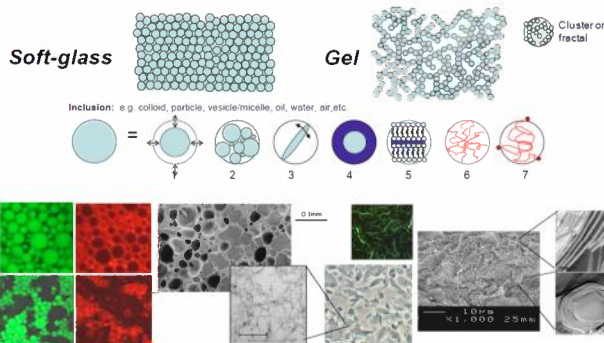


THE BRITISH SOCIETY OF RHEOLOGY

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Rheology Bulletin

ISSN-1469-4999

VOL 55 No 3 2014

THE BRITISH SOCIETY OF RHEOLOGY

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BSR BULLETIN 2014, Vol. 55, No. 3

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ISSN 1469-4999

EDITORIAL

Welcome to Volume 55 (issue #3) of the British Society of Rheology Bulletin. We are rather spoilt for in-depth articles in this issue of the Bulletin having a lead article provided by the Annual Award winner, Jason Stokes, concerned with food rheology, an article on yielding of suspensions by Richard Buscall and collaborators, and an article concerned with “rheology in the snow” by Ralph Oliver where you can learn about the dangers of rheologists sitting on glass tables (NB. If any readers are interested in the rheology *of* snow we’d gladly accept an article for the bulletin!).

Rob Poole, Liverpool December 2014.

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 image used to illustrate the cover supports the main article by the Annual Award winner Jason Stokes and is a cartoon of microstructures present in foods. Reproduced and adapted from Stokes JR, Frith WJ, ‘The rheology of yielding and gelling soft matter systems’, *Soft Matter*, 4, 1133 - 1140, (2008).

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.

What is challenging about food rheology?

Associate Professor Jason Stokes.

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Jason.Stokes@uq.edu.au.

The rheology of foods and beverages is important to its processing, stability and organoleptic properties. There is much to study concerning the rheology of food, far beyond common misconceptions of the field. When performing research associated with the rheology of foods, it is startling to think of how foods pretty much cover the full spectrum of materials and fluids (examples in figure 1):

- *Polymers* - including polysaccharides and proteins;
- *Particles* - including colloids, hard spheres, soft spheres, anisotropic hard/soft particles, ice crystals, solid fat (covering nano- to centi-meter length scales) ;
- *Multiphase fluids* – including foams, emulsions, etc.;
- *Multiphase “solid” composites* – including gels, polymer gel blends, phase-separated polymers, etc.. with embedded particles, air, oil/fat, etc.;
- *Soft solid-like structures* - including soft glasses and particle gels;
- *Self-assembled structures* – including those formed from surfactants, colloids, proteins etc..
- etc. etc..

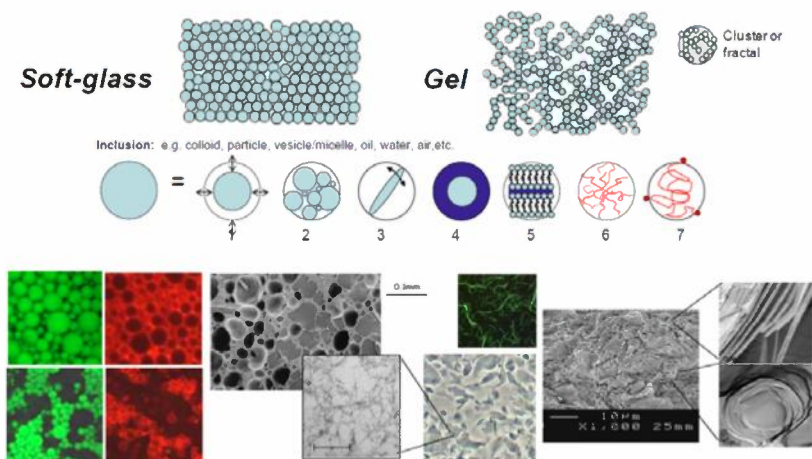


Figure 1 - Cartoon of microstructures present in foods. Reproduced and adapted from [1].

In terms of rheological properties, foods and beverages also cover the full spectrum of behaviours: *Newtonian*, *viscoelastic*, *viscoplastic*, *elastoviscous*, *poroelastic*, *thixotropic*, etc. and combinations thereof. Thus there are many examples where rheological properties such as viscosity are dependent on: *shear*, *time*, *shear-history*, *thermal-history*, *biphasic flow* etc.

Thus a majority of articles in rheology journals, as well as many in materials, macromolecular, polymer, colloid and soft matter physics journals, are entirely relevant in understanding the origins to the rheological behaviour and performance of food. The tailoring of food rheology is brought about by controlling the microstructure at a range of hierarchical length scales and kinetically trapping it in a non-equilibrium state, usually as a soft glass or gel. This has a number of positive and negative consequences:

- Shear and thermal history affects microstructures and thus rheology.
- 'Aging' occurs due to slow structural rearrangements and phase transitions, which has the potential to cause significant alterations in the structure and rheology during storage. This can also occur from perturbations due to shear, temperature and pressure.
- There is a cyclic relationship between processing-structure-rheology that is difficult to quantify, and it is thus extremely challenging to define a constitutive model for such materials.

The study of these and many other soft matter or out-of-equilibrium phenomena are highly relevant to the food stability and processing, and understanding them in relation to the underlying structure of food provides the potential for superior products and process design. However, while there is intense fundamental studies on these phenomenon, and references to food in the introductions of many articles concerning soft matter, there is surprisingly little that is performed directly on complex foods as researchers favour more model systems. Hence, there are significant opportunities in translating soft matter research to real material systems, and this would greatly assist in the variety of issues that arise in food processing.

Rheological characterisation is most routinely practiced in food product development and quality control as well as in food research. It provides important design criteria, and typical measurements include:

- viscosity at 50s^{-1} for fluids;
- yield stress of soft solids (using vane tool);
- linear viscoelasticity (G' , G'') as a function of frequency for soft solids and gels
- steady shear stress or rate sweeps spanning shear rates of 1 to 1000 s^{-1} for fluids and semi-solids;
- hardness measurements for solid foods.
- as well as several other product specific measurements.

Food rheology has played a key role in the design of foods for combating industry targets of lowering fat, sugar and salt in foods. This is demonstrated by the same rheological properties (e.g. yield stress, modulus) being obtained when measuring off-the-shelf samples of low and full fat mayonnaises and yogurts (Example figure 2). Food developers are thus pretty good at controlling rheology due to their good working knowledge on the role of different structuring agents including starches and polysaccharides and their microstructures.

While rheology is routinely used to good effect in the food industry, it is not always performed optimally - it is challenging dealing with the assortment of different artefacts that arise in rheology and many users are untrained in the complexity of rheology. Too often incorrect geometries are used - the cone-and-plate in my experience is among the least reliable tools to characterise multiphase complex fluids, yet is favoured by both newcomers to the field and many professional rheologists who deal with less complex single phase systems such as polymer solutions and melts.

The vane is invaluable for obtaining accurate yielding properties of soft solids; in the case of mayonnaise, it is best inserted directly into the jar itself as it minimises structure breakdown during sample loading and slip during measurement. The parallel plate, despite the radial dependence of the shear rates, is also invaluable for soft solids using roughened plates (preventing slip) as well as for fluids generally; this includes taking it to very narrow gaps (< 100 microns) to characterise samples where only ultra-low volumes are available (< 100 micro-litres), and it provides access to high shear rates and measurement of normal stresses for weakly elastic fluids. In terms of procedures, some good standard practices and rules-of-thumb have been developed, but too often researchers have settled on a limited number of rheological measurements (e.g. viscosity at 50s^{-1}) and struggle to delve deep. Limiting the range of rheological characterisation may prevent deeper insight into the relevant properties of foods and beverage systems, and thus limiting the ability to rationally design superior products.

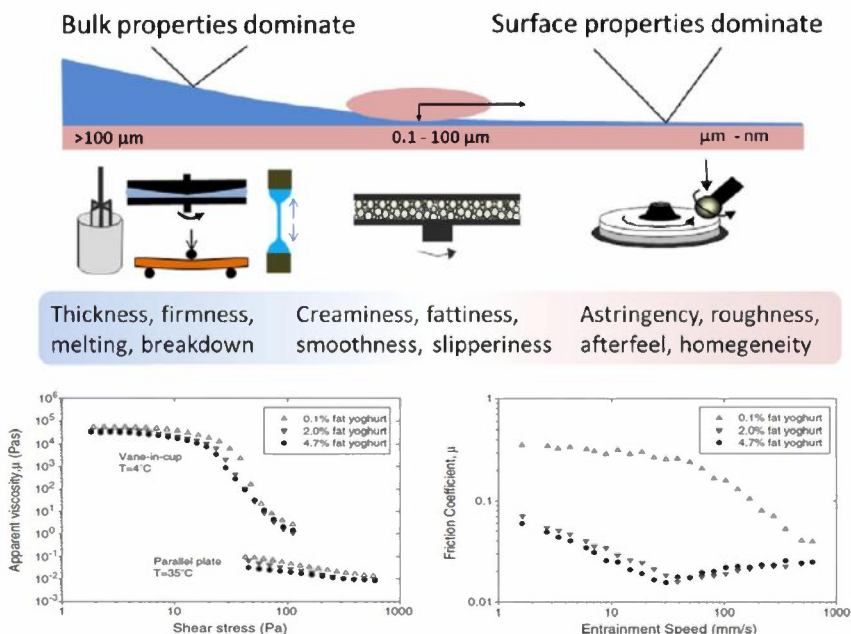


Figure 2 - (top) Depiction of the transition in film thickness of foods/beverages between oral surfaces, indicating how it goes from a rheology-dominant deformation process to where tribology and surface properties dominate. Also shown is an indicator of the types of techniques that can be used to study multiscale deformation and where typical textural attributes may lie (reproduced from [2]). (bottom) The plots provide an example where different yogurts can be matched in their bulk rheological properties (left) but these are differentiated based on tribological measurements (right) (reproduced from [3])

Rheological characterisation of intact foods is particularly relevant to assessing stability and quality control, as well as being an indicator for the *initial* organoleptic properties of the intact food including texture. However, they are less relevant beyond 'first bite' and the initial stages of oral processing of food and beverages where the products are substantially altered and experience forces and conditions not captured by traditional rheological measures. The ability to rationally design food texture beyond

'first bite' is thus a major challenge for the food developer, yet it is imperative in creating consumer acceptable foods with lower sugar, salt and fat, more phyto-nutrients, less additives, and various other requirements, which the industry is currently striving to do. Foods are unacceptable if their texture does not meet expectations of consumers, and it is the texture perception that occurs during oral processing that presents the greatest challenge to control. Texture is a sensory percept, and should not be confused as being a physical property that is instrumentally measured (despite many attempts to do so and the existence of so-called Texture Analysers). While we cannot measure texture per se, rheological-based measurement methodologies do provide some insight. However, they must now go beyond current methodologies that rely on measuring the rheology of intact food, in order to obtain product attributes that are relevant to temporal oral sensation that occur during oral processing.

Rather than rely on characterising the rheology of intact foods, it is necessary to consider the oral environment and how the rheology of the bolus evolves during oral processing. Exploring this challenging paradigm through systematic *in vitro* studies rather than *in vivo/ex vivo* (e.g. chew-and-spit) studies is favourable due to challenge of biological variability inherent within and between individuals.

Saliva adds significant complexity when considering oral processing. For a start, saliva itself has fascinating and unique rheology. It has a relatively low viscosity that is not much more than water at shear rates of around 1000 s^{-1} . Its elasticity can be enormous, whereby acid-stimulated saliva

exhibits an enormous normal stress to shear stress ratio of around 100 and Trouton ratio $\gg 1,000$, which are well beyond most commonly studied elastic fluids. It is of extreme importance for providing lubrication in the oral environment, yet it is rarely considered as a key parameter for how we perceive texture. Adding to the complexity, saliva is also stimulated by the taste, aroma and mastication of foods; it is directly relevant to the perception of beverages where stimulation of saliva may dominate over the perception of the beverage itself. It can affect food rheology and texture in a variety of ways, including: mixing, dilution, buffering, enzymatic attack, inducing flocculation, etc..

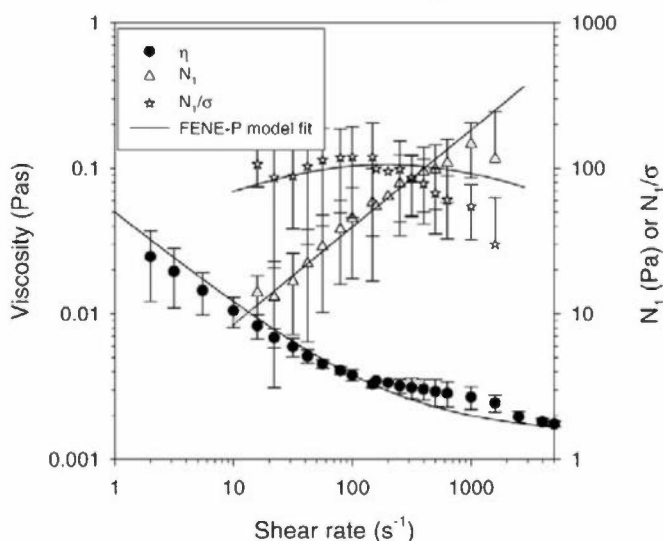


Figure 3 - Rheology of acid stimulated saliva. Reproduced from [4]

It is often quoted in the foods literature that the shear rate in the mouth is 50s^{-1} . This is incorrect; there are a huge range of relevant shear rates occurring during oral processes. In fact, the tongue and teeth manipulate

and shear food/beverages/saliva at very narrow gaps, and the field of tribology is entirely relevant. This is the study of friction, lubrication and wear of interacting surfaces in relative motion, and it has gained some prominence in trying to understand how foods behave under soft tribological contacts so as to predict new properties of relevance in oral processing and texture perception. Aqueous lubrication is inherently dependent on the rheological properties of films formed from adsorbed macromolecules at substrates as well as the high-shear viscosity of any fluid in the contact zone. This includes saliva which is bound to oral surfaces as a highly viscoelastic gel-like film, which protects teeth and other surfaces from wear and irritation as well as facilitating transport of the food. The rheological properties of the film coating oral surfaces during food consumption also affect mass transfer processes for aroma and tastant delivery.

In conclusion, there are many challenging rheological problems associated with the processing, stability and consumption of foods and beverages. There are thus many opportunities for both academic researchers and industrial scientists to advance the field and enable superior products and processes to be generated, including consumer acceptable healthy foods. An area not receiving much attention to date is modelling of oral processes, including those related to momentum, heat and mass transfer. The uniqueness of working in this field is that the types of studies highlighted are both of fundamental relevance and complexity, as well as being of significant industrial importance.

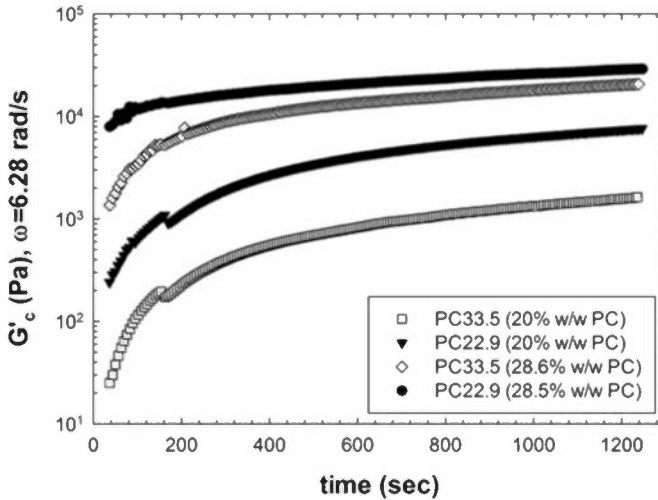


Figure 4 - Rheology of comminuted potato chips containing high (empty symbols) and low (fill symbols) amounts of fat showing evolution of modulus upon hydration in physiological buffer solution. Reproduced from [5]

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* *Recommended Reading for further information.*



Annual Award winner, Jason Stokes, receiving his award from BSR president Rhodri Williams

The yielding of concentrated cohesive suspensions can be deformation rate-dependent.

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Empirical models of yield stress liquids in steady shear-flow such as the popular Herschel-Bulkley model partition the total stress into two parts: a part associated with the solid phase, the yield stress, and a viscous part, which, in Herschel-Bulkley [1], is power-law shear-thinning in general. In simple shear then, the Herschel-Bulkley equation can be written as $\sigma = \sigma_0 + k\dot{\gamma}^n$, the simpler Bingham model being recovered in the special case of $n = 1$. The yield stress or solid phase part σ_0 accounts for stress transmission by direct inter-particle interactions, notionally, whereas the viscous part accounts for dissipation in the suspending liquid and the effect of the particles upon it. Viscous shear thinning ($n < 1$) can be interpreted in terms of a decrease of effective volume-fraction with increasing shear-rate.

My no means all cohesive suspensions show simple Herschel-Bulkley behaviour. The apparent yield stress can depend upon how one sets out to measure it [2,3,5]. It can be very irreproducible too, even within the scope of a single test protocol [3]. Furthermore, some cohesive suspensions display highly non-monotonic flow curves [3,4]. We have recently found a suspension that will show any of the aforementioned behaviours, depending upon the type of test protocol used. The material is a concentrated suspension of 4.5 μm CaCO_3 particles in water, coagulated at the IEP of CaCO_3 [3,5,8].

The table below lists some of the test modes used and the behaviours associated with them. Note that ‘CR’ therein denotes ‘controlled rate’, whereas ‘CS’ mean ‘controlled stress’. Pe_0 is the so-called “bare” Péclet number $6\pi R^3 \mu \dot{\gamma} / k_B T$ [9], where R is the mean particle radius, μ the viscosity of the liquid phase, T is absolute temperature and k_B is Boltzmann’s constant.

Table 1: Yield behaviour depends upon test type.

Test protocol			Behaviour
A	An ascending “staircase” of rates in time, all at $Pe_0 > 1$.	CR	Herschel-Bulkley [3].
B	As above but starting from $Pe_0 \ll 1$	CR	Non-monotonic flow curve [3].
C	Creep testing at a series of stresses.	CS	Time-dependent yield over a modest range of stress [5].
D	An ascending “staircase” of stresses in time (CS flow curve).	CS	Erratic yield and shear banding [3,5].
E	As above but with a return down the staircase of stresses.	CS	Hysteresis between ascending and descending branches [3].

We found that the response changed from test to test because the yield stress was deformation-rate dependent. It was so to the point where, at a volume-fraction of 0.40 for example, the apparent yield stress varied from < 5 Pa to ca. 200 Pa, depending upon the method used and the rate of deformation associated with it [3,5]. Appreciable variation from one method to another has been reported before (e.g. [2]) but nothing quite on this scale perhaps. The yield *strain* varied with deformation rate too, from a value of ca. unity at low Pe_0 , a value to be associated with cooperative local or “cage” melting according to Pham et al. [2] and others, down to a value

of ca. 10^{-4} at $Pe_0 \sim 1$ and above, this being the magnitude of strain needed to break interparticle bonds in the $CaCO_3$ suspension [8].

The diversity of behaviour summarised in table 1 could be rationalised in terms of deformation-rate induced melting of the local structure [8]. Furthermore, for steady-state purposes, all that one needs to do in order to account for it is to modify the Herschel-Bulkley equation by incorporating a second shear-rate or Pe -dependent function, together with a new constant thus,

$$\sigma = \sigma_0 g(Pe_0) + \sigma_{iso} + k \dot{\gamma}^n, \quad (1)$$

where, in simple shear-flow, the function $g(Pe_0)$ is a decreasing function of shear rate, one that decays to zero at some point, and where the constant σ_{iso} is introduced to recover Herschel-Bulkley behaviour as a limiting case at high Pe_0 .

Flow curves for the $CaCO_3$ suspension at a volume-fraction of 0.40 are shown in Fig. 1. The figure displays data obtained from tests of types B, D and E above. The data were obtained using cruciform cross-section vanes immersed in wide cylinders giving wide gaps [3,5]. The stress is plotted against the logarithm of the angular velocity, the *apparent*, or Newtonian-equivalent shear-rate at the vane being a little over twice this.

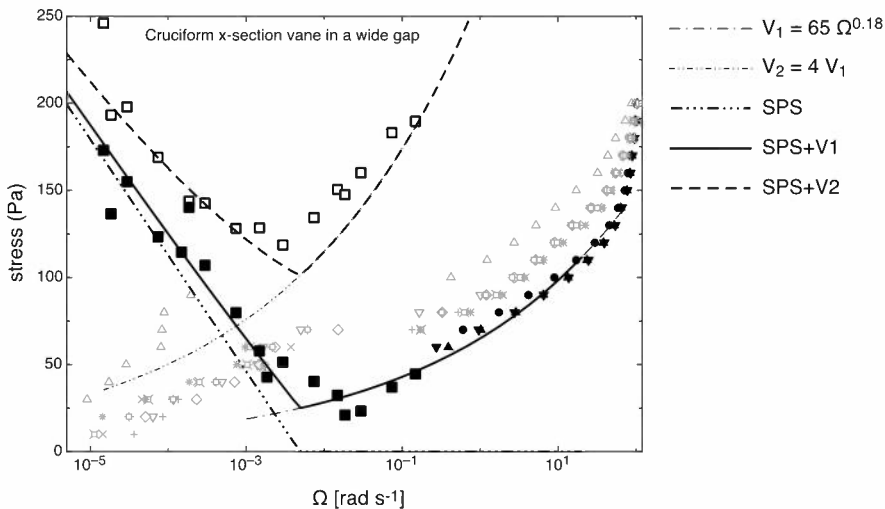


Fig. 1 Composite flow curve for a 40%v/v coagulated CaCO_3 suspension. The smaller black points are from CS in descent (cf. "E" in the table above). The greyed out symbols are the erratic CS ascent data (cf. "D"). The larger filled and unfilled black squares are the CR steady-state and peak stresses respectively (cf. "B"). The flow curves have been fitted as shown (cf. eqn 2). The apparent or Newtonian equivalent shear rate is approximately twice the rotation rate. On the ascending branch the true shear rate is ca. 5.6 times that. Data taken from reference 3.

The calculation of the true shear-rates on the left-hand, descending branch is problematic even in the case of controlled-rate where there can be no shear banding. The right-hand, or viscous branch is however straightforward as here all one needs to do is to divide the apparent shear-rate by the power-law index, n . On the left-hand branch the material behaves like a different Herschel-Bulkley liquid at each point in effect; one with a different yield stress at each shear-rate. The way that we have solved the problem of estimating the true shear rate is to suppose that the viscous power-law fit to the right-hand branch can be continued leftwards, i.e., that the total stress on the left hand branch is given by the sum of a solid-phase contribution, 'SPS' in the legend, and a power-law viscous contribution, ' V_1 ' as shown. The vane shear-rates can then be calculated. The results are model-dependent, of course, except that there is no avoiding this there being no model independent way of attacking the problem.

The dependence of the solid phase stress on the apparent and corrected shear-rates is shown in fig. 2. The curves imply that the true strain-rate softening function $g(\dot{\gamma})$ producing the flow curve could well be much stronger than it first appears. One needs to be cautious about this conclusion though: stress growth measurements in step shear-rate [8] suggested that the solid-phase stress reached a constant value at an apparent Hencky strain (or, equivalently, scaled time for stress growth in step strain rate) of $\ln(1 + \dot{\gamma}t) \sim 0.5$ and it simply cannot be assumed that the flow is fully developed at such strains. Indeed, it was found that it was not, since the viscous stress peaked there before decaying to a somewhat noisy steady-state value at a Hencky strain of ~ 3 [8]. The underlying or true dependence of the solid phase stress on shear rate is thus thought to be closer to the continuous line. Evidence for this will be presented in the next article when we will discuss the transient behaviour in more detail.

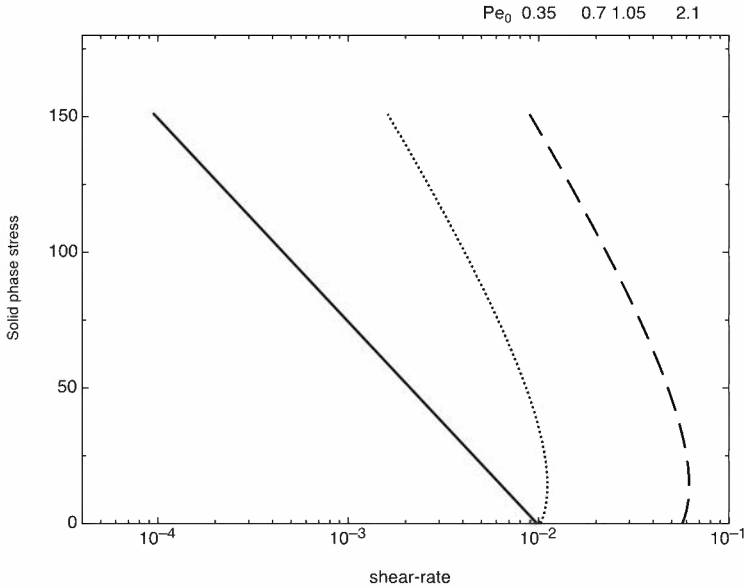


Fig. 2 Solid-phase stress (SPS from fig.1) plotted against shear-rate. Continuous line – apparent, Newtonian, shear-rate, dashed line – against the corrected steady-state shear-rate. The dotted line merely serves to show that part of the difference between the former two curves comes from the power law, i.e. a $1/n$ shift, the remaining difference is due to the fact that the yield stress is rate-dependent. The true dependence of SPS on shear rate is believed to be more like the continuous line because it plateaus at strain ~ 0.5 where the flow is not fully developed.

The peak stress (located at strain ~ 0.5) is also plotted in fig. 1. It can be modelled approximately by supposing that the viscous stress there is ca. 4 times the steady state viscous stress at all shear-rates. The fit is not perfect, but then there has been no attempt to optimise it by, say, varying power-law index slightly. It suffices though to confirm that the idea that the solid phase stress reached its steady-state value at a strain ~ 0.5 whereas the viscous stress took much longer to settle down.

That the peak stress plotted in fig. 1 decreases with increasing shear-rate initially is telling. By contrast, Koumakis & Petekidis [6], extending the work of Pham et al. [2] on cohesive PMMA dispersions, only saw the peak stress increase with shear-rate, even though the range of Pe they explored overlapped with ours. They saw only monotonic Herschel-Bulkley type flow curves too, the two things being associated one-to-one, we think. If so, this raises the question as to why they did not see non-monotonic behaviour, especially when their stress-growth curves were not dissimilar to ours qualitatively speaking (please see fig. 3 for an example). In our case, the subsequent increase in peak stress with rate at higher rates was a viscous effect and so one possible explanation is that the overall balance of solid-phase and viscous stresses was different in their system. Their suspensions were certainly very different from our $CaCO_3$. They comprised the beautiful PMMA particles developed by ICI Paints Division [7], depletion-flocculated with polystyrene of molecular weight $> 10^5$. The particle size was ca. 17 times smaller than ours, the interparticle force is estimated to have been perhaps 200 times smaller and the liquid phase of polystyrene in cis-decalin was substantially more viscous than water, hence the balance of viscous to solid-phase stress could well have been very different for one or more of several reasons.



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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 Wotan, 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 $44\,000\text{ s}^{-1}$ 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 $50\text{ }\mu\text{m}$ 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.

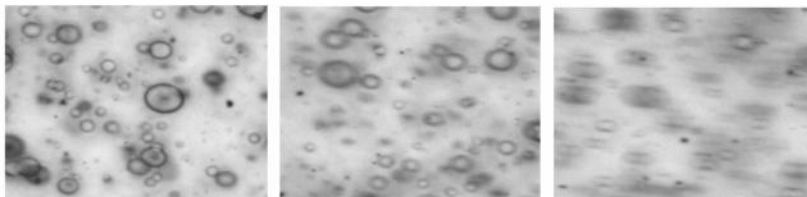


Fig. 1a - c: Images taken using a cold light source at different shear rates: 630 s⁻¹ (1a), 1290 s⁻¹ (1b) and 2520 s⁻¹ (1c)

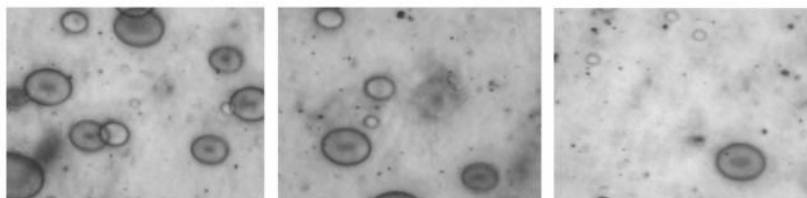


Fig. 1d - f: Images taken using a stroboscope light source at different shear rates: 630 s⁻¹ (1d), 1290 s⁻¹ (1e) and 2520 s⁻¹ (1f)

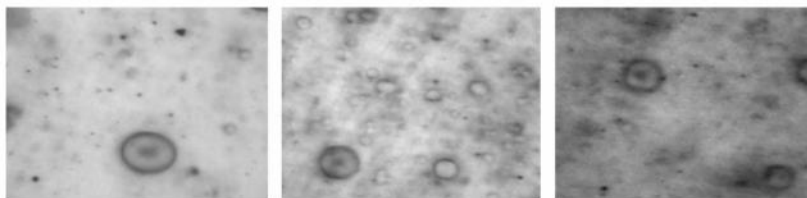


Fig. 2a - c: Images taken using a stroboscope light source at higher shear rates: 5670 s⁻¹ (2a), 12600 s⁻¹ (2b) and 44000 s⁻¹ (2c)

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)

thermoscientific.com/mc

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Material Characterization

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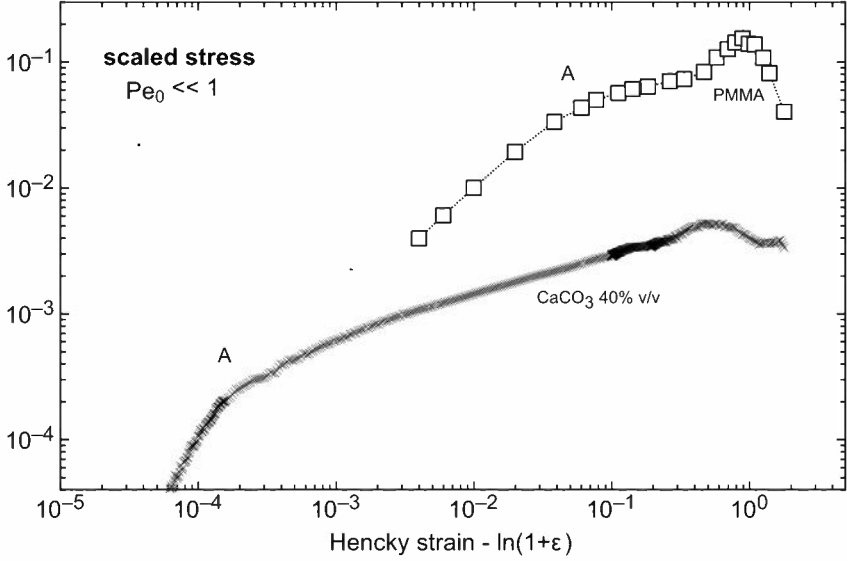


Fig. 3 Stress growth at constant rotation rate. The nominal or “engineering” strain used to calculate the Hencky strain is given by $\mathcal{E} = \dot{\gamma}_N t$ where $\dot{\gamma}_N$ is the Newtonian or linear shear-rate. The stress is scaled on the shear modulus and the two curves look different qualitatively because strain-softening due to interparticle bond breakage (A) occurs at very different strains for the two systems as a result of particle size etc. PMMA data from Ref. 2.

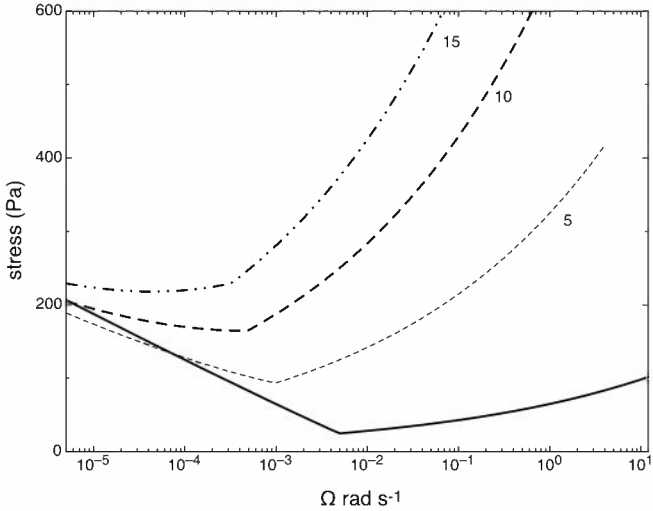


Fig. 4 Effect of increasing the liquid phase viscosity by a factor x on the fitted flow curve from fig. 1, viz. the new total stress is given by $\text{SPS}(x\Omega) + xV_1(\Omega)$.

We do not know how to scale our flow curve data in order to compare it with theirs, especially given the very large disparities in interparticle force and particle size. Except in one respect, that is. What we can do readily is to acknowledge the difference in liquid phase viscosity: we can simply take the curve-fit of our flow curve (fig.1) and increase viscous term by a constant factor. This has been done in fig. 4. It can be seen that increases much greater than ten eliminate or disguise the strain-rate dependence of the solid phase stress. Fig. 4 suggests that the following two experiments could be of some considerable interest:

- 1) Replace water with corn syrup in the CaCO_3 system so as to increase the liquid viscosity.
- 2) Reduce the background viscosity of the PMMA system, either by replacing PS by, e.g. reverse-micelles, or, by replacing the solvent/PS combination by a poor solvent, thereby to induce incipient flocculation instead of depletion.

To conclude then, we think that we have hit upon a model suspension system that shows most if not all of the features of yield stress liquids observed or reported hitherto, but in one system. The large particle size (by colloidal standards) turns out to be a real advantage in two respects: It separates the characteristic “bond” and “cage-melting” strains by nearly four orders of magnitude, allowing much detail to be seen, and it renders a very wide range of Pe accessible experimentally. Furthermore, it is suspected that the strain-rate dependent yield could well be the rule rather than the exception, it being overt or not being more a matter of degree or scale, as opposed to presence or absence, and with the balance of the solid-phase and viscous stresses and their relative dependencies on Pe controlling what is seen. That is informed speculation at this stage, even if it is plausible, it is however a proposition that is readily amenable to further testing by means of range of different kinds of experiments, including those mentioned above and those others suggested in [8].

In subsequent articles we will compare the transient behaviour (cf. fig. 3) of our CaCO_3 system with that reported by Pham et al. [2], Koumakis & Petekidis [6] and others in more detail and we will look further at the mechanism of the deformation-rate softening. In the unlikely event that any BSR member cannot wait several months, a slide show giving more detail

can be made available upon request, as can a preprints of references [3, 5 and 8] if required.

Acknowledgements: Funding sources are acknowledged in papers [3,5 & 8].

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- [6] Koumakis, N. and G. Petekidis, Two step yielding in attractive colloids: transition from gels to attractive glasses, *Soft Matter*, **7**, 2456 (2011).
- [7] Dispersion Polymerisation in Organic Media, Barrett, K.E. (ed.), Wiley (1974).

This book is long out of print and S/H copies can be hard to find, it is however of substantial historical interest in the view of the authors. The PMMA particles have been used by many, inc., e.g., Mewis et al., for whom particles were made either by ICI Paints or ICI Corporate Colloid Science Group. The PMMA particles have enabled much. A review of their role might be appropriate at some point.

[8] Buscall, T.E., Stickland, A.D., Scales, P.J., Teo, H-E and Lester, D.R., Dynamic and rate dependent yield in model cohesive suspensions, (JNNFM submitted September 2014). arxiv.org/abs/1410.0179.

[9] “Bare” Péclet because it is the Pe of a free particle at infinite dilution, the supposition being that the unknown but non-ideal Pe that controls the phenomenon at hand will somehow be proportional to it (i.e. it is the best we can do in the first instance).

RHEOLOGY IN THE SNOW

D.R. Oliver

Snow, thrills and spills, with much derision from home-bound cynics, these were our lot for thirty years of Rheology meetings in the French Alps. It all started with a meeting in the Vosges region of north eastern France, which was followed in 1986 by a memorable meeting in L'Alpe d'Huez. On arrival by train at Grenoble, Russell Davis found that his brown case had been replaced by a white one marked "Colette". This he left at the station with a note giving the name of our hotel in L'Alpe d'Huez. Imagine his glee when a few hours later, a little Renault battled the numerous hairpins carrying Colette and his suitcase to the front door of our hotel. A very big bear hug was in order!

The popular meeting was held at a modern church with central heating, which became important as blizzards started on Tuesday and only died down on Friday morning! Snow drifts fifteen feet deep buried all cars parked along the roadside and we could only leave our hotel via a narrow passage between the front wall of the hotel and a massive drift. Buried cars were freed by digging in from the road, regularly snowploughed, to free the exhaust pipe and then the driver's door. The car would then be backed out looking just like an ice-cream van! I saw a man dig down to his car, starting from a garage roof. Skiing was limited but conference attendance was excellent.

However, John Hutton amused everyone by announcing at the bottom of a beginners slope "I'm off back to the hotel..... Oh no, no!!" as he fell into a deep snow-hole which was certainly difficult to spot. It took three of us twenty minutes to drag him out!

Chamonix was another big, successful meeting held at the central Hotel Alpina. I remember shredding my wallet on wet slush (only wearing two pairs of ordinary trousers) and losing a ski at Le Tour with Eirean Jones helping me to find the ski, which had shot off down the hill.

Our first Combloux meeting in 1989 was more intimate, the “Aux Ducs de Savoie” hotel being run by the friendly Corinne Perrin. For the first time (keep it secret) the rheology lectures were held between 4pm and 7pm with the day free for skiing.

People often overdo things on the first day and I was no exception. After many runs on a nursery slope, Josie Walters offered to take a party of tyros up to a higher run involving the use of a chair lift. Now, getting on and off a swinging chair is easy with practice but to a nervous novice it is a nightmare! I had Eirean Jones on one side and Jim Ferguson on the other, but I sat down too soon, grabbed the others and fell into a muddy puddle in front of the chair, which passed over our cowering bodies! Later, in thick mist, we skied close together between rows of fir trees before emerging into sunshine and a lovely wide piste. Going much too fast, I baled out in deep snow on one side of the piste, poles and skis flying. They said I did three somersaults and when I got up I found that ligaments in the right shoulder were damaged. No more skiing that week but plenty of walks with Mervyn Jones and some excellent rheology.

Our visit to Villard de Lans coincided with the first Gulf War, in which George Bush senior defeated Saddam Hussein’s forces in Kuwait but did not follow through to Baghdad. French television showed the prolonged aerial bombardment of Iraq really well, a firework display in which we were regularly told that laser-guided bombs and cruise missiles would always hit their targets, or even “put one through Saddam’s front window”.

Mary Walters was on a narrow green run with a steep, snowy drop on the right hand side. She slipped over on the left hand side but did not quite stop – something to do with those shiny modern ski suits. Flailing and giggling in equal proportions she slipped downwards and sideways, to the wrong side of the run! From some way back, it looked as though she had stopped but she rolled gracefully over the edge and soon stopped in about four feet of fresh snow. Finding skis and poles was the first job; after that it was the sheer drudgery of three people slipping, sliding and falling over

until Mary was pushed back onto the piste, followed by two puffing, overheated rheologists!

At a somewhat isolated part of Chamrousse called La Roche Beranger, Ken Walters finally convinced a group of budding downhillers to go cross-country once again. The narrow skis had a “rough patch” under them, to slow the skier down on steep sections whilst running in two ruts. We were not familiar with this oddity and some of us fell flat on our faces at first, whilst Ken sailed round. Two circuits were enough to leave us sweaty and exhausted! Jim Ferguson always had a large bottle of Scotch in his room and the stories we told there were the forerunners of our more organised Friday evening parties.

Val D’Isere is a classy resort which we visited in March (1994) with the sun rather hotter than usual. Eirean Jones and I spotted a cable car close to our hotel and got on it, though realising that a “short” red run would be our first challenge. At the top we slithered through a rutted, icy tunnel and emerged into a bright sunshine. Ahead lay a massive slope with a restaurant way below us. “If we get down this I’m going to have a beer down there”, I said as we took a deep breath. We fell over many times between us but we certainly enjoyed the drink as we recovered in the sunlight!

Other features of this visit were that paragliders from on high kept landing just outside our lecture room window – rather nice if the lecture was dull – and the fact that some of us got badly sunburned. I was said to look rather like Quasimodo!

By the time we went to Les Deux Alpes, Morzine and La Clusaz, we had changed from train to air travel. This was much easier, of course, but we missed the night, in Paris or Lyon, the lovely meals and the mad dashes to catch TGV trains. Opponents of HS2 please note: the French were building similar lines thirty years ago!

Friday evenings were now transformed by a party – first squashed into a bedroom – later in the cleared lecture room, with some regular “turns”. Mary Walters not only organised the wine and snacks but also provided several prizes:

“Most improved beginner”,

“Most stylish skier”,

“Best crash”,

“Fastest skier on his bottom”

being typical categories, most of which were “tongue in cheek”. Peter Townsend was a wonderfully droll master of ceremonies and later on, Susie Webster organised a series of popular games. Most unexpected were the pantomimes produced by Dwryd Townsend, in which the players sat on a row of chairs and leapt to their feet to say their lines – often just one word! The party was a largely British affair, but our European friends sometimes came too and took part in the proceedings. Balthur Mena, of Mexico, was quite a hit on his guitar but was less popular with a local disc jockey when he tried to join in with his show!

Another visit to Combloux saw Mike Webster borrow a ski suit which was not only a tight fit but coloured yellow and bright green. He flew down the slopes looking like a canary! Jim Ferguson had a crash in which he lost everything – skis, poles, gloves, glasses and hat – leading us to christen the slope “Jim’s wall”!

Meanwhile, Ken Walters had made the big change from cross-country to downhill skiing. Following several sessions of coaching and with Mary’s constant guidance, Ken made several descents of the more difficult “blue” runs – quite an achievement, for believe me, skiing is not a sport which is easy for all. Icy patches in the morning, chairs swinging high in the breeze and badly fitting boots are just a few of the problems which need to be faced, along with boy racers on snow boards. I was hit hard from

behind by a snowboarder at Chamonix in 2002, scattering all my equipment and losing a lens from my sunglasses!

Les Deux Alpes (1999) has a piste high on a glacier which was reached by two consecutive cable cars followed by a funicular railway which climbed another kilometre through the mountain itself. Called “Ski d’ete”, at over ten thousand feet the snow never melted in the summer. However, the skiing was not difficult, through the air was chillingly cold.

Our most spectacular crash was provided by Jo Maia. Finding a suitable mound from which to do a ski jump, he made sure that Mats Stading was on hand to video proceedings. A few practice jumps gave him confidence, which seemed to be enhanced when the camera started rolling. He went much faster and whilst airborne began to tip rapidly forwards so that he made an uncomfortable landing on the tips of his skis and his forehead!

I found him soon afterwards, sitting by the piste, head in hands and badly concussed. He was taken down on a stretcher on skis by two alpine rescue men who were expert in their task. Discharged from hospital, he reappeared before dinner with bruised face and forehead. But he has a ready answer to the question

“What was the damage then?”

“Four hundred and fifty euros”, was the staccato reply!

A quite different accident occurred at Pralognan, where I went into a small lounge with a large glass embossed table surrounded by chairs, all occupied by chattering rheologists. Realising that it was dangerous to sit on the glass, I perched carefully on a solid metal corner of the table for some time. Then it was time to go in to dinner, but just as I was rising there was a great crash as the table top exploded and threw shards of glass all over the room, the chairs and the remaining rheologists! The Madame took the incident well, refusing my offer of payment, but never again have I sat on a glass table.

But our worst skiing accident was at Samoens, where Glenys Jones fell awkwardly and broke her arm. Fortunately, her hospital treatment was very good and she cheerfully returned to the hotel in the late evening. In view of the wide spread of abilities of our scientific skiiers, not to mention the age of some of them, we were lucky not to have had more serious injuries. My own crash (mentioned earlier) and Ken Walters later calf muscle injury were little more than the kind of damage often sustained during sports at home.

A more amusing incident occurred at Chatel, during Eirean Jones' last year on the slopes. Another "first day" red run saw a group of us skiing merrily in sunlight when we came to a very steep slope. At the same time, mist enveloped us and visibility dropped to about ten yards. Eirean made a couple of turns and disappeared, his muffled cry telling us he was now on the way down on something other than his skis. Both skiing and walking now felt hazardous. But Mats Stading, a cool head at all times, came up with a solution. "Let me carry your skis - then slide down on your bottom", was his advice which I then attempted. Strangely, feet forward on the back with both heels digging in, it was just possible to control the rapid acceleration. I shot past Eirean in the gloom and was glad there were no trees or bushes to bring the run to a painful end.

Later, Eirean emerged from the slowly clearing mist, bringing my skis. We looked back up the slope to see random chaos, several of our group, including Mike and Susie Webster, struggling to stand up and with various items of equipment dotted over the slope!

A second visit to Tignes gave us another chance to take the cable car over a high ridge and into the Bellegarde region of Val D'Isere, this time without being sunburned. Alternatively, there was a level walk across a frozen lake to the centre of the village. Two visits to the friendly resort of Les Saisies and two more to Les Gets (2012 and 2013) completed our French visits, after which a major change was made in moving to Austria.

Our French colleagues, Claude Wolff and Jean Micheal Piau had played a major part in finding suitable hotels and later, Laurent Jossic and Frederic Bossard were invaluable. On our side, David Binding mastered the difficult art of rushing round airports like Geneva to find our bus and assemble groups from different places at different times. If David was the binding, then Ken Walters was the glue which held the disparate group together for so long. His many contacts and standing in the world of rheology were vital, his effort always being supported by Mary and often by Jonathan, Jeremy and by Josie.

And finally, an apology to top drawer scientists like Ken and Manfred Wagner, I've not said a word about the world class rheology on show! Shame on you, Sir!

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 Friday 13th February 2015 with successful applicants notified by the end of February. 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, 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

BSR Membership News

New Members

Zainab Talib Al-Sharify (Birmingham)
David Harbottle (Leeds)
Yannis Hardalupas (Imperial College)
Adam Townsend (UCL)
Mathieu Meerts (KU Leuven)
Marios Hatzopoulos (Reading Scientific Services)
Pretima Titoria (Leatherhead Food Research)
Rangarajan Radhakrishnan (Durham)
Bernice Ridley (Croda)
Aditya Jaishankar (MIT)
J Rafael Castrejon-Pita (Cambridge)
Andrew Clippingdale (ToneJet)
Lorenzo Botto (Queen Mary)
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Colin Bain (Durham)
Josie Harris (Domino UK)
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Maria Dolores Torres Perez (Cambridge)
Katie Liu (Xaar)
Claire McIlroy (Leeds)
Clare Conboy (Printed Electronics)
Stephen Wilson (Strathclyde)
Stuart Reynolds (Domino UK)
Maelle Douaire (Xaar)
Christine Tock (Birmingham)
Shahad Zuhair Al-Najjar (Birmingham)
Haifa El-Sai (Wentworth Institute of Technology)

New Honorary Members

Charles Chaffey
John Collier

Membership Subscription Reminder for 2015

Please note that the annual membership subscription fee for the British Society of Rheology for 2015 is due on 1st October 2014. 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.

Please ignore this message if you are an Honorary member, pay your BSR membership subscription by standing order or have already arranged payment.

Maria Charalambides
BSR Membership Secretary

Commentary on the 340th Council Meeting of the BSR

The 340th BSR Council meeting was held in the impressive surroundings of the Institute for Manufacturing, Alan Reece Building, Cambridge on the 17th December 2013. It followed on from the BSR Midwinter meeting on “Coating, Printing and Painting”.

Following a train journey from a gleaming new Kings Cross station through some delightful mid-winter sunshine, I arrived at the dreaming spires of Cambridge to some little chaos at the station, where finding a taxi was more like a blood sport and not for the faint-hearted. A short journey past the medieval splendour of the colleges brought me to the beating modern heart of Cambridge academia and the ultra-modern surroundings of the Institute for Manufacturing on Charles Babbage Road. The mid-winter meeting was just finishing and a few mildly disoriented delegates were in search of caffeine.

The meeting started just after 2, and was swiftly and efficiently led through the agenda by the BSR president Rhodri Williams. Discussions were held on the BSR website and its web presence, the Council archives, online membership, and on-line rheology courses. The reports of the Officers followed, with a short summary of the BSR accounts and finances

by the Treasurer, Steve Goodyer. Happily, these are in good order and recorded an overall net gain over the year. The membership secretary reported the good news that several new members had joined the Society and that membership was holding up well. The death of Rheology Abstracts was formally decided and the Council expressed their gratitude to Nick Hudson for his untiring efforts in its production.

Arrangements for the AGM and the Institute of Non-Newtonian Fluid Mechanics meeting at Lake Vyrnwy in April were discussed as well as nominations for Council for the following year. The post of Abstracts Editor was abolished and it was agreed to replace the post with an officer devoted to the website and interaction with the membership. Several upcoming scientific meetings were discussed, including a meeting on Food Rheology organised by the Non-Newtonian Club at Reading University, the next mid-winter meeting at Durham on bioactive fluids and future meetings.

The meeting ended promptly at 3.30 and the members dispersed back into the winter sunshine.

Bogdan Dobraszczyk

Commentary on the 341st Council Meeting of the BSR

This meeting of Council immediately followed the 2014 INNFM Meeting on Rheometry and General Rheology on 16th April 2014. Following an excellent scientific meeting enjoyed in glorious surroundings and unseasonably fine weather, members of Council convened to discuss Society business.

The meeting began by reviewing the minutes from the previous meeting and matters arising. There were ongoing concerns about the Society's conference registration system. When this is working well it is a real benefit to conference organisers. However, there are a few issues such as the automatic confirmation of registration that need to be resolved so that the full power of the system can be harnessed. It was reported that there was a sparsity of UK attendees at the most recent AERC in Karlsruhe and a consensus that this would need to be monitored. All Council members had dutifully completed all the tasks that had been assigned to them at the previous meeting and so all actions had been completed.

The President, Rhodri Williams, reported on discussions he had held with EPSRC concerning the lack of successful Fellowship applications

in Rheology/Complex Fluids. He suggested ways in which the BSR could support this activity through the provision of mentor support external to the host institution for successful applicants and assistance for prospective applicants. A 'White Paper' on this would be produced by Rhodri. The Treasurer, Steve Goodyer, reported that the Finances were in good shape. He expressed the need to find a suitable account for the bulk of the Society's reserves to ensure that the best rates of interest were earned. Council agreed to seek independent advice on this matter.

There was a discussion on potential recipients of the Annual Award for 2014 and the Gold Medal of the Society. You will hear more about the outcome of this discussion in due course but members should be encouraged about the health of the discipline by the quality of the prospective candidates. Only one application for a travel award had been received and everyone was encouraged to publicise the availability of these awards.

Every two years the Society elects a new President. It seems only yesterday that Rhodri was elected to this high office but the search for his successor has begun. Council discussed possible successors and several potential candidates were considered. Again more news on this will be reported in in due course.

Finally, Council discussed the scientific meetings on offer over the next two years. These included the BSR Midwinter Meeting in 2014 to be held in Durham, Non-Newtonian Club Meeting on Food in Reading, INNFM Meeting in 2015 on Rheology of Structured Fluids to be held in Ruthin Castle and the BSR Midwinter Meeting in 2015 to be held in Glasgow. The next AGM of the Society will be held at Ruthin Castle on 1st April 2015.

Tim Philips

Commentary on the 342nd Council Meeting of the BSR

As the wonderfully warm and extended summer was continuing the BSR council gathered at the School of Chemical Engineering, University of Birmingham for the mid year council meeting.

After a light lunch the meeting opened with apologies, approval of the previous minutes and dealt with the actions arising from the previous meeting. The president reported on a proposal for a mentoring scheme for young rheologists, which is being discussed with the EPSRC. The treasurer's report outlined the level of the accounts being low due to having

paid expenses for the last mid-winter meeting but not yet had income from this years, due to the accounts being based on the calendar year. Member subscriptions which are due on the 1st of October for 2015 will also bring the accounts back to the levels expected for the end of the financial year.

The membership secretary reported that there have been nine new members since the last council meeting and that honorary membership was bestowed on Charles E. Chaffey and John Collier. The bulletin (volume 55, issue 2) had been sent to the printers in August and would soon be received by members. It was available in electronic form on the website by the time of the meeting.

Following the creation of the position of editor (web) at the last AGM discussion on the state of the website and what we need to do with it in the future was held following the investigations of the web editor. Discussions were also held on the creation of a subcommittee for the judging Vernon Harrison prize, the annual award for 2014 and the next BSR president.

Bogdan reported on the success of the Non Newtonian Club meeting on Food Rheology in May with 30 delegates attending, a good mixture of academics, students and industrialists. The next meeting of interest is the mid-winter meeting being held in Durham on the 17th-18th of December.

Richard Watson

Conference report on the Non-Newtonian Club Meeting 22 May 2014

RSSL at the University of Reading's Whiteknights Campus hosted the BSR Non-Newtonian Club Meeting on Rheological Measurements of Food Properties in the industry on 22 May 2014. Organiser Bogdan Dobraszczyk brought together a good range of speakers covering a range of the rheological questions encountered in the UK food sector for the delegates.

Maria Charalambides (Imperial College) started the meeting with a report on micromechanical modelling of bread doughs. She described work at Imperial describing this highly viscoelastic material with a Lodge rubber-like model. The need to include damage functions and debonding models for evolution of starch granule/gluten matrix interactions was demonstrated. There were neat results presented for a multi-particle model, digitising detailed microstructural images to construct a composite, heterogeneous structure for FEM simulations.

David White, now at Kraft but whose PhD was sponsored by Unilever, presented work from his PhD on the rheological behaviour of Marmite(TM). Whether you like this spread or not, it certainly exhibits unusual behaviour: David reported

measurements of strong thixotropy, sensitivity to cumulative strain and jamming phenomena at higher protein content.

Ian Wilson (Chemical Engineering, Cambridge) talked about bubbly liquids, which are two-phase fluids with sub-millimetre bubbles dispersed in a viscous liquid as continuous phase. This work had evolved from studies of cake batters and more recently had concentrated on the effect of using a non-Newtonian liquid as the continuous phase. Strongly viscoelastic effects arose from the presence of the bubble phase, and the results did not map simply onto results obtained with a Newtonian liquid. The Giesekus constitutive model had proved particularly useful to describe both the shear and extensional rheology of these complex fluids.

Richard Watson (Birmingham) spoke on the effects of salt on food structure and rheology. This was more of a survey of factors in the field affecting manufacturing and consumer preference. While salt level reduction is targeted for various physiological reasons, NaCl serves as a structuring agent in many others.

Ross Winter (Imperial College) reported results for bubbly flows, involving bubbles considerably larger than Ian's, related to interest in aerated foods from Nestle (chocolate, coffee). Ross has been visualising these bubbles by a number of techniques and he discussed some of the issues with interpreting the videos and modelling these flows.

Bill Frith (Unilever) completed the day with an overview of how FMCG companies like Unilever achieve microstructures in food and personal care products. He sprinkled the talk with examples of the use of particles, droplets, bubbles and foams as well as achievable polymers. These all involved multiphase materials, and Bill presented some of the sensitive challenges in measuring (and exploiting) liquid-liquid interfacial tensions, and how phase separation (and phase behaviour) under sheared conditions compares with quiescent ones. Exploiting gelation to trap two phase microstructures (and preventing them from reverting to their thermodynamically preferred state) finds its way into all sorts of things – foods, shampoo, shower gel! Bill showed that rheology can find a use in almost every product.

The day was completed by a tour of the RSSL labs and facilities. Our thanks go to Bogdan and his colleagues for hosting and feeding us very well.

Loly Torres-Perez, Cambridge

Conference Report: on the INNFM Meeting on Rheometry and General Rheology 14th – 15th April 2014, Lake Vyrnwy, Wales

I would like to thank the British Society of Rheology for its kind support, which made my attendance possible at the INNFM Meeting on Rheometry and General Rheology, held at Lake Vyrnwy, Wales, from 14th to 15th April 2014. This has proved an inspiring experience for me, and had a marked impact on my professional development as a rheology practitioner.

This meeting, organized by Rhodri Williams and Peter Townsend, consisted of a single session, spanning over a three-day period, with key lectures from high-profile researchers and practitioners. The venue was most accommodating, offering a welcoming and beautiful environment, to listen and share ideas, and the opportunity to meet well-known figures from the field of rheology in the north Welsh town of Llanwddyn.

The breadth of scientific topics presented in this meeting was wide. I was most interested in topics linked to my PhD studies, which is related to numerical modelling of wormlike micellar complex fluids in complex flows. This covers use of the Bautista-Manero constitutive approach, with application to viscoelastoplastic and biofluids representations. With this in mind, I found most instructive the papers on flow through contraction settings and complex flows in general, shear banding and yield-stress fluids. My contribution to the meeting was given through a poster presentation, in which our latest results on High-We numerical solutions for wormlike micellar systems in complex flow were exposed. Here, numerical studies using the Bautista-Manero equations of state, have led to corrections in this family of constitutive equations that account for (i) the inclusion of the viscoelasticity (via the characteristic time) into the structure construction-destruction mechanism; and (ii) the consideration of the absolute value of the dissipation function as the driving influence to depart from Oldroyd-B-like behaviour.

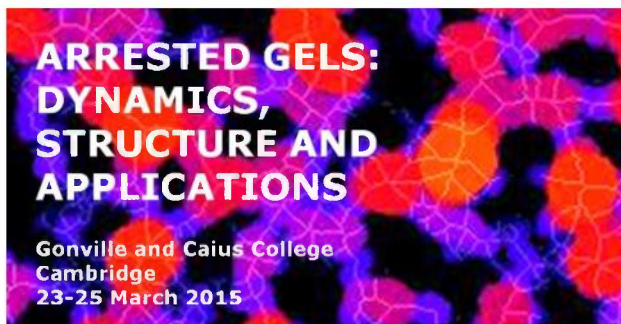
A plethora of interesting talks and posters were presented during the meeting. On the relatively new topic of large amplitude oscillatory shear flow, Michael Renardy shared notable ideas on data for thixotropic and yield stress fluids; and Jeffrey Giacomini showed data on normal stress difference for dilute rigid dumbbell suspensions. As an approach for extreme extensional rheometry, Oliver Harlen talked about jet break-up of complex fluids. Octavio Manero exhibited a comprehensive study on flow of viscoelastic liquids through contraction-expansion geometry with various contraction ratios, with experimental pressure-drop and streamline visualization data. Roger Tanner talked about non-colloidal suspensions theory and experiments in shearing flow. On biofluids and food rheology, Crispulo Gallegos talked about rheological characterisation of oral thickened products for

dysphagia support. On the modelling side, Manfred Wagner exposed a consistent model for elongational flow of polymer melts and solutions based on the interchain tube pressure. Francisco Chinesta provided results on multiscale modelling of dilute and concentrated suspensions of rigid particles, and Helen Wilson talked on an interesting criterion for nonlinearity classification of instabilities in viscometric flows. On this occasion, Jason Stokes received the BSR Annual Award Rheology for his research work.

Moreover, I took benefit from the opportunity to expose my own wider research work and in gaining feedback from many senior colleagues, as with Octavio Manero. Particularly so, in regard to the formulation of constitutive models and numerical simulation in complex flows for micellar fluids, with application in viscoelastoplastic materials and in shear-banding situations.

I was highly motivated to meet those practitioners whose research I have been addressing during my PhD studies. This experience has been truly beneficial, in offering the opportunity to share promising ideas with high-profile researchers in the field. Of these, a personal note must go to Prof. Ken Walters FRS, a long-standing rheologist in the field, whose birthday we celebrated during this INNFM meeting. Happy birthday, Prof. Walters!

J. Esteban López-Aguilar, Swansea



Arrested Gels: Dynamics, Structure and Applications

Gonville and Caius College, Cambridge, 23-25 March 2015

Call for papers

The RSC/SCI Joint Colloids Group (www.colloidsgroup.org.uk) is pleased to announce a meeting for academia, industry and students to link the latest research on gels to tomorrow's applications in the captivating and inspiring atmosphere of Cambridge.

Researchers from academia, industry and students are invited to submit abstracts for oral and poster presentation.

<http://www.constableandsmith.com/arrestedgels/default.htm>

The focus of the meeting is the dynamics, structure and applications of arrested gels; colloidal gels are complex materials that when suitably designed give the performance and function to a wide range of advanced modern day products. Fundamental to designing such materials is understanding the interplay between interparticle forces on the molecular level and mesoscopic and macroscopic phenomena of network formation, mechanical properties and time-evolution. Understanding how all these components behave and interact together will be the focus of this colloquium.

Arrested Gels 2015 is organised by the RSC/SCI Colloids Group (RSC Colloid and Interface Science Group and SCI Colloids and Surface Chemistry Group).

CONFERENCE DIARY

2014		CONFERENCES & MEETINGS
17 -18 Dec Durham	BSR MWM2014 Organising Committee: Suzanne Fielding (Durham), David Hoyle (Durham) and Ricard Matas-Navarro (Durham). https://www.dur.ac.uk/bsi/bsrwinter2014/	
2015		
30 Mar - 1 Apr Ruthin Castle, Wales	INSTITUTE OF NON-NEWTONIAN FLUID MECHANICS “Rheology of Structured Fluids”. Conference Contact: Simon Cox: foams@aber.ac.uk , tel. +44 1970 622764 Tudur Davies: itd@aber.ac.uk , tel. +44 1970 622813	
14 -17 Apr Nantes, France	10th Annual European Rheology Conference (AERC 2015) Organiser/Contact details: Michel Cloitre, Lionel Choplin, Jean-François Tassin Conference website: http://rheology-esr.net/events/aerc-2015-nantes/	
7- 9 Sept Coimbra, Portugal	IBEREO 2015 Challenges in rheology and product development Maria Graça Rasteiro (Chair) (University of Coimbra and CIEPQPF-UC) Conference website: http://www.uc.pt/en/events/ibereo15	
11 – 15 Oct Baltimore, Maryland USA	87th Annual Meeting of The Society of Rheology More information can be found at the SoR web page in due course.	

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