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Links to profiles:

https://www.itcp.kit.edu/wilhelm/english/manfred_wilhelm.php

www.rheo-chalmers.se

Description:

This short course will focus on some of the most common spectroscopic tools that can be combined with rheological measurements.

The first part (lecture 1 and 2) will focus on dielectric spectroscopy (BDS), infrared spectroscopy (IR) and time domain nuclear magnetic resonance spectroscopy (NMR). As rheology will be known by the audience, the focus will be on the different spectroscopies: molecular origin, related time and length scales and the experimental set-up to conduct these spectroscopic methods within a rheometer. What type of useful information can be gained? At the end of the first two lectures a presentation about current results of our group related to Rheo-NMR, Rheo-dielectric and Rheo-IR combinations will be given. This will display the strong interaction between molecular structure, molecular dynamics on one side and mechanical properties on the other side. One of the main points is that mechanical properties have their root in the molecular structure and local dynamics.

In the second part (lecture 3 and 4) we will present an overview of rheo-optical methods and light-matter interaction, with a particular emphasis on hierarchical material systems anisotropy. Linear birefringence and linear dichroism will be presented as a general framework for anisotropy and absorption, relation to anisotropy and the stress-optical law. Rheo - polarized light imaging (PLI) and polarization imaging (PI) will be presented from macroscopic retardance mapping to quantitative orientation fields, and their extension to circular birefringence/dichroism in chiral and optically active systems. This will be followed by an overview of rheo-scattering techniques, with an emphasis on rheology combined with small-angle x-ray scattering (SAXS). Data processing will also be addressed, with a special focus on anisotropy. Several science cases will be thereafter presented.

The course may contain a few live demos and elements of augmented reality: so get ready for a deep-dive adventure into combined rheological methods!

Course outline: 4 lectures, 1.5 h x 4

Lecture 1. (M. Wilhelm)

- Broadband Dielectric spectroscopy (BDS)
- Infrared spectroscopy (IR)

Lecture 2. (M. Wilhelm)

- Nuclear magnetic resonance spectroscopy (NMR), with a focus on time domain NMR
- Research cases for Rheo-BDS, Rheo-IR and Rheo-NMR

Lecture 3. (R. Kádár) Rheo-optics, structure and anisotropy

- Overview of rheo-optical methods and light-matter interaction, especially in hierarchical systems
- Linear birefringence (LB) and linear dichroism (LD) as a general framework for anisotropy in refractive index and absorption; relation to molecular orientation and stress-optical law; circular birefringence/dichroism
- Rheo - Polarized Light Imaging (PLI) and Polarization Imaging (PI): from macroscopic retardance mapping to quantitative orientation fields.
- overview of rheo-scattering techniques, fundamentals of small- and wide-angle X-ray scattering (SAXS and WAXS)
- structure and anisotropy from radial and azimuthal integration, anisotropy parameters

Lecture 4. (R. Kádár) Method development and case studies for multiscale analysis

- Rheo-PLI/PI-SAXS and the propagation of orientation across lengthscales
- TC-PLI-SAXS (Taylor-Couette-PLI-SAXS) and the multiscale time-resolved analysis of flows beyond the laminar flow limit
- DMA-H/T-SWAXS (dynamic mechanical analysis - humidity and temperature controlled SAXS/WAXS) -

