Johannes Gutenberg-University Mainz

Institute for Physics

Lecture

Introduction to Polymer Physics II
(3 SWS+ lab course)

PD Dr. Silke Rathgeber

1. Polymer Dynamics

1.1 Fluctuation-Dissipation Theorem
1.2 Dynamic structure factor of a Gaussian chain
1.3 Rouse model
1.4 Zimm model
1.5 Reptation model

2. Rheology (mechanical spectroscopy) & Viscoelasticity

2.1 Definition rheological quantities: stress, deformation, shear rate etc.
2.2 Ideal elastic & ideal viscous material: Hookean solid & Newton fluid
2.3 Viscoelastic material: Voigt-Kelvin solid & Maxwell fluid
2.4 Linear Viscoelasticity: superposition principle & oscillatory shear
2.5 Rheological test modes
2.6 Predictions of Rouse-, Zimm- und Reptation model
2.7 Deborah number, time-temperature superposition principle

3. Glass Transition & Glassy State

3.1 Thermodynamic theory of Gibbs-DiMarzio & Adam-Gibbs
3.2 Free volume theory
3.3 William-Landel-Ferry-equation
3.4 Glass transition temperature T_g and its determination
3.5 Factors influencing T_g and molecular weight dependence

PD Dr. Silke Rathgeber
Johannes Gutenberg-University Mainz
Institute for Physics – KOMET 331
Staudingerweg 7
55099 Mainz
Germany

phone: +49 (0) 6131/ 392-3323
Fax: +49 (0) 6131/ 392-5441
email: s.rathgeber@uni-mainz.de
webpage: http://www.cond-mat.physik.uni-mainz.de/~rathgebs/

4. Dielectric Spectroscopy

4.1 Definitions: electric dipole, polarization, electric field strength, dielectric displacement, dielectric constant & susceptibility, different types of polarization

4.2 Response types: dielectric relaxation (Debye relaxation, models for Non-Debye relaxation) and conduction

4.3 Classification of experimental methods: broadband dielectric spectroscopy and time-domain dielectric spectroscopy

4.4 Applications: dynamic glass transition and polymer dynamics

4.5 Comparison dielectric and mechanical spectroscopy

5. Networks & Rubber Elasticity

5.1 Comparison of properties: metal, gas, polymer network

5.2 Materials & synthesis

5.3 Elemental statistical theory for an ideal network

5.4 Affine network model

5.5 Phantom network model

5.6 Mooney-Rivlin theory

5.7 Comparison between theories by means of simple deformations

5.8 Real networks

5.9 Network swelling

Lab course (5 days):

1. Rheology
2. Static and Dynamic Light Scattering
3. Dielectric Spectroscopy
4. Polarization Microscopy or Fluorescence Correlation Spectroscopy (with short theoretical introduction into the method)
5. Data analysis and discussion

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