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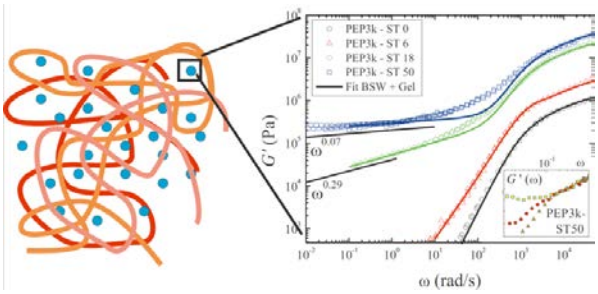
The Interplay of Different Experimental Techniques to Understand the Fundamentals of Polymer Dynamics in Nanocomposites

Abstract

Polymer based nanostructured materials promise substantially improved features such as increased tensile strength, abrasion resistance, and gas barrier tightness. Even composites with very different material behavior such as an enhanced electrical conductivity or the opposite way around better insulating properties can be assembled. Though extensive research in this field has led to substantial progress toward the physical understanding of the interrelation of polymer-filler affinity, filler structure, and macroscopic properties of filled polymer melts, the chain dynamics of the underlying polymer phase and the interaction mechanisms remain poorly understood.



The macroscopic properties are exemplified on the left: The storage modulus G' vs. frequency ω from oscillatory shear rheology changes significantly due to the particles. The lines indicate that assuming just topological particle-particle interactions and unchanged polymer dynamics does not suffice to describe these macroscopic results properly.

In order to understand the relationship between macroscopic and nanoscopic properties, the talk illuminates the polymer dynamics at the nanoscale in model nanocomposites exploiting the high space-time resolution of neutron scattering experiments. For example, the figure on the right shows the intermediate scattering function S(Q,t) vs. time t, for one momentum transfer Q and various particle fractions Φ. The particles cause a change of the plateau at high t, and thus, a change of the tube diameter as highlighted by the inset. The talk addresses such fundamental changes at the micro- and mesoscale an how they affect the material properties.