, should we write “Walters’ wish” or “Walters’s worry”? I prefer the latter, so one rule does for all cases, but we could not agree, so each Chapter has the style of the main author. I do not know if anyone has noticed this quirk.

The next Chapter is also mainly mine - it has the title “The growing years before 1945”. It contains the wonderful work of Boltzmann on linear viscoelasticity, which is still valid; he did this work in a few weeks and then did not return to the subject in a major way. The Chapter also describes the beginnings of the study of non-linear effects, including the inspirational demonstrations of normal stress effects by Karl Weissenberg. In writing Chapter 2 we discovered that the life of Heinrich Hencky was largely unknown.

Hencky (1929) of course promoted the use of logarithmic strain, equal in a tensile test to $\ln$ (final length/original length); when the ratio is close to one the classical small strain is recovered. After the book was published my wife Elizabeth and I set out to find out about Hencky’s life .We had a wonderful time following his life from Ansbach (Bavaria) where he was born in 1885 to Darmstadt where he got his PhD, and then to Dresden. He was working on the Russian railways during World War 1 and was interned in Kharkov (now in Ukraine). Somehow he met Alexandra Yuditskaya there and they got married before returning to Germany in 1918. In 1922 he went to Delft in Holland as an academic, but he was not a good linguist and his teaching in the Dutch language was not appreciated. So he went to MIT in the USA, but was not given tenure. It was 1932 in the Depression and he went to Lisbon, New Hampshire as a potato farmer, although he knew little about farming. Lisbon N.H. is depressing today - I prefer the Portuguese Lisbon. Then in 1936 he went back to Kharkov as Professor. However, the Russians soon gave him 48 hours to leave the country so he went with his family back to Hitler’s Germany in 1937. He was not warmly welcomed there - he spent the rest of his career in the MAN company in Mainz, before dying in a mountain-sports accident in 1951.

Without the book, we would not have had this fine experience of discovering Hencky, so this was a definite benefit of working with Ken. Rheologica Acta published our work on Hencky in 2003.

Ken wrote Chapter 3 entitled “Interlude: Rheology becomes an independent science: Societies, Congresses and Journals”. He has been active for a long time in all of these activities and is very knowledgeable about them. We went to the 4th International Congress at Brown University in Providence, R.I in 1963 - it was my first international Congress. I met Ronald Rivlin at breakfast one day and he was complaining that the Bingham medallist (Clifford Truesdell) had been promised an air fare from Italy so he could receive his medal in person, but Truesdell would not come unless he was given a first-class ticket. So Rivlin had to find extra money.

Ken really got stuck into critics of Jim Oldroyd, who had been his PhD supervisor, in the next Chapter, the fourth, entitled “Constitutive relations”. Oldroyd had been ignored by Truesdell, and Ken set the record very straight.

The next Chapter was entitled “From Continuum theory to microstructure (and vice versa)”. The late Arthur Lodge is featured here - he began to connect microstructure with macroscopic entities like stress in nonlinear materials, thereby advancing the study of Rheology to another dimension. One needs to mention R.B (Bob) Bird and Hanswalter Giesekus who were also prominent in this context.

Ken has always been a great organizer of Workshops and so he wrote the Chapter on “Rheometry beyond viscosity”. It included the well-known infamous picture on extensional testing, a relic from a 1993 Workshop.

The difference between where I live (New South Wales) and Ken’s Wales is that there are more dragons and myths in his Wales. Strangely, the book does not mention the Myth of the Yield Stress which emanated from Wales in 1985. This is Ken’s best-cited journal article –at least 255 citations so far in the ISI Web of Science.

Finally, I did a chapter on Computational Rheology. One of the best remarks on the book was received from Marcel Crochet who said that two important rheologist bios were missing - certainly Ken’s inclusion would have been extremely well deserved.

The picture on the back cover of the book shows us during one of Ken’s visits to Australia - we were standing on the Bowral Cricket ground, about 120 km from Sydney, where the world’s greatest cricketer, Don Bradman,

began his sporting career. Ken was an excellent sportsman and he played cricket at county level, and also enjoyed golf.

How did we get all the writing done? It was greatly facilitated by a resident Workshop at the Isaac Newton Institute at Cambridge in 1996 which Ken helped to organize and to which I was invited. We met every weekday to discuss ideas and progress. Despite his fairly benign appearance, Ken is actually a slave-driver when engaged in such an enterprise.

Overall, the book would not have succeeded if it had not been for Ms. Pat Evans in Aberystwyth, who prepared the camera-ready copy for us from our hand-written scribbles. We - and also Elsevier - owe her a great deal. Ken did the references, appendices and the indices – a heroic effort. I think he didn't want me to get in the way.

We had done a colossal amount of work over six years to produce the camera-ready copy, and in turn Elsevier set a monumental price for the finished book.

Obviously, writing the book was a great experience for me and I thank Ken for suggesting it. Whether it will indeed influence the future of Rheology and help to avoid useless repetition remains to be seen.

I believe the Congress Symposium was a fitting tribute to Ken's great influence on Rheology, not only for his notable science, but also for his organizing ability and his superbly helpful attitude in promoting the careers of others.

BSR Student Travel Awards

The 301st Council Meeting established the principle that student travel grants have the objective of encouraging students to disseminate their research. Applicants for a student travel bursary must normally have been a member of the Society for 9 months, may be working worldwide and presenting research at a conference, by paper or poster. The grant will be made on receipt of a report on the event.

The British Society of Rheology wishes to establish a transparent mechanism for the award of travel bursaries and to solicit applications from its student membership. Travel bursaries are available to student members of the Society to present their research at a conference that contains a strong rheological element, in situations where no other sources of funding are available to cover the whole cost of the meeting. Suitable conferences include the International Congress of Rheology, the Annual European Rheology Conference and conferences organized by the Society.

The next closing date for consideration of the award of a travel bursary is Thursday 28th February 2013 with successful applicants notified by 8th April. Applicants should include in their submission the name and location of the conference, the title, authors and abstract of the paper submitted to the conference, a breakdown of the projected costs of attending the meeting and a supporting letter from their research supervisor. The support of the British Society of Rheology should be mentioned in the conference presentation. The Society's logo may be used for this purpose. Payment of the bursary will be made on receipt of a report on the conference. The conference report will be published in the Bulletin of the Society.

Applications for a travel bursary should be sent to the Secretary (secretary@bsr.org.uk).

Simon Cox
BSR Honorary Secretary

BSR Membership News

The Society has welcomed the following new members since the AGM:

Ben Proudlove (Marrow Scientific)
Monica Oliveira (University of Strathclyde)
Emma Hodson (Unilever)
Nadji Chioukh (Algeria)
Alexander Holder (Swansea University)
Afshin Tarat (Swansea University)
Rebecca Hambly (Swansea University)
Ross Winter (Imperial College)
Idris Mohammed (Imperial College)

One year's free membership is offered to participants of BSR meetings who are not already members. The following accepted the offer of membership for 2012 following the BSR Midwinter Meeting at UCL in December 2011:

Robyn Morrcroft (University of Durham)
Claire McIlroy (University of Leeds)
Marc-Antoine Fardin (Université Paris Diderot)
Liyan Yu (University of Cambridge)

New Honorary Member: Ian Guthrie

Deceased Member: Mr E B Atkinson (a BSR member since 1946)

Membership Subscription Reminder for 2013

Please note that the annual membership subscription fee for the British Society of Rheology for **2013** is due on **1st October 2012**. If you haven't done so already, please arrange payment as soon as possible. Payment may be made by cheque, paypal or standing order. Our preferred method of payment, however, is by standing order since this reduces the administrative overhead. A payment form can be found on the website (<http://www.bsr.org.uk/renewal.asp>).

You may view your past payment history by logging into the BSR website. If you have forgotten your username and password please let me know and I will forward these on to you. Please check that your contact details stored on the website are correct so that we can ensure that notifications about conferences and meetings, for example, reach you.

Tim Phillips
BSR Membership Secretary

Conference reports

BSR Student Travel Award Report for the 16th International Congress on Rheology, Lisbon, Portugal, 5-10th August 2012

Report 1.

I would like to thank the BSR for awarding me the TA poster prize at the BSR mid-winter meeting in 2011, which funded my attendance at the XVIth International Congress on Rheology in Lisbon in August 2012. The conference, organised by João Maia, Crispulo Gallegos and Igor Emri, was the largest I've attended yet, with eleven parallel sessions covering seventeen topics; in all nearly a thousand presentations were given, this was no mean feat of organisation!

I was also given the fantastic opportunity of presenting my work to the most learned audience possible; this focussed on shear banding in complex fluids, where I have been working under the supervision of Dr. Suzanne Fielding (Durham). I was also extremely grateful to meet some of the most experienced and enthusiastic minds in the field, who really engaged with my work and asked the most insightful questions that have subsequently aided me to focus my explanations in my thesis towards the most relevant issues. This was a most valuable experience to have at such a crucial stage of thesis writing; I left the conference with a renewed buzz of excitement for research, though now feel I have too many interesting questions for future work to explore before the end of my PhD...

Robyn Moorcroft, Durham.

Report 2.

Thanks to the BSR travel award, I was privileged to attend and present my work at the 16th International Congress on Rheology in the beautiful city of Lisbon, Portugal, 5-10th August 2012. A huge thank you must go out to Joao Maia and his team of organisers for their great success in coordinating such an enormous meeting of rheologists from across the globe. The conference was held at the Belem Cultural Centre, framed by the exquisite Jeronimos monastery and historic monuments Belem tower and the Discoveries; it was a pleasure to visit this picturesque area of Lisbon, located on the Tagus river estuary. As well as the meticulously planned scientific programme, an enjoyable social programme made the conference an unforgettable experience.

The many fields of rheology were covered over 18 symposia, including my main areas interest: 'Non-Newtonian Fluid Mechanics', 'Complex Flows' and 'Polymer Solutions, Melts and Blends' and applications in 'Industrial Rheology' and 'Biopolymers, Biofluids and Food'. In addition, a special symposium was held to honour Professor Ken Walters in which his friends and colleagues had the opportunity to thank Ken for his advice and inspiration over the years. The 11

parallel sessions needed to accommodate the numerous presentations were overwhelming, but the research on offer was truly inspirational.

6 plenary lectures were given over course of the week; I particularly enjoyed Friday's session in which Gareth McKinley presented a set of tools for characterising complex fluids using large amplitude oscillatory shear (LAOS), dubbed 'rheological fingerprinting' and Gerry Fuller discussed recent advances in interfacial rheology of biological interfaces including treating dry eye syndrome. 58 keynote lectures were also given across the various symposia. Two talks that I found particularly interesting included Ron Larson's presentation entitled 'From atoms to beads and springs', in which he explained the best ways to model dilute solutions using bead spring models and Henrik Rasmussen's presentation characterising polymer melts in extensional flow, in which he showed that the sample failure during stress relaxation after stretching could be predicted using current constitutive models.

I had the opportunity to present my research on 'Molecular Weight Dependencies in Inkjet Printing' at one of the 5 poster sessions and I was encouraged by the interest and positive feedback I received. As well as giving less experienced students a chance to showcase their research at an international conference, the poster sessions provided a relaxed environment to discuss current research and future developments. It was also possible to meet the industrialists responsible for developing increasingly advanced rheometer technology, facilitating new research techniques. Sponsors included Anton Paar, TA instruments and Malvern to name but a few.

Relaxing and socialising was also on the agenda with a port and pastry tasting evening, an excursion followed by a beach party and the congress banquet. A choice of excursions were available, including bus tours, cycling and golf, of which I chose a trip to the small fishing village of Seisimbra and a scenic drive along the Arrabida mountain, a preserved National Park due to its unique vegetation which include cork trees. The evening beach party was held in an exclusive bar and we were served a traditional Portuguese barbeque. Although 80's pop music wouldn't be my choice, the abundance of wine and beer on offer ensured everyone had a thoroughly enjoyable evening. The final night of the congress was celebrated by an extravagant banquet in a former 15th century convent. We enjoyed traditional Portuguese Fado music over dinner, which was served in a magnificent glass covered courtyard.

The 16th International Congress was a huge success and it was a pleasure to be introduced to so many great rheologists. I have come home with a new found motivation for my own research and fresh ideas. I am very proud to be a part of such an open, supportive community and look forward to attending to the next international congress to be held in Kyoto, Japan in 4 years time.

Claire McIlroy, University of Leeds

Commentary on the 336th Council Meeting of the BSR

Birmingham University, 20th September 2012

Back in August, whilst holidaying on the beautiful and scenic island of Mykonos, I was delighted to receive an email from the president of BSR, Bill Frith, asking me if I would be willing to join the council as an ordinary member. Proudly announcing this over breakfast to my family, my nine year old specifically was extremely impressed, her current aspirations being to join as many student Councils at her school as possible (hence have numerous shiny badges proudly pinned on her uniform)!

So on the 20th September, with the summer holidays a sweet but distant memory, I found myself on a train to Birmingham from London, destined for my first ever BSR council meeting. The meeting was held at the Chemical Engineering Department, in the heart of a very green and leafy university campus.

After a prompt start with the president opening the meeting, the other new council member, Richard Watson, and myself, were introduced and welcomed to the council. And in keeping to the council tradition of the newest members writing the commentary on the meeting for the bulletin, I was given my first task! Whilst starting to get mildly disconcerted about having to publish comments on a meeting at which I was a newcomer, to my pleasant surprise, I swiftly found my way round how the Council meetings were structured. I took the latter as evidence of a well organised council and efficient running at meetings. The president expertly guided us through the published agenda and a summary list of actions arising from the previous meeting, ensuring the various officers and members of the council adhere to the decided plans of action! The president gave a brief report on the issue of the ESR structure and constitution changes, as discussed at the last ESR committee meeting in Lisbon during the ICR Congress. These changes which were voted in will now enable the ESR to accept individual members in the future. This was seen as a positive change as long as it does not lead to competition with national societies for membership subscriptions. Moving on to finances, the treasurer, Steve Goodyer, reported that the Society roughly broke even, having 'healthy' accounts. The membership secretary, Tim Phillips, stated that the Society has currently 363 members. Though this is a decent number, new members are always welcome as well as payments by members with overdue bills! The Bulletin editor, Rob Poole, produced a membership survey with the aim of pinpointing BSR benefits that members value most and whether activities such as online discussion forums would be useful in the future. In addition, it was discussed that the Bulletin goes way back with a first issue in 1946. A decision needs to be made as to how to best make these historic issues electronically available to the members (currently only issues post -1997 are available electronically). Regarding the society's website, the

secretary, Simon Cox, confirmed that the recent changes enabled a more modern drop down menu layout. It was felt that any further changes should wait until after the new ESR website is available, from which the BSR news and activities can be accessed. The council also reviewed and discussed applications for the Travel, Vernon-Harrison and the Annual awards. Finally, details of the upcoming scientific meetings were given and it was decided that the next Council meeting would take place at the Mid-winter Meeting 2012 at Aberystwyth while the next AGM will take place at the INNFM meeting at the RS Chicheley Hall in March 2013.

The meeting drew to a close after approximately two hours when everyone departed. I gladly accepted an offer of a lift to the station by the treasurer, giving me the opportunity for a short walk to the car park, enjoying the last few rays of weak but warm sunshine before British winter weather comes upon us!

Maria Charalambides
Ordinary member of Council

Obituary

Philip Sherman, 1922 – 2012

Philip Sherman can be regarded as one of the founding fathers of food rheology. He was born in Leeds in 1922 and received his undergraduate degree in Plant Physiology and his PhD in Physical Chemistry from the University of Leeds. In 1966 he was also awarded DSc from Leeds University. He worked for more than 20 years as an industrial scientist for Colgate-Palmolive, Gestetner, a manufacturer of reprographic equipment and for the ice cream manufacturer, T. Wall and Sons Ltd as Manager of the Physical Laboratory. When the company became a part of Unilever, Philip became Head of the Rheology Section in the Unilever Research laboratory in Welwyn, Hertfordshire. The excellent facilities at Welwyn allowed Philip to pursue his interest in applying fundamental rheological methods to foods. For example he used shear sandwich geometry, originally developed for synthetic polymers, to measure the creep behaviour of frozen ice cream (Shama and Sherman (1966) *J. Food Science* **31**, 699ff). The response was then fitted to viscoelastic models consisting of a Maxwell element and two Voigt elements in series. These were related to structural components in the product i.e ice and fat crystals, and the stabilizer gel network.

His industrial experience combined with his interest in fundamental rheology prompted Philip to write the book “Industrial Rheology” which was published in 1969 by Academic Press. In the forward to this book Philip acknowledged the important influence of George Scott Blair¹ who was a close friend. Philip’s book focused on the application of rheology to the food, cosmetics and pharmaceutical industries. In the same period he also edited the book “Emulsion Science” (Academic Press 1968) and contributed an excellent chapter on emulsion rheology. Five years earlier he had edited the Proceedings of a British Society of Rheology Symposium on the rheology of emulsions. In 1970 he was given the International Literature Award of the Society of Cosmetic Chemists for his paper, “Contributions to the field of physical structure and rheology of emulsions.”

In 1970 Philip entered the academic world and joined Queen Elizabeth College (now King's College), University of London, where he was quickly promoted to Reader in Food Physics and in 1982 to a Personal Chair of Professor of Food Rheology. Although in poor health George Scott Blair attended Philip's inaugural lecture. A major interest that covered both the industrial and academic phases of his research was the relationship between the rheology of a product and its perception by the consumer. A question of continuing interest is: what rheological measurement can predict a consumer's perception of thickness of a food product? Early work proposed that the appropriate measurement was the viscosity at a shear rate of 50s^{-1} . An extensive study was carried out by Philip's group at the Welwyn laboratory (Shama and Sherman (1973) *J. Texture Studies*, **4**, 111ff). A sensory panel was used to rank the thickness of a range of liquid and semisolid Newtonian and non-Newtonian foods where the flow curves cross. A procedure was developed for calculating a viscosity from the flow curve for non-Newtonian liquid and semi-solid foods which provided the best prediction of perceived thickness. The appropriate shear rate is not a constant but depends on the consistency of the food. At Queen Elizabeth College Philip extended the interest in the relationship between perception and rheology to solid foods. Using cylinders of cheese he investigated the deceptively simple experiment of compression to large deformations e.g. Culioli and Sherman (1976) *J Texture Studies*, **7**, 353ff. As well as considering the effect of friction at the cylinder surface he determined the degree and rate of compression which gave the best prediction of perceived firmness in the mouth. Like many of us who started our career before the availability of relatively cheap commercial rheometers with extensive data processing facilities, which started to appear from a range manufacturers from the mid-1980s, Philip was less comfortable with probing viscoelasticity by oscillation, but with his final research student he did publish work on the relationship between dynamic parameters and perception of a food product (Hill, Mitchell and Sherman (1995) *J Texture Studies* **26**, 457ff) .

Even in his industrial years Philip collaborated extensively with rheologists around the world. In 1969 with Dr Alina Szczesniak the American sensory scientist working for General (now Kraft) Foods, he was the founding co-editor of the *Journal of Texture Studies* and remained co-editor in chief for 24 years). The journal publishes papers on rheology, psychorheology and physical and sensory testing of foods. From an academic environment

Philip was able to further extend his international activities, hosting visiting scientists and research students from around the world. In 1978 he organised a seminal meeting on food texture and rheology which included important contributions from his extensive international collaborators (*“Food Texture and Rheology”* ed. P Sherman (Academic Press 1979)). He gave invited lectures in many countries in Europe and in North America, Japan, Israel and Australia. His presentations were a model of clarity and not surprisingly he was in demand as a contributor to short courses. Most notably the course on industrial rheology run at Massachusetts Institute of Technology by Professor ChoKyun Rha for several years.

He was a Fellow of the Royal Society of Chemistry, a Fellow of the Institute of Food Science and Technology (UK), a member of British Society of Rheology and a Chartered Chemist. He also served on the Advisory Board of the *Journal of Colloid and Interface Science*. He was very supportive to young scientists and many of us, including myself, owe a lot to Philip’s support during the earlier stages of our careers. Although, like many people brought up in Yorkshire, he could initially come through as quite a serious person, he had a strong underlying sense of humour and was particularly fond of the TV series “Last of the Summer Wine”.

Philip died on the 29th March after a short illness at the age of 89, only 10 months after the sad loss of his wife Gina. He is survived by his two sons, and five grandchildren.

John Mitchell

University of Nottingham, Sutton Bonington Campus

¹A collection of George Scott Blair’s work donated to the British Society of Rheology is now available on <http://scottblair.bsr.org.uk>

Midwinter Meeting 2012: Extensional Flows

December 17-18, 2012

Aberystwyth University, Aberystwyth, Wales

The midwinter meeting of the British Society of Rheology will be held at Aberystwyth University, Aberystwyth, Wales from 17-18th December 2012 on a theme of extensional flows.

Invited speakers are Jens Eggers (Bristol), Sean McKee (Strathclyde), and Gareth McKinley (MIT).

Meeting Contact:

Simon Cox (sxc@aber.ac.uk), David Binding.

Website: <http://bsr.org.uk/meetings.asp>

INDUSTRY NEWS

TA Instruments introduce DETA capabilities on the Discovery Hybrid Rheometers

The **New Dielectric Accessory** expands the testing capabilities of all models of the Discovery Hybrid Rheometer (DHR) to measure the electric response of materials through probing the capacitive and conductive properties. The DHR platform provides flexible and easy experimental setup and superior dielectric data accuracy through standard instrument features including the Environmental Test Chamber for temperature control from -160°C to 350°C , axial force control to 50 N with gap temperature compensation, and method programming integrated in TRIOS Software. The Dielectric Accessory can be operated with the DHR in either stand-alone mode or in simultaneous dielectric and mechanical measurement mode.



Dielectric Variables

The LCR meter provides the capacitance C and the dissipation factor D or loss tangent $\tan \delta$. The TRIOS software calculates and provides the following variables:

- Capacitance: C (μF)
- DE loss tangent: $\tan \delta$
- Complex permittivity: ϵ^* (pF/m)
- Storage permittivity: ϵ' (pF/m)
- Loss permittivity: ϵ'' (pF/m)
- Conductance: G (μS)
- DE frequency: f_{DE} (Hz)
- DE AC Voltage: V (V)
- LCR Meter Circuit Mode: Parallel or Series

High Temperature Viscometer

With the purchase of the Bähr-Thermoanalyse GmbH, constant innovator in the field of dilatometry and thermal analysis, the high temperature viscometer VIS403 has been added to the TA Instruments product line. The VIS403, measures the dynamic viscosity of materials with Newtonian behaviour such as glasses, slags or mold powder. Tests are based on concentric cylinder configurations and may be conducted in controlled stress or controlled rate conditions, and under isothermal or temperature ramp programs over a temperature range of 20 to 1700°C.

Annual User Day

TA Instrument is pleased to announce its annual user meeting at Donnington Park on Tuesday 6th November. The latest developments in thermal, thermophysical and rheological measurements will be presented by guest specialists from industry and academics. Users of all brands of equipment are welcomed to participate. Registration for the day is free of charge and includes lunches, refreshments and access to the Grand Prix Collection museum. To register simply go online at <http://www.regonline.com/2012UKUsersMeeting>

CONFERENCE DIARY

2012	CONFERENCES & MEETINGS
12-14 Dec Leeds	Dynamics of Architecturally Complex Polymers: Current and Future Trends (The University of Leeds) dynacopadmin@leeds.ac.uk Conference website: https://eudoxus.leeds.ac.uk/dynacop/LeedsConference.html
17-18 Dec Aberystwyth	BSR Midwinter Meeting 2012: Extensional Flows Prof. Simon Cox (sxc@aber.ac.uk), David Binding Conference website: http://bsr.org.uk/meetings.asp

2013	CONFERENCES & MEETINGS
10-14 Feb Pasadena California	The Society of Rheology 84th Annual Meeting Organiser/Contact details: Shelley Anna, Carlos Rinaldi and John Brady Conference website: http://www.rheology.org/sor/annual_meeting/2013Feb/program.htm
25-27 March Chicheley Hall	INNFM Advances in Non-Newtonian Fluid Mechanics Prof. Ken Walters (kew@aber.ac.uk) and Prof. Peter Townsend (p.townsend@swansea.ac.uk). Conference website: http://www.innfm.org.uk/gpage.html
2-5 April Leuven Belgium	AERC 2013 8th Annual European Rheology Conference Organiser/Contact details: Professors Peter Van Puyvelde and Patrick Anderson Conference Website: http://www.rheology-esr.net/AERC/2013/
30 -31 July Zlin, Czech Republic	'Novel trends in rheology V' Contact person: Prof. Ing. Martin Zatloukal, Ph.D. mzatloukal@ft.utb.cz Conference website: http://noveltrends5.ft.utb.cz/home.html
18 – 22 Aug Durham	IUPAC 10th International Conference on Advanced Polymers via Macromolecular Engineering Organiser: Dr Lian Hutchings (l.r.hutchings@durham.ac.uk) Conference website: http://www.dur.ac.uk/soft-matter/apme2013/
13 -17 Oct Montreal Quebec	The Society of Rheology 85th Annual Meeting For updates see http://www.rheology.org/sor/annual_meeting/default.htm

2013	COURSES & WORKSHOPS
14-16 May Glasgow	Process Rheology CONTACT: Dr Nick Hudson, Dept Pure & Applied Chemistry, University of Strathclyde, 295 Cathedral Street, Glasgow, UK T: +44(0)141 5482162; F: +44(0)141 5484822 E: n.e.hudson@strath.ac.uk

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