5TH LIQUID MATTER CONFERENCE

KONSTANZ, GERMANY
SEPTEMBER 14TH - 18TH, 2002

The Liquid Matter conferences are organised every three years under the auspices of the European Physical Society. In 2002 the 5th Liquid Matter conference took place in the beautiful city of Konstanz, on the edge of the Bodensee in southern Germany. The scientific sessions were held on the very pleasant campus of the University of Konstanz. These Liquid Matter conferences bring together diverse strands of the liquid matter community. They cover everything from simple and quantum liquids through to complex fluids and rheology, and it is a great pleasure to be able to report on some of the developments which may be of interest in the field of Applied Rheology.

The rheology session itself contained talks by Fuchs, Nagele, di Meglio and Porte. I shall leave discussion of M. Fuchs' contribution on glassy rheology to later. G. Nagele gave a theoretical talk on generalised Stokes-Einstein relations in charge stabilised colloidal suspensions, which may be useful to relate diffusion coefficients to dynamic shear viscosity. J. M. di Meglio described how his group has experimentally characterised the surface rheology of soap films and determined for example the two-dimensional analogue of the shear viscosity (as was explained elsewhere in the conference by H. Stone and D. Weaire, such surface rheological properties are important for foam drainage). Finally G. Porte talked about an interesting experimental system comprising an oil-in-water microemulsion plus hydrophobically end-capped water soluble polymers. The hydrophobes tend to be trapped inside the microemulsion droplets therefore the whole system forms a transient network. The rheology as a function of composition is quite remarkable, showing in places a Maxwell-like mono-exponential viscoelastic response, and in other places a Bingham-like yield stress at high shear rates, but there are also other regions where no steady shear could be maintained. It was speculated that the underlying flow curve could have a maximum in shear stress versus shear rate, making the system mechanically unstable in a certain range of shear rate. Needless to say, this contribution generated much debate amongst the shear-banding and non-linear rheology specialists! Finally, in the spirit of applied rheology, I should mention some beautiful experiments on tack and adhesion presented in a poster by S. Poivet and co-workers. They have characterised what happens as plates, with silicone oil in between, are pulled apart. They see a competition between a Saffman-Taylor fingering instability and cavitation / fibril formation as a function of separation velocity (experiments on more complex fluids are promised).

Outside of the above session, there were of course other contributions of interest. For example, friction mechanisms and interfacial slip at fluid-solid interfaces were the subject of a plenary talk by L. Leger. She demonstrated how fluorescent tracers with evanescent laser light could be used to determine the flow profile adjacent to a wall, and experimentally extract a wall friction coefficient. For polymer melts against polymer coated surfaces, strong non-linearities in the wall friction coefficient can be found as the polymers in the melt become disentangled from the surface polymers. For simple fluids (eg hexadecane on sapphire), there is some evidence for wall slip but the effect is destroyed by even very slight amounts of surface roughness.

One particularly striking theme of the conference is an emerging theoretical and experimental consensus on ageing and rheology in glassy systems. Structural glasses include dense colloidal suspensions, polymer melts, and certain molecular liquids, which exhibit common features like 'frozen' amorphous stuctures, diverging relaxation times, and tantalising thermodynamic signatures. They continue to be of interest to the liquid matter community, and indeed the problem

The medieval Konzil building at the harbour in Konstanz, where the welcome reception for the 5th Liquid Matter conference took place.

of the glass transition could be described as one of the greatest remaining puzzles in statistical physics. Glasses were represented in the rheology session by M. Fuchs who described the latest developments of mode coupling theory for sheared dense colloidal suspensions, giving a microscopic model for shear thinning exponents, Herschel-Bulkeley constitutive equation parameters, and explicit expressions for dynamical yield and normal stresses. Elsewhere J. L. Barrat in a plenary talk showed how a unified description of glassy behaviour, ageing, and non-linear rheology is now emerging. Ageing is the property that the longest relaxation time in the dynamics, as probed for example in the viscoelastic response or a light scattering experiment, grows with the time since the system was first prepared in the glassy state. Experimental results on ageing (including over-ageing) were presented at the meeting by V. Viasnoff and F. Lequex. They used light scattering to monitor the shear history dependence of structure in sheared dense colloidal suspensions. It is remarkable that the level of detail revealed in these experiments can be recovered almost in its entirety within the general framework of the so-called 'soft glassy rheology' (SGR) model [see Fielding SM et al: Ageing and rheology in soft materials, J. Rheology 44 (2000) 323-369] which extends an earlier 'trap' model of structural glasses by Bouchaud. Another novel conceptual direction was the idea of attractive glasses, presented by W. Poon, who showed how this idea might be used to understand the formation of particulate gels.

It is clear that there are some very interesting developments taking place in the liquid matter community at the moment, especially in the understanding of glassy systems. More generally the growing importance of soft matter (including biological soft matter) as a field in its own right can be recognised: there were at least 20 talks and more than 100 posters falling into this category. I am sure these developments will continue, so it only remains to advertise the 6th Liquid Matter conference which is scheduled to take place July 2-6, 2005, in Utrecht in the Netherlands.

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