Conference Report

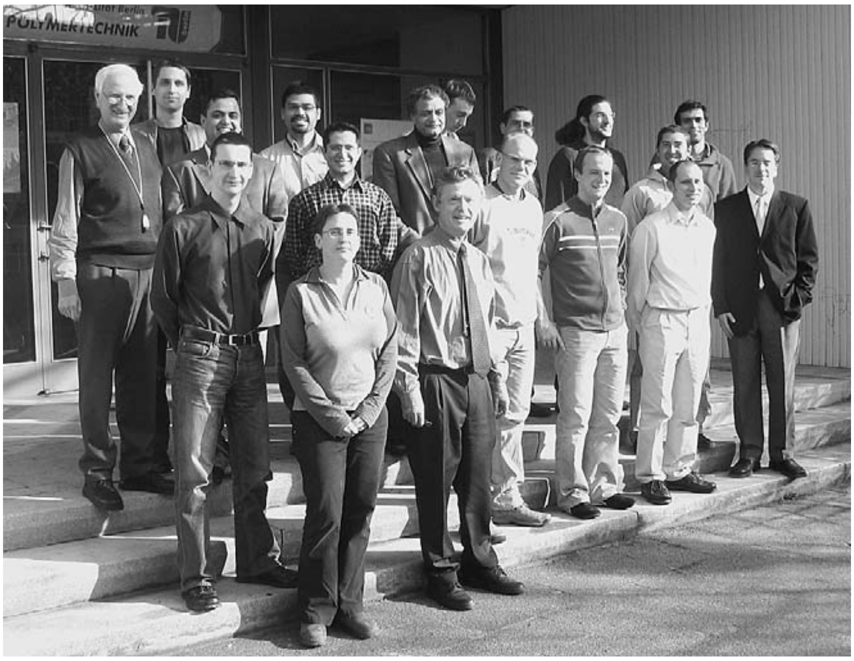
Amherst Rheology Course ARC2005 "Merging Experiment with Theory in Rheology"

7.-8.4.2005
Technical University Berlin, Germany

The second Amherst Rheology Course (ARC2005) met in Berlin/Germany at the Institute of Professor Manfred Wagner at the Technical University Berlin. ARC2005 was jointly organized by H. Henning Winter (USA) and Manfred Wagner. Two more instructors joined the team: Richard Blackwell (UK), Jonathan Rothstein (USA). Fifteen rheologists participated in the two-day course. The main objectives of the course were to give a broad overview of experimental and theoretical rheology, to provide participants with the tools to obtain quantitative answers in rheology, and to develop understanding for the underlying concepts that lead to the quantitative results.

Short lectures on rheology were combined with hands-on tutorials. Lectures were backed up with calculations that participants performed by means of an integrated, state-of-the-art computational platform called IRIS (for "Integrated Rheology Interactive Software"). The IRIS platform is dedicated to rheology. It connects a wide range of highly specialized software modules that perform calculations and return the corresponding results to a central graphics screen. IRIS fully supports the analysis of experimental work but also invokes theory for predicting the dynamics of polymers and food materials. Seemingly disparate rheological theories and experimental observations get linked and explored. This often leads to unexpected insights and questions. On the graphics screen of IRIS, the user analyses rheological experiments, performs calculations with the help of modules, plots the results, generates new data files, and continues with further calculations or with writing a report (for example). Data remain in the background but are available at any state of the work.

Figure 1:
1. ARC2005 participants.



The rheology platform allows the user to compare experiments (dynamic mechanical, steady shear, startup of shear, startup various extensional flows, molecular weight distribution) with predictions from a range of theories: classical theories (Maxwell, Rouse, Lodge, Doi-Edwards), two advanced polymer dynamics theories: the 'tube dilation' theory of McLeish and coworkers (McLeish et al. 1998, 1999; Milner and McLeish 1997, 1998; Blackwell et al. 2001; Pryke et al. 2002) and the "molecular stress function" theory of Wagner (Wagner 2003). New is the simulation with "NAPLES" (Masubuchi et al. 2003). Also new is the module for predicting the molecular weight distribution of linear polymers from their dynamic mechanical data; it was written by Nobile and Cocchini (2001, 2003) and adapted to the platform by Mours.

The platform technology has the objective of merging the diverse knowledge in rheology into a unifying workspace that seamlessly connects modules of different kind (experiments, theories, simulation, molecular structure). Progress is expected from this bundling of many tasks onto a single platform from which experimental and theoretical information can be disseminated easily to a broad user group of scientists and engineers. For industry, the novel rheology tools provide an interactive environment by defining a common language that is independent of individual company departments. For example, product design, production, and technical marketing departments can efficiently collaborate to meet a customer's requirements. This can now be done rapidly, even over large geographical distances. The new way of sharing rheological information will potentially change the industrial production and application of complex materials.

The course started on April 6, 2005, with a welcome reception where the course participants could get acquainted with each other. On April 7, the participants learned to work with IRIS (Winter) and performed standard data analysis tasks such as data input, time-temperature superposition manually and computer optimized, spectrum cal-

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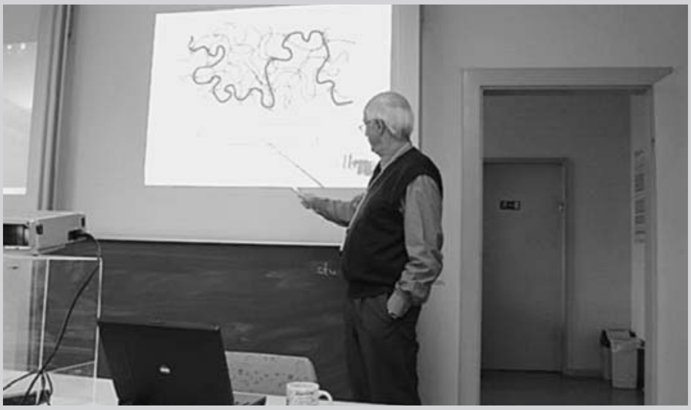

Figure 2 (left): M. Manfred Wagner lecturing.

Figure 3: Richard Blackwell's tutorial.

culation, expression of data in the wide range of linear viscoelastic material functions. Rothstein explained the fundamentals of extensional flow experiments and showed data on complex fluids. In the afternoon, Blackwell introduced the tube dilation theory and performed exercises in a practice session. The main topic was the relation between molecular architecture and rheology. The entire group compared linear viscoelastic data of model polymers with predictions they made with the tube dilation module.

Lectures and tutorials continued on the second day (April 8). Wagner introduced the fundamentals of polymer dynamics theories and followed up with tutorials on molecular stress function theory, where he presented extensional flow data and predicted extensional flow behavior for a wide range of polymers. Winter modeled steady shear flow (time-temperature superposition and fitting to the most common functions) and yield stress functions in an interactive tutorial with the group. Rothstein explained optical methods for rheology. Winter practiced the second shift option (same as time temperature superposition but for parameters such as concentration, molecular weight, etc.). Winter presented time resolved mechanical spectroscopy and used gelation as example in a tutorial. The course ended with extensive discussions and improvised rheological calculations.

Amherst Rheology Course (ARC2006) will convene again in June 2006, in Amherst, Massachusetts, USA. Information can be found at http://rheology.tripod.com/ARC.htm.

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