Linear and Nonlinear Dynamics of Reversible Polymer Networks

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Reversible polymer networks are networks formed by both chemically and physically reversible bonds, which can be broken and reformed within observable time scales, granting these polymers the ability to recover their original state. Over the past two decades, there has been significant progress in comprehensively understanding the dynamics of these networks.

In this presentation, we will overview the recent developments in interpretating the rheology of reversible polymer networks. Our discussion will encompass the behavior of these networks under both small and large deformations. Initially, we will explore the linear viscoelastic properties under small strain or slow flow conditions, which reflect the dynamics of the reversible networks when they are close to equilibrium. The influence of various factors on linear viscoelasticity, such as the concentration, strength, and distribution of binding sites, as well as the polarity and topological structure of the polymer chains, will be detailed. Special attention will be given to the sol-to-gel phase transition and the viscoelastic properties across different regimes of this transition.

Moving on to more extreme conditions, we will delve into the structural changes that reversible networks undergo, including the orientation, stretching, fragmentation, and re-formation, when subjected to intense shear and elongational flows, and how these changes manifest in the material's nonlinear stress responses. We will highlight the mechanisms underlying the brittle-to-ductile transition.

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