

CPP 7 SYMPOSIUM Disperse Polymer Systems I

Time: Tuesday 09:30–12:15

Room: ZEU 160

Invited Talk

CPP 7.1 Tue 09:30 ZEU 160

Structure and interfacial rheology of aggregated two dimensional suspensions — ●JAN VERMANT¹, SVEN REYNAERT¹, MADIVALA BASAVARAJ¹, MOLDENAERS PAULA¹, and FRANSSAER JAN² — ¹Department of Chemical Engineering, K.U. Leuven, Belgium — ²Department of Metallurgy and Materials Science, K.U. Leuven, Belgium

Tailoring the structure and rheological properties of particle-laden interfaces is of importance in a number of practical applications such as the stabilization of emulsions, polymer blends and foams. In the present work, different methods are compared to generate weakly aggregated two-dimensional suspensions with controlled interactions. Adequate combinations of electrolyte and surfactant destabilized particulate monolayers, both at the water-oil and water-air interface. The structural and kinetic aspects of the induced structures are compared to the underlying changes in the interparticle interactions, and the conditions under which reproducible results could be induced are reported and discussed. Also effects of particle shape are explored. Secondly, a magnetic needle interfacial rheometer is used to characterize the rheological behaviour of the particle monolayer. Preliminary results show the presence of a two-dimensional yield stress and control over the surface rheology much like for the three dimensional weakly aggregated suspensions.

CPP 7.2 Tue 10:00 ZEU 160

The Influence of Triblock Copolymers and Low Molecular Weight Homopolymers on the Structure of Microemulsions — ●TINKA SPEHR and BERND STÜHN — Institute of Condensed Matter Physics, Technical University Darmstadt, D-64289 Darmstadt

We use small angle X-ray scattering (SAXS) to study a microemulsion consisting of water droplets coated by the anionic surfactant AOT dispersed in decane. At a constant water-to-AOT ratio the dependence of droplet radius, polydispersity and structure factor of the pure microemulsion on droplet density and temperature were investigated. Unexpectedly the radius of the water core decreases with increasing droplet volume fraction. At a volume fraction of droplets of ten percent we added different amounts of the amphiphilic triblock copolymer PEO-PI-PEO, which has hydrophilic headgroups and a hydrophobic middle part (PEO: polyethyleneoxide, PI: polyisoprene). There is clear evidence for an increasing crosslinking of the droplets with increasing polymer concentration. Already a low number of polymer molecules per droplet causes network formation as opposed to the complementary system (o/w-microemulsion with nonionic surfactant) for which the interconnection of the droplets via an amphiphilic triblock copolymer has previously been shown [1]. Structure factors were extracted from the SAXS profiles. Furthermore the effect on droplet structure caused by the incorporation of low molecular weight PEO homopolymers will be discussed. [1] M. Schwab and B. Stühn; J. Chem. Phys. 14, 6461 (2000)

CPP 7.3 Tue 10:15 ZEU 160

Correlation between morphology, rheology and foamability of immiscible PPE/SAN blends — ●HOLGER RUCKDAESCHEL¹, ANDREAS GOELDEL¹, SAMPATH BANGARU¹, JAN K.W. SANDLER¹, VOLKER ALTSTAEDT¹, HOLGER SCHMALZ², and AXEL H.E. MUELLER² — ¹Polymer Engineering, University of Bayreuth, Universitaetsstrasse 30, 95447 Bayreuth, Germany — ²Macromolecular Chemistry II, University of Bayreuth, Universitaetsstrasse 30, 95447 Bayreuth, Germany

The morphology as well as the interfacial properties of immiscible polymer blends are of key importance for the processing behaviour and the materials performance. In this particular study, both phenomena were analysed in detail for blends of poly(2,6-dimethyl-1,4-phenylene ether) (PPE) and poly(styrene-co-acrylonitrile) (SAN). Melt-processing and batch-foaming were used as processing techniques. The morphology development following melt-processing revealed a strong dependence on the blend composition as well as on the viscosity ratio between the constituents. Subsequent batch-foaming of the two-phase blend highlighted further special features which could be correlated both to the melt-elongational behaviour and to the blend morphology. Furthermore, the addition of further components was identified to be one efficient route to adjust the rheological as well as the interfacial properties of the blend. In particular, the effect of triblock terpolymers as compatibilising agents

as well as the effect of a selectively miscible third blend component were demonstrated. This final approach ensures to control both the morphology development and the foamability of PPE/SAN blends.

CPP 7.4 Tue 10:30 ZEU 160

Linear viscoelastic shear oscillation investigations of melt mixed blends of polycarbonate with multiwalled carbon nanotubes and polyethylene — ●PETRA PÖTSCHKE and MAHMOUD ABDELGOAD — Leibniz Institute of Polymer Research Dresden, Hohe Strasse 6, 01069 Dresden, Germany

The concept of double percolation was adapted to melt mixed blends of a conductive polycarbonate composite containing 2 wt% multiwalled carbon nanotubes (PC-2NT) and polyethylene (PE). The blends were melt mixed using a small scale twin-screw compounder over the whole composition range. This study presents linear viscoelastic shear oscillation tests on these blends performed at 280°C. We investigated the question, if melt rheological measurements are able to detect the co-continuous composition range in such systems unequivocally. The percolation of the nanotubes in PC is clearly detected by an increase in complex viscosity by lowering oscillation frequency and the formation of a plateau of G' at low frequencies. Viscosity and moduli of the selected high density PE are higher than those of PC-2NT which gives favourable conditions for the formation of a continuous PC-2NT phase at low concentrations. Whereas all blends show values of G'' between those of the parent materials, some of the composites in the middle concentration range exceed the parent values of G' and complex viscosity, especially at low frequencies. It was found from morphological studies and selective extraction experiments that the co-continuous structure formation starts at 20 vol% PC-2NT. At this composition, we also find maximum values of G', G'' and complex viscosity over the whole frequency range.

— 15 min. break —

Invited Talk

CPP 7.5 Tue 11:00 ZEU 160

Non-linear rheological properties of glassy colloidal dispersions — ●MATTHIAS FUCHS¹, OLIVER HENRICH¹, MICHAEL CATES², MATTHIAS BALLAUFF³, JEROME CRASSOUS³, and FATHOLLAH VARNIK⁴ — ¹Fachbereich Physik, Universitaet Konstanz — ²School of Physics, The University of Edinburgh — ³Physikalische Chemie I, Universitaet Bayreuth — ⁴MPI fuer Eisenforschung, Duesseldorf

Soft materials, such as particle dispersions, quite universally exhibit a strongly decreasing viscosity as function of shear rate ('shear thinning'). We study theoretically an universal mechanism explaining the reduction of the viscosity or stress in such disordered colloidal systems.

Our first-principles approach [1] to the non-linear rheology of dense colloidal suspensions predicts an universal transition between the yielding of amorphous solids and non-Newtonian (shear-thinning) fluid flow. The approach builds upon a microscopic description of structural relaxations in quiescent suspensions provided by the mode coupling theory. The advection of density fluctuations is the dominant mechanism captured, while hydrodynamic interactions, non-linear flow profiles and ordering phenomena are neglected. Comparisons with experiments in model colloidal dispersions support the approach [2], as do computer simulations of Newtonian supercooled liquids, which find a finite dynamic yield stress at low temperatures [3].

[1] M. Fuchs and M. E. Cates, Phys. Rev. Lett. 89, 248304 (2002); Faraday Discuss. 123, 267 (2003); J. Phys.: Condens. Matter 17, 1681 (2005)

[2] M. Fuchs and M. Ballauff, J. Chem. Phys. 122, 094707 (2005)

[3] F. Varnik and O. Henrich, submitted (2005)

CPP 7.6 Tue 11:30 ZEU 160

2-Fluid Description of Disperse Polymer Systems — ●HARALD PLEINER¹ and JAMES L. HARDEN² — ¹Max Planck Institute for Polymer Research, Mainz — ²Johns Hopkins University, Baltimore

We combine the recently developed nonlinear hydrodynamic description of viscoelastic fluids [1] with a general 2-fluid hydrodynamics of 2-component and 2-momentum systems [2] to give a generalized-hydrodynamics model for disperse polymers. The former covers the usual non-Newtonian effects, like shear thinning, strain hardening,

stress overshoot, normal stress differences and non-exponential stress relaxation, while the latter deals with the relative velocity and its relaxation, the stress division between the two subsystems, the convective velocity problem and the anomalous concentration dynamics.

[1] H. Pleiner, M. Liu and H.R. Brand, *Rheologica Acta*, **39**, 560 (2000) and **43**, 502 (2004). [2] H. Pleiner and J.L. Harden, in *Nonlinear Problems of Continuum Mechanics*, Special issue of *Notices of Universities. South of Russia. Natural sciences*, p.46 (2003) and cond-mat/0404134.

CPP 7.7 Tue 11:45 ZEU 160

Flow behavior of two-phase polymer blends — •BERNHARD A. WOLF, VERENA E. ZIEGLER, and MATTHIAS SCHNELL — Institut für Physikalische Chemie der Johannes Gutenberg-Universität Mainz, Germany

The processing of polymer mixtures (for instance in extruders at high temperatures) is usually taking place in the heterogeneous state. Under these conditions two liquid phases (the melts of normally almost immiscible polymers) coexist and the viscosities of these mixtures are not only determined by the properties of the components, but modified considerably by the morphology of the system.

The lecture demonstrates for two binary polymer blends of different degrees of incompatibility [polyethylene oxide/poly(dimethylsiloxane) and poly(dimethylsiloxane)/poly(dimethylsiloxane-*ran*-methylphenylsiloxane)], how the spatial arrangement of the coexisting phases (as observed with an optical microscope during shear) influences the viscosities and the storage plus loss moduli of the mixture. Furthermore it deals with the changes resulting from the addition of compatibilizers. The measurements demonstrate that the viscosities as well as the storage moduli are normally markedly larger than predicted under the assumption of additivity of the properties of the pure components. The variations of these quantities with blend composition and with shear rate indicate under which conditions droplet/matrix structures or co-continuous morphologies are stable.

CPP 7.8 Tue 12:00 ZEU 160

Shear and melt elongation of polycarbonate/multiwalled carbon nanotubes composites — •U.A. HANDGE¹ and P. PÖTSCHKE² — ¹Institute of Polymers, Dept. of Materials, ETH Zürich, 8093 Zürich, Switzerland — ²Leibniz Institute of Polymer Research Dresden, Dept. of Polymer Reactions and Blends, Hohe Strasse 6, 01069 Dresden, Germany

The discovery of carbon nanotubes initiated intensive research activities which also led to applications of these remarkable molecules. For example, composites that consist of commercial polymers and carbon nanotubes can serve as possible antistatic or conductive materials. Processing of polymers is intimately associated with their rheological properties. In this work, we studied the rheological properties of pure polycarbonate and a polycarbonate/multiwalled carbon nanotubes (PC/MWCNT) composite in the melt. The weight fraction of the multiwalled carbon nanotubes for the composite was 2 wt.% and the test temperature was $T = 190^\circ\text{C}$. We performed linear viscoelastic shear oscillations and elongational tests that were followed by recovery experiments using the uniaxial elongational rheometer RME. The analysis of the linear viscoelastic shear oscillations of the composite revealed that at low and large frequencies elastic forces dominated. In melt elongation, the transient viscosity of the PC/MWCNT composite did not differ much from the elongational viscosity of pure polycarbonate. However, the recovered stretch of the composite was significantly smaller than the corresponding values for pure polycarbonate. We discuss these results by taking into account the extension of the macromolecules in elongational flows and the yield stress of the composite.