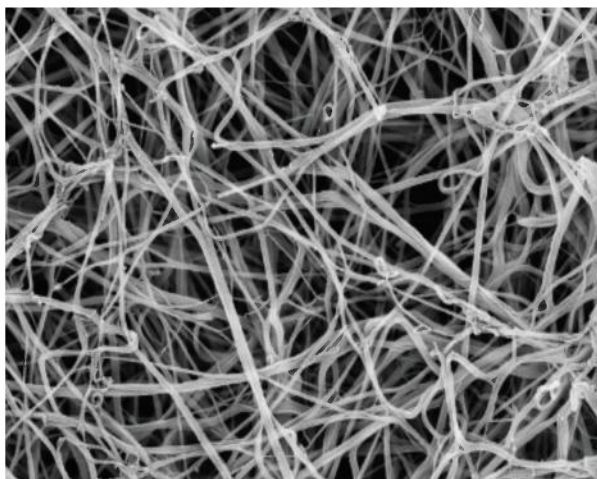

THE BRITISH SOCIETY OF RHEOLOGY

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THE BRITISH SOCIETY OF RHEOLOGY

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THE BRITISH SOCIETY OF RHEOLOGY



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Hon Bulletin Editor:

Prof. Robert J. Poole

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

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EDITORIAL

Welcome to Volume 56 (issue #2) of the British Society of Rheology Bulletin. We have a bumper issue this time which includes an in-depth article by the winner of the 2014 Vernon Harrison award Dr. Nafiseh Badieli concerned with “Microstructural and rheological studies of fibrin-thrombin gels”, a tribute to John Hutton provided by Prof. Ken Walters and a new rheological Sherlock Holmes story from a “Dr Watson” (not the Honorary Treasurer) sent to us from Berlin via Prof. Manfred Wagner. The BSR news section provides information on our new President, Dr. Helen Wilson, together with the citation used when Prof. Gareth McKinley was awarded the BSR Gold Medal late last year plus the usual combination of travel and award news mixed with conference reports and commentaries.

Rob Poole, Liverpool Sept 2015.

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.

COVER ILLUSTRATION

The cover image shows SEM images of fibrin clots formed under small amplitude oscillatory shear. See lead article for more details: Microstructural and rheological studies of fibrin-thrombin gels by Nafiseh Badieli (see Figure 1 for details).

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
- receive publications including Rheology Abstracts, Bulletin and Rheology Reviews
- learn of current instrumentation and accessories plus new developments.
- access to non-Newtonian Club linking industry and academia
- travel Grants, Poster Prizes, Career Opportunities
- network with fellow members who, while working in a different discipline or industry, may be facing similar problems to yours

The Society is non-profit making and is registered as a charity. For the details, you are warmly welcome to visit our web site <http://www.bsr.org.uk/>, and to apply for membership on-line.

MICROSTRUCTURAL AND RHEOLOGICAL STUDIES OF FIBRIN-THROMBIN GELS

Dr Nafiseh Badii

College of Engineering, Swansea University, Swansea, UK

In Western society, venous and arterial thromboembolic disease and associated blood coagulation abnormalities cause major morbidity and mortality, with stroke being the third leading cause of death in the UK [1]. Abnormal blood clot formation is associated with significant changes in viscoelasticity, some of which have been related to pathologies such as myocardial infarction, diabetes, atherothrombotic vascular disease and cancer [2,3]. Fibrin gel networks, which result from the polymerisation of fibrinogen by thrombin, provide the principal microstructural basis of blood clots [4]. The fibrin clot plays a pivotal role in the pathophysiology of vascular disease. Its structure-function relationship is complex and is subject to several genetic and environmental determinants [5].

Studies of the viscoelastic properties of coagulating blood have established that the fractal characteristics of the incipient clot's fibrin network represent a significant biomarker for normal (healthy) clot development [6] and pathological clotting abnormalities [7]. Rheological measurements of the Gel Point of clotting blood by small amplitude oscillatory shear (SAOS) provide a means of detecting the establishment of the incipient clot, and estimating the fractal dimension, d_f , which characterises the spatial arrangement of fibrin mass within the incipient gel network. Thereafter, polymerisation results in the clot's final, mature (mechanically stable) form. The sensitivity of evolving clot microstructures to unidirectional shear flow has recently been reported in a study of blood clot formation involving the rheometric technique of controlled stress parallel superposition, CSPS [8].

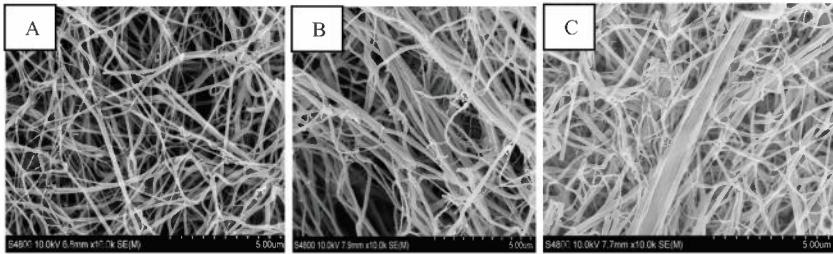


Figure 1. SEM images of fibrin clots formed under SAOS (A) and under CSPS (B and C) at different levels of applied unidirectional shear stress, σ_s . Exposure of the fibrin-thrombin system to the unidirectional component of the superposition flow has a marked effect on the microstructure of the fibrin gel network. (A) SAOS ($\sigma_s = 0$ Pa, $d_f = 1.99 \pm 0.01$), (B) CSPS ($\sigma_s = 0.1$ Pa, $d_f = 2.03 \pm 0.01$) and (C) CSPS ($\sigma_s = 0.35$ Pa, $d_f = 2.3 \pm 0.05$), respectively.

It is the microstructural and mechanical properties of the mature fibrin gel which have been most extensively studied, leaving relatively little explored the claimed role of the incipient gel network as a microstructural template for ensuing gel evolution [9]. Elucidating this templating role is necessary in order to establish improved predictions of mature clot characteristics. This is a focus of recent studies that have reported how a fractal analysis of incipient clots (based on rheological Gel Point measurements) may be combined with a spectral analysis of mature clot microstructure (based on laser scanning confocal microscopy, LSCM).

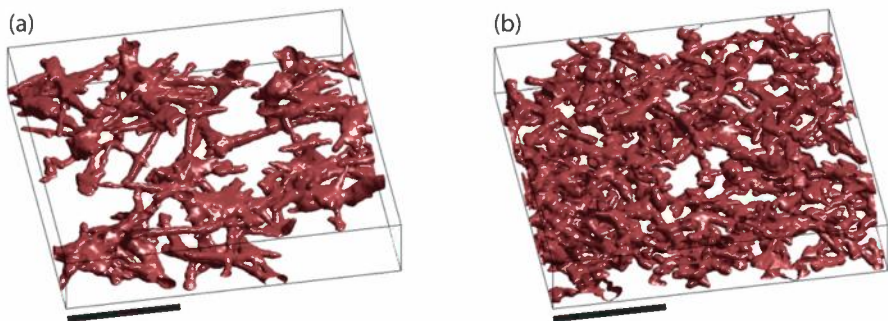


Figure 2(a). 3d reconstructions of LSCM data for mature fibrin gels formed at two different thrombin concentrations (a) 0.01 NIH/ml, and (b) 0.19 NIH/ml and a patho-physiological concentration of human fibrinogen. The scale bar length is 5 μ m.

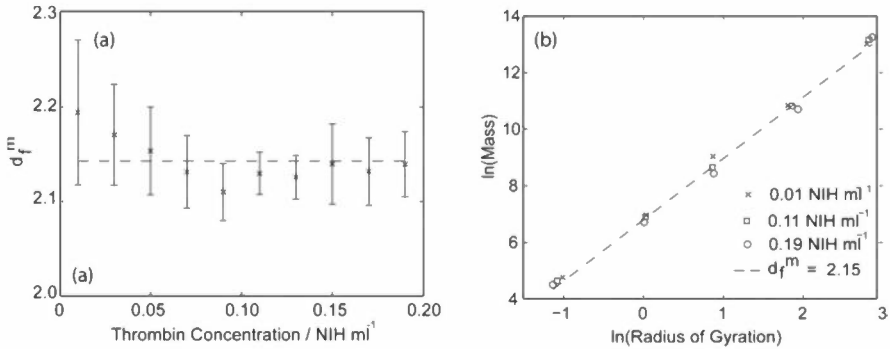


Figure 2(b). (a) values of d_f^m (estimated from the radius of gyration method) as a function of thrombin concentration, ϕ (Pearson correlation coefficient $r = -0.309$, $p > 0.95$). (b): Calculation of d_f^m (radius of gyration method) for $\phi = 0.01, 0.11$ and 0.19 NIH/ml

A significant finding which emerges from these studies is that the microstructures of mature fibrin gel networks, formed over a range of thrombin concentration, are indistinguishable in terms of their fractal dimension d_f^m ($d_f^m = 2.15 \pm 0.05$), prompting the need to develop a more appropriate fractal analysis based on the *spectral dimension*, d_s^m . In contrast to d_f^m , the spectral dimension is capable of reflecting differences arising in the *internal connectivity* of the mature clot networks, being a statistical measure of the ease with which adjacent network sites can be accessed. The selection of d_s^m for this study was prompted by (i) the previously reported observation that fibrin polymers formed after the GP are incorporated within the general architecture of the existing gel network [11]; and (ii) by the results of magnetic resonance studies which demonstrate that d_s is sensitive to alterations of microstructure in pathological tissue [12].

Estimating the value of d_s^m for mature gels involves the analysis of random walks, RWs, on the fibrin networks represented within 3d (x-y-z) reconstructions of LSCM data sets. The spectral dimension of the mature gels is estimated using the relation $P(0, N) \sim N^{-d_s^m/2}$ in which $P(0, N)$ is the return-to-origin probability (RTOP) of a N -step RW conducted on the reconstructed 3d network. The value of $P(0, N)$ is determined by averaging over 10^3 individual RWs, each RW comprising 10^3 steps. The magnitude of d_s^m is then obtained from the gradient of the linear relationship between $\log(P(0, N))$ and $\log(N)$ (see figure 3).

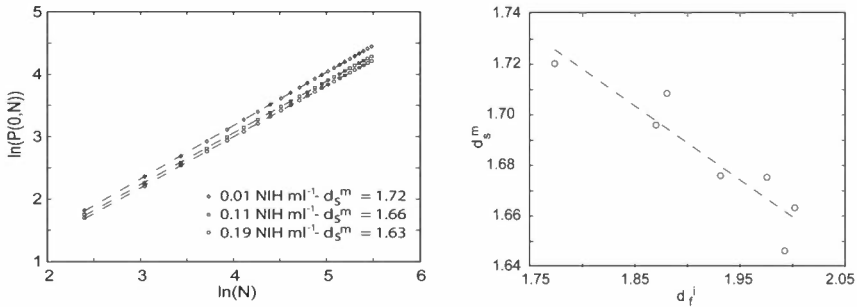


Figure 3. (Left) Calculation of the spectral dimension d_s^m . Broken lines show linear fits to data for which the linear correlation coefficient, $R^2 > 0.99$. (Right) Relationship between the spectral dimension of the mature fibrin gel network and the fractal dimension of its corresponding incipient ‘template’.

Networks in which individual units of mass are connected to many adjacent mass units are associated with higher values of d_s^m because each random walk has a lower probability of stepping to previously visited sites (i.e. it has a lower RTOP), for any given number of steps. A reduction in network connectivity forces the RW to retrace its path many times, which results in a lower value of d_s^m . It follows that those fibrin gel networks which are generated at low values of thrombin concentration, and which consist of thicker fibres, exhibit the highest values of d_s due to the fact that the RTOP is reduced as random walks can step to many previously unvisited sites on the network. Conversely, in the case of those gel networks which are generated at higher values of thrombin concentration, and which consist of thinner fibres, the random walks are more constrained. Hence, on average, the RTOP is increased and consequently the random walks report lower values of d_s .

Figure 3 (right) shows a plot of d_f^i (incipient gel) and d_s^m (mature gel) where the data points are averaged over five replicate measurements at each value of thrombin concentration, ϕ . In this case the fractal dimension of the incipient forms of the gel networks are obtained from rheological Gel Point data. For clarity, the magnitude of d_f^i and d_s^m is shown over the range $0.01 < \phi < 0.13$. A correlation ($r = -0.926$, $p < 0.005$) establishes that d_f^i is predictive of differences in mature forms of gel microstructure (characterised by d_s^m) providing evidence to support the suggested role of the incipient fibrin network as a ‘template’ for microstructural development during fibrin gel formation.

The fractal characterization of incipient and mature fibrin gel microstructures has potential significance in terms of the design of drug delivery vehicles and tissue engineering scaffolds as well as the development of therapeutic strategies for thrombolysis. Blood clots with altered fibrin microstructure exhibit different susceptibility to fibrinolysis [13,14], with intra-clot diffusion representing a rate limiting factor for the activity of the fibrin network degradation enzyme plasmin. Thus the release of therapeutic species embedded within a fibrin gel ‘carrier’, or the breakdown of a blood clot, is ultimately dependent on intra-gel/intra-clot diffusion. Diffusion within fractal systems is characterized by the anomalous diffusion coefficient d_w which has been related to the fractal dimension d_f and the spectral dimension d_s through the relationship $d_f = (d_w \cdot d_s / 2)$ [15]. Processes involving normal diffusion are characterized by $d_w = 2$, whereas in anomalous diffusion diffusing particles exhibit a slower-than-linear (i.e. ‘sub-diffusive’) time dependence.

Studies of fibrin clot microstructures provide insight into the relative ease with which intra-clot diffusion can occur. A knowledge of the incipient gel network’s fractal characteristics might be used to better predict long-term diffusion characteristics. In the context of blood clot formation, where the fibrin network provides the clot’s principal microstructural basis, such studies may lead to a better understanding of the evolution of the clot’s vital mechanical properties and long-term susceptibility to lysis. Such studies are being conducted under an EPSRC Healthcare Impact Partnership award (EP/LO24799/1] at Swansea University, in collaboration with the ABMU NHS Trust translational research unit at Morriston Hospital, Swansea, UK.

Acknowledgements

The author wishes to express her gratitude to the adjudicating committee of the British Society of Rheology for the award of the Vernon Harrison Doctoral Prize 2014.

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A Tribute to JOHN F. HUTTON (1924 – 2015)

What follows is an abridged version of a Tribute given by Ken Walters at the funeral of John Hutton, which was held in Wrexham on Wednesday, 18th March, 2015.

“I first really got to know John in the late 1960s. In the March of 1968, John and I were both invited to be members of a British Standards Institution Committee to produce a “Standard Glossary of Rheological Terms”. Over the next five years, we met in London on nineteen separate occasions, and the Glossary was finally published in 1975. So, we got to know each other pretty well!

The BSI Committee met under the chairmanship of one of the founders of the modern science of Rheology. His name was George Scott Blair. I recall that John and I sometimes gave him a rough time during those five years!

But my connection with John can really be traced to an International Congress on Rheology, which was held in Kyoto, Japan, in 1968. For some reason, John, myself, and a number of our friends felt it necessary to travel

via Alaska, Hong Kong, Thailand and Cambodia, and the experience involved a three week stay away from the U.K. Why do I mention this? Well, I vividly recall travelling up to Angkor Wat in Cambodia in an old DC3, with the pilot needing to avoid the many thunderstorms in the area.

For this and other reasons, I decided not to fly back to Phnom Penh but to catch a taxi instead, with a journey lasting several hours. Looking back, that journey along the Meekong River valley was much more hazardous than the DC6 journey enjoyed by the others.

I mention this because, without any prompting from me, John offered to travel with me, as company, rather than with the rest of the party. That experience was to mould a friendship, which was to last for nearly 50 years. It sums up for me what a thoughtful gentleman John was.

Anyway, in the following year, John and I, together with our long time travel companion, Ralph Oliver, attended a scientific conference in Herceg Novi, which is south of Dubrovnik and just north of Albania. I persuaded John and Ralph that it would be good to travel by road. So we hired a car from John's Shell Thornton Research Laboratory. I will limit myself to just one of our multitude of experiences.

On leaving Ljubljana on the way to the conference venue, we realized that we were driving in the wrong direction down a very wide dual carriageway. John was driving at the time. But how was he to turn around? Well, John decided to use a Zebra Crossing, which saw us on the right track, much to the amusement and amazement of the locals!

That was in 1969 and we continued to meet up in the subsequent decades. Indeed, John was a regular attendee at many of our INNFM conferences.

But allow me to say something about John's research during his long career at Shell's Thornton Research Centre, which was based just north of Chester. He was their 'Rheology expert', with a detailed knowledge of the properties and performance of lubricants and other fluids of interest to Shell. He wrote a number of influential research papers and in 1989, I

persuaded him to join Howard Barnes of Unilever and myself to write a book for Elsevier entitled “An Introduction to Rheology”. That book has sold over 6,000 copies and has been translated into Chinese and Korean.

As I have implied, John and I were very good friends and scientific collaborators – and that association resulted in a succession of successful research grant proposals from us that were funded by Shell and involved close collaboration between John and his group at Shell and the Non-Newtonian Fluid Mechanics group at Aberystwyth University (particularly Russell Davies and Tim Phillips).

That contact lasted several years and resulted in warm friendships as well as trailblazing research.

Shell Research weren’t the only funders I should add. Sometimes the research was funded by the so called EPSRC CASE scheme. So the research students (e.g. David Binding) effectively had two research supervisors – John at Shell and myself or one of my colleagues at Aberystwyth. Those were exciting days for us all.

John’s reputation as a rheologist resulted in him being elected as a President of the British Society of Rheology in the 1980s.

One final word. I am so glad that we (and the Olivers) were able to meet up with John and his daughter Alison for lunch a few months ago in Shrewsbury. The friendship which began in 1968 was still very evident.

Thank you, John!”

The Case of the T1 Event

After a superb Easter dinner, Dr. Watson was sitting in the Tudor style study of Sherlock Holmes watching the wind blowing snowflakes against the single-pane window. He felt the cold draft, and moved his chair closer to the fireplace. “Climate change – nothing but false promises. I have not seen any climate improvement for over 15 years!” Holmes, reading the Financial Times, did not respond. “They will start another bubble on climate change later this year at Paris and call it COP 21”, Watson insisted, but Holmes was apparently not in a mood to discuss the bubbling of the IPCC.

Watson sighed, and took another sip of the 25 year old Port that Holmes had ordered to be served. After the wine had warmed him up a bit, he tried again to start a conversation with Holmes: “By just doing nothing, my net worth has increased by a healthy 68% last year, which is good news when you live from pension funds as I do. But who knows when the bubble will burst?”

This time, Holmes lowered the Financial Times slowly and remarked after some moments of suspense: “My dear Watson, I shouldn’t tell you this, but the bubble will not burst. As I have recently learnt from an eminent Welsh Scientist working on bubble dynamics, it will rather collapse, and a sharp jet will thereby be created that will directly obliterate your funds”.

“Good grief, Holmes, how did you get to know this?” Watson exclaimed. Holmes, lowering his voice replied with some hesitation: “Please keep it to yourself, but I have spent the days just before Easter on the invitation of my good old friend Lord Simon the Cox at a secretive meeting on some remote castle in North Wales. He had assembled a fine panel of scientists working in bubble mechanics for a medieval banquet presided over by Baron Ken and Baroness Mary. They were looking for generic traits in deforming bubbles of all kinds, and were hoping to be given inspiration from Welsh songs and Keltic beer bubbles.”

Watson could not help but interrupting Holmes: "If only the public had known, there would have been surely full media coverage of this event!"

"Not so loud, my dear Watson," Holmes replied again in a low voice, "the likes of GCHQ and NSA, and not to mention Professor Moriarty, have their ears everywhere, and they would certainly like to grab these secrets for their bubbling intelligence centers."

"So what are these secrets of the trade", Watson whispered. "Well, my dear Watson", Holmes responded, and it was obvious that he was barely overcoming his hesitation, "they were talking darkly about T1 events, and whenever they were seeing one, real, imaginary or simulated, they became truly excited about it!"

"What are these T1 events, my dear Holmes", Watson exclaimed in anguish. "Will they have some detrimental effect on my financial future?"

"Well," answered Holmes, "the origin of the notion "T1" unfortunately remained obscure. Not even the most senior scientist prominent in non-Newtonian fluid jets, Sir Ralph, a former Royal Squadron member who managed to burst several bubbles by his fearless comments, dared to ask. But I learnt from a scholar of the old Canadian capital of Kingston that if one expands the co-rotational model, the 4th order mathematical bubble will always be too large to be presented on any screen."

Watson again interrupted Holmes impolitely and with a certain urge: "This is really exiting news, my dear Holmes, but what is the case of the T1 event?"

Holmes, raising solemnly his glass of Port, was carefully choosing his words: "As far as I was able to follow the bubbling specialists into the awesome profundity of their scientific insight, it has to do with bubbles changing neighbors – next neighbors will rearrange spontaneously their positions and create new connectivity."

“This is really enlightening, my dear Holmes, and it was certainly worthwhile to spend 3 days in a medieval castle amidst a veritable storm in order to learn about these secrets”, exclaimed Watson. “I can now fully understand that whenever bubbles in the public’s mind change their position and priority, we have a T1 event! Case solved!”

This conversation was leaked to Manfred Wagner from the secret files of the NSA.

Letters to the Editor

I was pleased to receive my copy of the BSR Bulletin recently and to catch up on Society news, since I was unable to attend the AGM this year. I noticed in the nominations for Officer and Members of Council that Dr Nick Hudson was not listed and I understand that he has stood down from Council. I would not wish Nick’s efforts over the years to go unnoticed so may I, through the Bulletin, offer some public appreciation?

Nick joined Council at the same time as I started my term as Bulletin Editor in 1990 and in due course he started to organise the printing and distribution of our publications through the University of Strathclyde and also, linked to his professional work in technical awareness, involving scanning the literature, it made sense for him to take over editing Rheology Abstracts. He has served continuously as Abstracts Editor and/or Publications Manager since then, which makes a total of 25 years’ service. Even if this is not a record for continuous service to BSR, it is still worth recognising. Over the years, as fellow Council Member, Secretary and eventually President, I have seen all the hard work, time and commitment that he has made to the Society, and members should be grateful to him for this. It is worth recalling that publishing Rheology Abstracts made a very significant contribution to the Society’s finances, and was much valued by the scientific community until it was rendered obsolete by the arrival of effective searchable electronic databases in recent years. I wish him well in his retirement.

Best wishes, Phil

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British Society of Rheology Winter Meeting 2015: Microrheology and Microfluidics

**14th and 15th December 2015, Wolfson Medical Building: Yudowitz
Room, University of Glasgow**

Microrheology & Microfluidics are two closely connected and emerging fields of research. The difference in emphasis that separates them is the prior knowledge of the fluid's rheological properties. The meeting will embrace two mini-symposiums on Microrheology and Microfluidics, with the aim of encouraging collaboration between the two streams of research.

Confirmed Keynote Speakers:

Professor Pier Luca Maffettone (Università degli Studi di Napoli Federico II)
Professor Jon Cooper (University of Glasgow).

Confirmed Invited Speakers:

Dr Mathias Reufer (LS Instruments AG);
Dr Thomas Waigh (University of Manchester);
Dr R Mike L Evans (University of Leeds);
Dr Mark Haw (University of Strathclyde);
Dr Michele Zagnoni (University of Strathclyde);
Dr John Duffy (Malvern Instruments);
Dr Mónica Oliveira (University of Strathclyde).

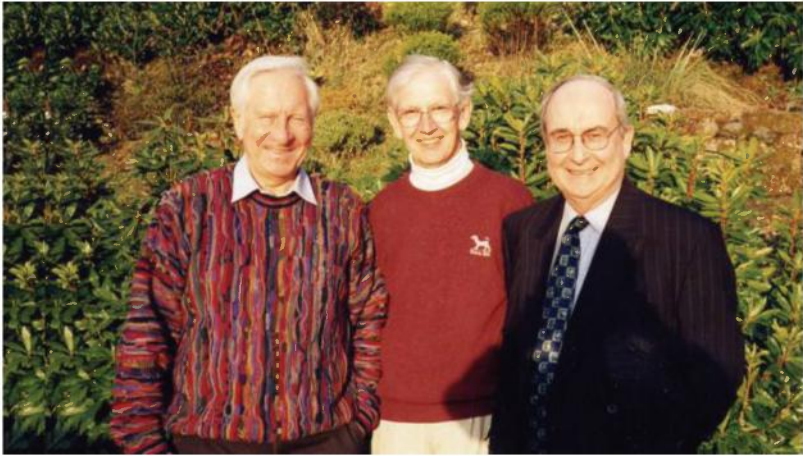
Contributions for oral and poster presentation are invited. For more information, and to register, please visit the following links:

<http://conferences.bsr.org.uk/conference.php?conf=47>

<http://www.gla.ac.uk/schools/engineering/research/divisions/biomedical/seminars/bsrwinter2015/>

Or contact the organisers:

Dr Manlio Tassieri, University of Glasgow (Manlio.Tassieri@glasgow.ac.uk)
Dr Nick Hudson, University of Strathclyde (n.e.hudson@strath.ac.uk)



The three authors of "An Introduction to Rheology". Left-to-right, Ken Walters FRS (BSR Gold Medal 1984), John Hutton (BSR Annual Award 1979), Howard Barnes OBE (BSR Annual Award 2001)



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Thanks & best regards, Richard Buscall

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British Society of Rheology News

New President – Dr Helen Wilson

Helen Wilson is a Reader in Applied Mathematics who is currently the Deputy Head of the Mathematics department of UCL (University College London).

She began her research career working with John Rallison in the Department of Applied Mathematics and Theoretical Physics at Cambridge, where her PhD was on linear instabilities in viscoelastic channel flows. She then moved to the University of Colorado at Boulder where she spent two years working with Rob Davis in the Chemical Engineering Department. Her first lectureship was in the Mathematics Department at the University of Leeds, and she moved to UCL in 2004.



She is an editor of the Journal of Non-Newtonian Fluid Mechanics and also of the Journal of Engineering Mathematics. She is a member of Council for the Institute of Mathematics and its Applications. She also served on the mathematics panel of ALCAB, the A-Level Content Advisory Board, which has recently reported on proposed changes to A-Levels in Mathematics and Further Mathematics for England. She was BSR Secretary from 2007-2011 and probably holds the record for smallest child brought to a BSR conference, having taken a 2-month-old to the 2009 Midwinter Meeting.

Her research spans a range of non-Newtonian phenomena, including elastically-driven instabilities in channel flows and contraction-expansion flow, bubble growth in viscoelastic foams, and predictions of steady macroscopic rheology in viscous suspensions of rough solid particles which can make contact. However, it is one of her undergraduate projects – The Fluid Dynamics of the Chocolate Fountain, carried out by Adam Townsend in 2012 – that seems to be attracting most attention outside the rheological community.

Gold Medal Award – Prof. Gareth McKinley

**Citation Address by Prof. P Rhodri Williams, President of the BSR
Durham, December 2014**

“Our Gold Medal Awardee is Gareth McKinley who is presently the *School of Engineering Professor of Teaching Innovation* at the Department of Mechanical Engineering at MIT.

Most of us – and probably all of us - will be familiar with at least one aspect of Gareth’s work due to the fact that it covers such a broad range – it encompasses contributions in areas such as extensional rheology of complex fluids, non-Newtonian fluid dynamics, microrheology & microfluidics, field-responsive fluids, super-hydrophobicity, wetting of nanostructured surfaces and the development of nanocomposite materials.

The striking thing is, however, that despite the impressive breadth of this range, his contributions are in each case so authoritative as to become a principal point of reference - both for people entering the field or indeed for more experienced workers who value the clarity of insight and scientific rigor which are such hallmarks of his work.

That clarity and rigor also characterize his lectures. Two in particular stand out in my mind – but colleagues will have their own of course – the first was his ICR2000 Plenary lecture at his *alma mater* in which he presented different facets of extensional rheometry and extensional flow phenomena – he explained his contributions to the establishment of rigorous approaches to filament stretching rheometry and placed them in context, against decades of work by others in this notably difficult field. Over a decade later I was struck by his exposition of Large Amplitude Oscillatory shear techniques at ICR2012 in Lisbon where he drew in historical

references which – in the hands of a less insightful scientist might have seemed arcane but Gareth conveyed their significance with the depth of understanding which makes his lectures so enjoyable – and so valuable.

He began his rheological career by being born in Wales and was subsequently awarded a masters Degree in Chemical Engineering from Cambridge England, followed by a PhD from MIT. His early research contributions were in fact recognized by the BSR some 20 years ago when he received its *Annual Award*... and other awards followed of course, culminating last year in the Society of Rheology's 2013 Bingham Medal.

This year it is the turn of the BSR to recognize his contributions to Rheology – and it *also* has chosen to do so with its highest Award. The significance of that award can be judged in part by recalling some of the names of previous awardees who – over the last half century – include Reiner, Oldroyd, Walters, Edwards, Giesekus and McLeish. And now it is the turn of Professor Gareth Mckinley – and so on behalf of the Council of the British Society of Rheology – in recognition of outstanding and sustained contributions to Rheology - it a great pleasure and a privilege to present you with the Society's GOLD MEDAL."

BSR Student Travel Awards

The British Society of Rheology wishes to solicit applications for travel awards from its student membership, with the objective of encouraging students to disseminate their research.

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. 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, suitable for publication in the bulletin of the society.

The next closing date for consideration of the award of a travel bursary is Monday 31st August 2015 with successful applicants notified by the end of September. 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, and the Society's logo may be used for this purpose. Payment of the bursary will be made on receipt of a conference report suitable for publication 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

Vernon Harrison Award 2015

In 2003 the British Society of Rheology decided to institute a new annual award for the most distinguished PhD thesis in rheology. The aim of this award is to recognise excellence, creativity and novelty in research. It will be awarded to the postgraduate student who, in the opinion of the adjudicating committee, has made the most original and significant contribution to any branch of rheological research (experimental, computational or theoretical) leading to the award of a PhD degree in a given academic year. This prize is partly supported by the Vernon Harrison Bequest. Dr Nafiseh Badiei from Swansea University was the 2014 winner with her thesis on “Microstructural and rheological studies of fibrin-thrombin gels”. The prize for the award will be £500 and an illuminated certificate.

Entries for the 2015 Vernon Harrison Award should now be submitted. The deadline is 30 September 2015.

Any person who has submitted and successfully defended a thesis in any area of rheology at a higher education institution in the United Kingdom between 1 September 2014 and 31st August 2015 is eligible, whether a member of the Society or not. Each entry should consist of:

- A two page summary of the research and the key achievements which especially distinguish it as a candidate for this award;
- A letter from the thesis supervisor confirming the recommendation of the award of a PhD to the candidate and supporting the case for the award, highlighting the specific original contributions of the candidate;
- The name and address of the external PhD examiner. The Committee may subsequently ask to see a copy of the final version of the thesis in reaching their decision.

An Adjudicating Committee appointed by the Council of the British Society of Rheology will consider the entries. Particular attention will be given to the originality and quality of the thesis. Entries will be selected by the Adjudicating Committee for presentation at a meeting of the British Society of Rheology in December. The Adjudicating Committee may award any number of first and secondary prizes. Travel funds will be available to assist candidates to attend the prize meeting.

Proposals should be sent to the BSR secretary at secretary@bsr.org.uk.

Simon Cox
BSR Honorary Secretary

Membership news

Membership news since December 2014 meeting

New members (paid for membership)

Emily Davies
Matthew Derry
Waleed Mohammed Abed
Ben Hanson
Andre Zamith Cardoso
Daniel Jon Read
Matthew James Lawrence

Free 1 year membership

Mid Winter BSR meeting delegates (emailed offer to all delegates):

Armando Maestro
Ignacio Pagonabarraga
Elsen Tjhung
Salvatore Croce
Raymond Goldstein
Ricard Matas Navarro
Ewan Hemingway
Tyler Shendruk
Buddhapriya Chakrabarti
Carl Reynolds
Mark Haw

Changed to Honorary status

Gareth McKinley

Resigned members

Graham Thomas

Deceased members

Arnold Axon

Maria Charalambides
BSR Honorary membership Secretary

Commentary on the 344th Council Meeting of the BSR – Ruthin Castle April 1st 2015

We made sure to start after noon (12.15 to be precise) on this April Fool's Day Council meeting. We assembled a very-nearly-complete set of Council members, missing only the Immediate Past President, Rhodri Williams, who'd made a flying visit the previous evening for his presidential address and the AGM. The sun was shining and the peacocks strutting outside the window as I chaired my first meeting as president.

There's a pretty fixed structure to each Council meeting (depending on the time of year). We run through the actions from the last meeting (and, in spring, from the AGM as well); the officers make their reports; we discuss awards and future meetings. It's much less predictable where we will spend most of the meeting time.

This time the actions from the previous meeting were a joy to run through – a lovely sequence of “yes, I did that” and “no, that's been superseded”. Various people have been contributing text and cover images to the Bulletin (as you can no doubt see!) and I know Rob is very grateful to you all for that.

The only other matter arising was the death, since the previous Council meeting, of John Hutton, who was BSR president from 1982-84. Ken Walters and Rhodri Williams had attended his funeral; I expect there is more about him elsewhere in this Bulletin.

We then moved to the reports of the officers. Some of these were extremely brief (I've been in post for less than a day; nothing's happened) and some purely factual (reports of the travel awards we've given in the last 3 months; yes, the Bulletin has gone to press) but three of them were rather more interesting.

The first was the Treasurer's report (or rather the discussion led by the previous Treasurer, Steve Goodyer, handover to Richard Watson having

not really got going since the previous day's AGM). We are in the envious position of looking to invest around £50,000 of BSR money safely and wisely. Steve had found a “safe” deal at 1.4% and a “risky” deal (but with only the interest being at risk) at 4%. Both of these involve some lock-in time, and we need to check that the BSR's money would be protected under the FSA rules, but if all goes according to plan the money will be invested by the time you read this.

The second source of substantial discussion was the report of the Membership Secretary, Maria Charalambides. Although we have a membership of around 400, many of these are dormant members who have not paid (or interacted with the society at all) for several years, and who have been left on the books. We are always reluctant to throw people out; but it is unfair to you, the paying members, if others get the benefits of membership (including this wonderful Bulletin) without paying their modest dues. We finally agreed that (after a month's hiatus for all Council members to personally nudge people) we would purge persistent non-payers.

A happy outcome of this discussion was that we spotted some potential Honorary members on the list. A member who has been a fully paid-up member of the Society for 20 years and then retires is automatically entitled to become an Honorary member. Council was happy to approve this transition for Professors Hinch, Laun, Mackley, Maitland and Rallison – all of them either former presidents or Annual Award winners (and Malcolm Mackley was both).

Finally we came to the relatively new office of Web Editor. Peter Hodder is preparing to commission a new BSR website. The current one is broken in some of its functionality, looks outdated, and isn't really serving our purpose. However, as soon as you start to try to write a specification, you discover that different people have different views of what our purpose – and the purpose of our website – really is. Should it be a key reference for those starting in rheology? Primarily a service to our members, giving information about our meetings and your membership status (and an easy way to pay)? A repository of historical BSR information? A tool for running conferences? It's clear that some of the current (near) functionality is vital – the keeping of membership records, for instance – and also that some simple enhancements (like allowing members to get themselves sent a password reminder without having to involve Maria) could make

everyone's lives a lot easier. This discussion will clearly run for a while, so we'll take it on into emails. If you have strong feelings about things you feel the BSR website could offer you, there is probably still time to feed them into the process: email Peter on phodder@tainstruments.com.

We had a surprisingly brief discussion of potential winners of the 2015 Annual Award. In April, we are still awaiting nominations from the membership, but it's good to have a few names in the pot already. We now have a few good names ready to discuss, along with any other nominations received, at the next meeting in September.

There is a standing item to talk about future meetings. These may be already planned, and just need details firming up; or longer-term plans for meetings to dream about! We talked about the possibility of bidding for an AERC, perhaps in 2017 or 2018. None of the academics on Council was immediately inspired to volunteer to host it at their institution, and we agreed that it would be impossible to prepare a bid before the AERC in Nantes (just 2 weeks away) so we agreed that those of us in Nantes would pay particular attention to the organisation there, and then we would, as a society, consider a bid for a year that wasn't decided in Nantes.

After a brief (and inconclusive) discussion on when and where to hold the next Council meeting (it will be Swansea or London, but that's pretty vague), the meeting closed. We finished in exactly two hours – not a record for speedy finishing, but not the sort of long-drawn-out meeting that causes anyone to miss a flight either. Roll on the next meeting!

Helen Wilson.

Conference report on 10th Annual European Rheology Conference April 14-17th, 2015, Nantes, France

Thanks to the BSR-TA travel award, I was privileged to attend and present my research at the 10th Annual European Rheology Conference held in Nantes, the capital city of the Pays de Loire region. With a rich maritime history, Nantes is now a thriving student and cultural hub boasting many attractions, the quirkiest of which is Les Machines des L'Ile on the exceptional site of the former shipyards.

The scientific programme covered areas as diverse as soft matter physics polymer science, micro fluidics, biological and life science engineering; 276 oral contributions were selected for 6 parallel sessions and more than

180 posters were presented. The 9 symposia included some of my own interests "Structured flows and instabilities", "Confined flows, microfluidics and rheology at the microscopic level" and "Colloids, suspensions and granular materials", where I presented my own research "Modelling capillary break-up of particulate suspensions".

My talk followed on from the two previous presentations given by Anke Lindner and Christian Clasen, each of whom presented experimental results demonstrating how the presence of particles affect the breakup of a liquid filament. It was highly valuable to discuss my numerical results with expert experimentalists, consider problems that remain to be addressed and also possible collaborations for future work.

Additionally, four plenary lectures included the Weissenberg Award Lecture "Outstanding challenges in entanglement dynamics: beyond the classic picture", presented by Dimitris Vlassopoulos; a fascinating talk by Jian Ping Gong discussing a novel way in which to strengthen hydro gels by means of 'sacrificial bonds'; David Pine's presentation exploring the yielding transition of concentrated emulsions; and the Maurice Couette Lecture, presented by Lyderic Boquet, who gave a compelling insight into flow transport at nanoscales and demonstrated experiments of flow in individual nanotubes.

A huge thank you to the chairmen Michel Cloitre, Lionel Choplin and Jean-Francois Tassin and their team of organisers for their time and efforts. This year's meeting was a truly international conference, with 565 registered participants from 40 countries and 5 continents. We should also acknowledge the generous support given to the conference by a number of sponsors, including Anton Paar, TA Instruments and Total.

The 10th Annual European Rheology was a huge success and very enjoyable; there was great atmosphere and it was a pleasure to have the opportunity to network with such a spectrum of rheologists. I look forward to next year's International Congress of Rheology to be held in Kyoto, Japan.

Claire McIlroy, University of Leeds

Conference report on the Arrested Gels: Dynamics, structure and applications”, Gonville and Caius College, Cambridge, 23-24 March 2015

The conference was an excellent point for sharing up-to-date theories and experiments of rheological phenomena and forming ideas to tackle each of our research projects and company challenges. Within my personal goals, it was excellent to extend the analysis and understanding of my latest results. The British Society of Rheology (BSR) has been a key scientific community in my development for the same reasons and kindly awarded me a BRS student travel grant. Discussions with my fellow BSR members have enhanced my ability to further interpret my research group results and develop my skillset with rheological analysis of colloids. In last 23th to 25th of May 2015, I participated and presented my work at the RSC/SCI Joint Colloids Group (www.colloidsgroup.org.uk) conference on “Arrested Gels: Dynamics, Structure and Applications” at the Gonville and Caius College, Cambridge.

This conference was set at the crossover of scientific discoveries the city of Cambridge has witnessed. The conference main topics can be separated by the significance of arrest in chemistry. R. Schurtenberger and co-worker F. Xie (Lund), R. Capellmann (Dusseldorf), M. Hermes (Edinburgh) and E. Eiser (Cambridge) focus their participation on the models for spherical colloidal systems. D. Bonn (Amsterdam), R. Angelini (Rome), W. Ganley (Bristol), J. I. Dawson (Southampton), G. C. Maitland (London) and O. Kelly (BYK Additives) discussed the anisotropic systems of clay and Laponite. W. J. Frith (Uniliver), N. Mahmoudi (Lund), C. D. Munialo (Wgeningen), P. Laity (Sheffield) and myself (A. Z. Cardoso, Liverpool) discussed Protein gels. The conference organising committee noted that myself (A Z Cardoso, Liverpool), D. Vanderbrounca (Paris) and J. del Barrio (Schlumberger) presented Novel systems. Additionally, there were several very interesting poster presenters in the conference.

Overall, there were six main open questions discussed, three in the fundamentals of gels and other three in applications of gels. In the fundamentals of gels, R. N. Zia (Cornell), L. Berthier (Montpellier) and H. Tanaka (Tokyo) focused on the role of dynamic arrest in gels. The importance of internal and external stresses was discussed by D. Bonn, L. Cipelletti (Montpellier), W. B. Russell (Princeton), Tanaka, R. Buscall (MSACT), R. Seto (OIST Japan) and B. O Conchuir (Cambridge). The

influence of boundary conditions was another fundamental aspect that came into the discussion by M. Hermes and T. Gibaud (Lyon). On applications of gels, the key features that are still challenges for physical-chemistry and novel technologies are the control of structure and dynamics (Schurtenberger, Gnam, Del Barrio and Munialo)), the predictability and robustness (Angelini and Fleury) and finally rheological control (W. J. Frith, W. B. Buscall, G. C. Maitland, O. Kelly, A. Zamith Cardoso). I encourage the reader to look for this authors most recent and future publications to find further information on each of these particular topics.

P. Schurtenberger (Lund) started the conference discussing colloidal gels with tailored properties; he discussed the concepts of dynamic arrest, jamming and gelation. Himself and **R. Capellmann** (Dusseldorf) spoke about clusters percolation and arrested phase separation phenomena.

The company **Formulation**, through **M. Fleury**, presented their new systems of measuring physical stability and viscoelasticity, such as using multi light-scattering and micro-rheology techniques. **J. del Barrio** from Schlumberger (oil company) spoke about their tough poly(acrylamide)-poly(vinylpyrrolidone) polymer system which takes advantage of both thermal and/or pH-triggered gelation.

R. Buscall spoke about the interesting effect of different gravitational forces on sedimentation effects. **B. O Conchuir** explained a system under shear stress which shows a correlation of the gelation time with the Hoffmeister Series. **D. Bonn** discussed structure, dynamics and rheology of hard sphere colloidal glasses. It was very interesting to see that his group found that the probability of particle rearrangements shows a power law dependence on the free energy changes associated with the rearrangements similar to the Gutenberg-Richter law in seismology. **R. Angelini** discussed the phase diagram of diluted laponite suspensions. **R. N. Zia and W. B. Russel** (Princeton) elucidate the micro-scale dynamics of coarsening and its effects on gel rheology. It was interesting to learn that when colloids in suspension attract one another, the attractions lead to phase separation. However this transition is sometimes interrupted. For certain particle concentrations and inter-particle potentials, the same attractions that promote phase separation also inhibit it, dramatically slowing separation and ‘freezing in’ in a non-equilibrium particle microstructure. They conducted dynamic simulations to elucidate the post-gelation evolution of a system of 750,000 Brownian spheres (as of present time the largest ever

system studied of these hard sphere colloids simulated). **N. Mahmoudi** (Lund) investigations of the mechanics and structure of arrested spinodal-decomposition Casein protein gels and polymers. It was also very interesting to see the study of **M. Hermes** (Edinburgh) with magnetic resonance tomography of the collapse of colloidal gels. **L. Berthier** (Montpellier) spoke about his findings in aging dynamics and logarithmic coarsening in non-equilibrium gels. **H. Tanaka** presented very interesting understanding by simulations and complemented by confocal microscopy of viscoelastic phase separation. It was good fun and interesting to understand the wrinkling effect of gels such as yoghurt or cheese make in the talk of **T. Gibaud**. The lecture of **C. D. Munialo** focused on the details of energy storage in protein gels during mechanical deformation, very interesting to understand the structure of food materials. **E. Eiser** explained how can hybrid gels, made of DNA functionalized Gold nanoparticles and a virus, be prepared. **P. Laity** delivered a beautiful talk about the mechanical properties of the natural silk feedstock of the silk worm (*Bombyx mori*). To note also the winner of the best poster **Carla Weis** on the behaviour of highly concentrated colloidal dispersion on different length scales done by multiple particle tracking and bulk rheology and the interesting poster of **Bayer CropScienceAG** (Germany) by **M. A. Fears** on the aging and delayed collapse of arrested colloidal gels by rheology and confocal microscopy, on the question about why some gels suddenly collapse. In particular there was an interesting talk by **Bill Frith** (WJ Frith, from **Uniliver**), honorary member of the British Society of Rheology, about the unconventional properties of low molecular weight self-assembled peptide hydrogel systems, measured by complementary techniques of bulk rheology and microrheology. These systems are of the same class of materials as the ones studied in my research group. It was fascinating to see the explanations and surprises of the interesting break of the gels in 45 degrees (engineering plane of maximum shear breakage) when under the effect of a high normal compression stress whereas, curiously, if the same gel is slowly compressed, the hydrogels expel the water laterally and to not change shape, neither deform in the perpendicular direction to the shear stress applied. Additionally, Bill showed the complementary data from both microrheology methods and bulk rheology. With 0.12-1.01 μm particle probes the viscosity of the material probed is in strong dependence with the particle size used to track, however this result informs of other features than the bulk rheology. The rheological measurements (macroscopic measurements related to the microstructure of the gel) are critically

dependent on concentration, salt solution used (hofmeister series) and pH as well as the presence of other additives.

My presentation was in the area of gel behaviour (unconventional) and novel gels systems, so called supramolecular hydrogel systems [a]. They are based on N-protected dipeptides with a low molecular weight (below 500 g/mol). This work has been developed under the supervision of Dave Adams at the Chemistry Department of the University of Liverpool. Firstly, we have devised a new method to self-assembly this class of materials, using CO₂ to change the pH of the solution phase through the gas phase. This method has proven to be useful to understand the intermediate self-assembly step when the solution pH is equal to the pK_a of the low molecular weight building blocks used [b]. I have presented an example where the self-assembly process allows the formation of different forms of hydrogel (over 3 orders of magnitude different mechanical properties) with the same building block in water [c] and in mixtures with organic solvents [d]. Different phenomena happen when these materials are assembled at the interface [d] or in confinements [e]. Furthermore, we have found it is possible to magnetically align the micellar solutions preceding the hydrogels [f]. My latest results focus on the study of the transition between micellar phases of the starting solution phase and the nanofibre hydrogel properties. The initial micellar phase is quite diverse, including liquid crystalline phases, worm-like micellar phases and spherical aggregate phases. We used rheological, scattering, microscopy and ionic measurements to characterise these phenomena. We should be publishing this work soon.

I am very thankful to the British Society of Rheology committee for the Conference Grant and the advice from my fellow members.

[a] Raeburn, J., *et al.* Chemical Society Reviews, 42(12), 5143–56 (2013).

[b] Zamith Cardoso, A., *et al.* Faraday Discussions, 166, 101-116 (2013).

[c] Tao, L., *et al.* Langmuir, 30 (46), pp 13854–13860 (2014).

[d] Raeburn, J., *et al.* Soft Matter, 11, 927-935 (2015).

[e] Braun, H.-G. and Zamith Cardoso, A. *Colloids and Surfaces. B, Biointerfaces*, 97(0), 43–50 (2012).

[f] Wallace, M., *et al.* Chemistry-A European Journal, 20 (50), 16484–16487 (2014).

Andre Zamith Cardoso, Liverpool

INDUSTRY NEWS: News from Anton Parr

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CONFERENCE DIARY

2015	CONFERENCES & MEETINGS
11 – 15 Oct Baltimore, Maryland USA	87th Annual Meeting of The Society of Rheology More information can be found at the SoR web page: http://www.rheology.org/sor/annual_meeting/2015Oct/default.htm
5 – 7 Nov Seoul, Korea, South	8th Korean-Australian Rheology Conference More information can be found at www.rheology.or.kr email: ksr@ksr.or.kr
14 – 15 Dec Glasgow, Scotland	BSR Mid-Winter Meeting on Microrheology & Microfluidics More information can be found at http://www.gla.ac.uk/schools/engineering/research/divisions/biomedical/seminars/bsrwinter2015/ Or contact the organisers: Dr Manlio Tassieri, (Manlio.Tassieri@glasgow.ac.uk) Dr Nick Hudson, (n.e.hudson@strath.ac.uk)
2016	
8 – 13 Aug Kyoto, Japan	The XVIIth International Congress on Rheology (ICR2016) Chair: Hiroshi Watanabe (Kyoto University, Japan) More information can be found at http://icr2016.com/index.php?ICR2016
2015	COURSES & WORKSHOPS
2 nd - 3 rd Dec. 2015 St. Albans, UK	Rheology Workshop Steve Goodyer, Anton Paar Ltd, Unit F, The Courtyard, St. Albans, Hertfordshire, AL4 0LA T: +44 (0)1992 514730; F: +44 (0)1992 514739 E: steve.goodyer@anton-paar.com



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