

2ND BAYREUTHER KOMPETENZTAGE:
RHEOLOGY, MORPHOLOGY AND FRACTURE MECHANICS OF POLYMERS

BAYREUTH, GERMANY
NOVEMBER 28 – 30, 2011

Figure 1:
Participants of the workshop “Morphology, mechanics and rheology of polymers” in Bayreuth in November 2011 (Photograph by Alexander Kutter).



The second workshop on theoretical foundations and experimental methods of polymer science took place in Bayreuth from November 28–30. The workshop “Rheology, morphology and fracture mechanics of polymers” was jointly organized by the Department of Polymer Engineering of the University of Bayreuth, the Neue Materialien Bayreuth GmbH, Anton Paar GmbH Germany (Ostfildern) and WEE-Solve GmbH (Mainz). It took place at the competence center Neue Materialien Bayreuth GmbH (NMB). The workshop was addressed to all users of mechanical and rheological methods in academia and industry. Around 45 participants joined the three days-course.

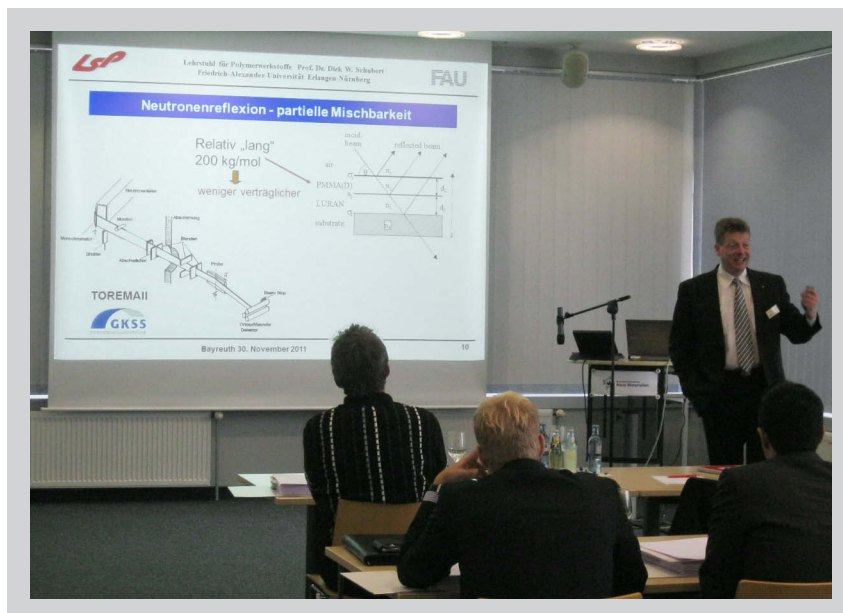
After a welcome, Professor Volker Altstädt (Polymer Engineering and NMB) opened the workshop and gave an introduction into the experimental facilities and research in the field of polymer science in Bayreuth. Then Dr. Alexander Kutter explained the foundations of polymer rheology. He explained the different measurement modes and the experimental apparatus for determining the rheological properties of complex fluids. Both oscillatory and rotational rheometry were topics of his lecture. Dr. Andreas Eich

(WEE-Solve GmbH) showed in an illustrative lecture how shear oscillations in the linear viscoelastic range can be applied and reasonably interpreted. The time-temperature superposition principle and the determination of the relaxation time spectrum were discussed in detail. In extensional flows, polymer melts can be deformed to a large stretch ratio. The determination of the transient extensional viscosity using various rheometers was discussed by Dr. Ulrich Handge (Helmholtz-Zentrum Geesthacht). Optimal sample preparation and accurate measurements were topics in his lecture. The method of dynamic-mechanical-thermal analysis (DMTA) is frequently applied in order to determine the thermal transitions of polymeric materials. Therefore two lectures were devoted to this highly relevant measurement technique. First the basics of DMTA measurements were explained by Dr. Alexander Kutter. In the following lecture, Dr. Helmut Steininger (BASF SE) illustrated different aspects which have to be taken into account for a correct interpretation of experimental DMTA results. At the end of the first day, the discussions were intensified during a “Get together” with beer & pretzels.

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The second day of the workshop was devoted to the discussion of the viscoelastic properties of special polymer systems. The accurate determination of the viscosity of polymer solutions requires special measurement techniques. In his lecture, Dr. Andreas Eich presented several methods in order to determine the viscosity of polymer solutions. Polymer dispersions are another important example for viscoelastic fluids. They play a dominant role in industrial applications, such as paint coatings. Dr. Meik Ranft (BASF SE) illustrated the characteristic rheological properties of polymer dispersions. Multicomponent polymeric materials are another group of industrially relevant viscoelastic materials. The rheology of multiphase polymer blends was the topic of the lecture of Professor Bernhard A. Wolf (Johannes-Gutenberg University Mainz). In his lecture, he showed the influence of the interfacial tension on the flow properties and discussed coalescence and breakup phenomena in polymer blends. The addition of nanoparticles strongly influences the rheological properties of polymers. The lecture of Dr. Dick Dijkstra (Bayer MaterialScience AG) was devoted to the flow and electrical properties of composites of polycarbonate and carbon nanotubes. Electrical conductivity and rheological quantities can be measured using a special setup in order to quantify the shear-induced breakup and the recovery of the nanotubes network. The following lecture was also devoted to polymer melts which were filled with nanoparticles. Professor Christian Friedrich (Freiburg Materials Research Center) discussed how linear viscoelastic shear oscillations of such nanocomposites can be thoroughly interpreted. In particular, he discussed the transition from a solid to a liquid in these systems. Dr. Tom Scherzer (Leibniz-Institute for Surface Modification e.V.) demonstrated how rheological methods can be coupled with other experimental techniques using UV-measurements. The last scientific lecture of the second day was given by Dr. Alexander Kutter. In his lecture, he showed the relevance of dielectric measurements and the potential of the combination of rheological and dielectrical methods. After the scientific presentations of the second day, the participants of the workshop had the possibility to see the experimental facilities of the Neue Materialien Bayreuth GmbH in a guided tour. In the evening, a tour through Maisel's beer museum and a dinner

in the atmosphere of the old brewery were part of the program.

On the third day of the workshop, morphological issues of polymers and mechanical properties were addressed. Professor Goerg Michler (Martin Luther University Halle-Wittenberg) presented in a stimulating lecture the methods of electron microscopy in order to determine the morphology and microstructure of polymers. The relevant aspects of polymer morphology and interesting experimental results, which were obtained by electron microscopy, were discussed by him. An overview on the foundations of the fracture mechanics of polymer materials was presented and the relevance for applications was discussed by Professor Volker Altstädt. Interfacial phenomena play an important role in polymer systems. The properties of interfaces can be determined using scattering methods which was shown by Professor Dirk Schubert (Friedrich-Alexander-University of Erlangen-Nürnberg). Finally, Dr.-Ing. Bahman Sarabi (UL International TTC GmbH) demonstrated the relevance of rheological and mechanical properties for technological applications and the power of artificial neural networks for their determination.

In summary, a workshop which covered a large range of topics in the field of viscoelastic and morphological properties of polymeric materials took place in Bayreuth. The lectures demonstrated that rheological, mechanical and morphological properties are strongly linked, and their interrelation has to be taken into account for processing of polymers. The workshop was organized by V. Altstädt (altstaedt@uni-bayreuth.de), A. Eich (andreas.eich@wee-solve.de), U. Handge (ulrich.handge@hzg.de), and M. Schäffler (michael.schaeffler@anton-paar.com).

Ulrich Handge

Figure 2: Dirk Schubert presents the determination of interfacial properties via neutron scattering (Photograph by Alexander Kutter).