CPP 9 SYMPOSIUM Disperse Polymer Systems II

Time: Tuesday 14:00–17:00 Room: ZEU 160

Invited Talk

CPP 9.1 Tue 14:00 ZEU 160

Rheology and Structure Kinetics of Filled Polymer Nanocomposites and Networks — •Gert Heinrich — Leibniz Institute of Polymer Research Dresden, Hohe Strasse 6, D-01069 Dresden, Germany

Dynamic-mechanical and rheological studies provide an excellent access to the morphology and dynamics of complex filled polymers and to tests of corresponding models. Based on several dynamic-mechanical and shear flow experiments we discuss common features of structural filler reorganization in diverse filled elastomers and in polymer nanocomposites consisting of a thermoplastic melt (LDPE) and nanofillers (Mg/Al based Layered Double Hydroxide). In the elastomer case the discussion is possible when studying the kinetics of the modulus recovery with experimental set-ups where the stiffness response on repeated amplitude steps is measured. In the stress growth experiment the nanocomposites exhibit a pronounced non-linear behaviour observed as a shear overshoot. The time, at which the overshoot appears, decreases as the LDH loading increases. This effect can be described using the Wagner model, in which the non-linearity parameter increases with the particle loading and the relaxation time of the system decreases with the increase in shear rate. Additionally, in the high loaded nanocomposites, we observe shear oscillations presumably caused by the presence of a LC texture formed by the anisotropic filler particles. We propose that LDH particles in the PE melt are organised in domains (perhaps, orientational) which size is drastically diminished upon shear application.

CPP 9.2 Tue 14:30 ZEU 160

A microscopic look at the reinforcement of silica filled rubber — •Ekkehard Straube[1], Alberto Botti[2], Wim Pyckhout-Hintzen[3], and Dieter Richter[3] — [1]Uni Halle-Saale — [2]Uni Roma TRE, Italy — [3]Forschungszentrum Jülich

The deformed state of filled rubbers under uniaxial strain has been investigated by a combination of SAXS and SANS. Using an extraction procedure the single chain scattering behavior as well as filler properties could be obtained. For the first time the deformation of the rubbery matrix on the length scale of a network chain is determined and no overstrain is observed. Likewise, the determination of filler deformation and filler destruction enables a first microscopic observation of possible mechanisms of the stress-softening Mullins-effect.

CPP 9.3 Tue 14:45 ZEU 160

Structure Property Relationships of Different Polymer Based Nanocomposites — •Andreas Schönhals, Ning Hao, Martin Böhning, and Harald Goering — Bundesanstalt für Materialforschung und prüfung, Unter den Eichen 87, D 12205 Berlin

Polymer based nanocomposites continue to receive tremendous attention for different applications. They show remarkable property improvements (increased tensile properties, decreased gas permeability, decreased solvent uptake, increased thermal stability and flame retardance) when compared to conventionally * scaled composite materials. Different polymer based nanocomposites are prepared where polypropylene, polycarbonate and polystyrene are used as polymer matrices. Montmorillonite clay, silicium carbide, multiwaled carbon nanotubes and polyhedral oligomeric silsesquioxanes (POSS) are used as nanoparticles. The property structure relationships of these nanocomposites are investigated by dielectric spectroscopy and gas transport measurements (permeation, sorption). The results are discussed with regard to the nanofiller dispersion and the phase structure of the nanocomposites. Special attention is paid to characterize the interfacial region between the polymeric matrix and the different nanofillers. This regards also to estimate the length scale of interaction between the nanoparticles and the matrix.

CPP 9.4 Tue 15:00 ZEU 160

Preparation and Viscoelastic Properties of Fibre Networks — •Christian Friedrich, Benjamin Grimminger, and Ciprian Iacob — Freiburg Materials Research Center (FMF), Albert-Ludwigs-Universität, Stefan-Meier-Str. 21, 79104 Freiburg

The dispersion of carbon nanotubes (CNTs) is of crucial importance for the understanding of their mechanical properties as well as for the enhancement of their application potential. Therefore, we dealt with methods enabling the molecular dispersion of CNTs in appropriate matrices. We found that CNTs are best dispersed in ionic liquids such as 1-butyl 3-methyl imidazolium tetrafuoroborate (BMIBF4) together with cosolvents and surfactants. The obtained dispersions were characterized morphologically and rheologically. For the highest concentrations, the rheological response of these compounds resembles that of fibre networks. Using models developed for semiflexible biopolymer networks we can understand the obtained results quantitatively. In contrast to actin-networks, the CNT-networks display rather energetic elasticity than entropic. We discuss the reasons for this peculiarity.

CPP 9.5 Tue 15:15 ZEU 160

Structure creation in pressure sensitive adhesives — •E. Maurer[1], S. Loi[1], D. Wulff[2], N. Willenbacher[2], M. Ruckpaul[2], and P. Müller-Buschbaum[1] — [1]TU München, Physik-Department E13, James-Franck-Str. 1, D-85747 Garching, Germany — [2]BASF Aktiengesellschaft, Carl-Bosch-Str.38, D-67056 Ludwigshafen, Germany

Pressure sensitive adhesives (PSA) play an important role as materials in the glue industry as well as in everyday life. The adhesion properties are depending decisive on the bonding history, which means parameters like contact pressure and time, temperature and debonding rate. Previous experiments were restricted to optical investigations addressing the macroscopic fibril structure. With ultra small angle x-ray scattering (USAXS) the microscopic length scales of the polymeric material have been investigated in the presented work. For this purpose an apparatus, combining both, a reproducible mechanical experiment of adhesive bonding and debonding and the requirements of in-situ scattering experiments, was built. Due to the weak scattering synchrotron radiation was required. The observed scattering signals show pronounced features originating from a highly ordered substructure of the adhesive material [1]. Several types of PSAs, homopolymers as well as statistical copolymers have been investigated.

[1] E.Maurer, S.Loi, D.Wulff, N.Willenbacher, P.Müller-Buschbaum; Physica B 357, 144 (2005)

— 15 min. break —

Invited Talk

CPP 9.6 Tue 15:45 ZEU 160

Microstructure design for food applications — •Bettina Wolf — Corporate Research Colworth, Unilever Colworth Park, Sharnbrook, Bedford MK44 1LQ, UK

In the food industry it is of great importance to control the stability and texture of structured products. Traditionally, biopolymers and more often mixtures thereof are used. One of the factors controlling the behaviour of such materials is the morphology of the biopolymer phases, being able to control and manipulate this is thus advantageous for product texture / property control. Of particular interest to us has been for some time to establish routes for influencing the morphology of particulate biopolymer gel phases, and to study the influence of particle shape and particle material properties on the rheological behaviour. Routes developed are based on permanently arresting morphologies developed in shear flow allowing for formation of gelled particles of arbitrary shape as well as ellipsoidal and cylindrical gelled particles. Other research interests in the field of microstructure and rheology concern the understanding of individual microstructure components on the rheological behaviour of full product formulations, development of appropriate instrumental techniques for the product itself as well as understanding its in-use behaviour.

CPP 9.7 Tue 16:15 ZEU 160

What is the link between gelation and partial solubility in the galactomannan polysaccharides? — •Michael Pollard and Peter Fischer — Laboratory for Food Process Engineering, Swiss Federal Institute of Technology, Zürich CH-8006

We are interested in the structure-property relations of the galactomannan storage polysaccharides found in the endosperm of Legumes. These nonionic, linear polysaccharides are used as thickeners/stabilizers, cogellants, and fat replacers in ice creams, sauces, and other food products. The primary biosynthetic product is a poly((1-4)-beta-D-mannose) having degree of polymerization ˜1000, with a statistical distribution of single-unit (1-6)-alpha-D-galactose side groups. These side-groups confer aqueous solubility via H-bonding at degrees of substitution greater than 20%; linear mannans are otherwise water-insoluble "cellulosic" polymers.

Locust Bean (Ceratonia siliqua) galactomannans display temperature-dependent aqueous solubility and a tendency to form weak gels without co-gellants present. Both properties are exploited to provide triggered viscosity increases and enhanced gel properties in ready-mix and frozen products, but the physical basis is poorly understood. The low galactose content and apparent statistical-blocky character of their distribution both probably play a role in the dissolution and gelation properties, but quantitative links have been very difficult to establish. We argue here that dissolving LB galactomannans effectively fractionates by chemical composition and possibly chain length, implying that the gels observed upon cooling may be a manifestation of very slow L-L demixing.

CPP 9.8 Tue 16:30 ZEU 160

Structure and dynamics of asymmetric block copolymers in thin films — •Larissa Tsarkova, Andriana Horvat, and Georg Krausch — Physikalische Chemie II, Universität Bayreuth, 95444 Bayreuth

With tapping mode scanning force microscopy (SFM) we study the development of non bulk morphologies in a layer of polystyrene-*block*-polybutadiene cylindrical domains (C) supported by two chemically different substrates. The mechanism of the thickness induced phase transition shows clear dependence on the substrate induced surface field. On a neutral surface (carbon coating) ordered clusters of the perforated lamella (PL) phase coexist with grains of the C phase. A fraction of the non bulk PL morphology reflects the thickness gradient within a single layer of structures. A strong surface field largely suppresses the mobility of the majority polybutadiene component on the silicon substrate resulting in a C to lamella phase transition. The important contribution of the chains lateral mobility on the structural development is demonstrated by in-situ SFM measurements of the microdomain dynamics. Computer simulations based on dynamic density functional theory (MesoDyn) are in a good agreement with the experimental observations.

CPP 9.9 Tue 16:45 ZEU 160

In-line monitoring of dispersion of nanofillers in polymer melts by optical spectroscopy — •Bernd Steinhoff and Ingo Alig — Deutsches Kunststoff-Institut Darmstadt, Schlossgartenstr. 6, D-64289 Darmstadt, Germany

For polymers a pronounced enhancement of material properties such as toughness, thermal stability or permeability can be obtained by adding small amounts of nanosized fillers. For the improvement of such properties a nanoscale dispersion within the polymer matrix is crucial. For effective processing reliable and rapid process control is therefore essential. Optical spectra of dispersions exhibit in addition to the absorption bands a contribution from light scattering. Since light scattering is sensitive to optical heterogeneities, morphological information can be obtained from that scattering background. Based on this consideration optical spectroscopy has been tested for in-line control of the degree of dispersion of nanofillers in polymer melts during extrusion. The melt were extruded through a slit die equipped with UV/VIS and NIR transmission probes. The degree of dispersion was varied by changing the mixing conditions (e.g. direct melt mixing or dilution of a masterbatch) and the amount of a compatibilizer. Due to electron microscopy and x-ray analysis it has turned out that from the scattering background the average size of the dispersed particles can be extracted.