Effects of network connectivity/concentration of transient networks with uniform network strands on spatial structures

T. Katashima[A], T. Sakai[A], M. Ohira[A], X. Li[B]

[A]*Univ. of Tokyo,* [B]*Hokkaido Univ.*

Polymers, linked through temporary interactions, give rise to transient networks like slimes, exhibiting a captivating viscoelasticity attributable to the limited lifespan of their crosslinks. Recent findings suggest that these temporary crosslinks significantly influence the resilience and self-recovery properties of polymeric materials. Consequently, discerning the interplay between micro-kinetics and overarching physical attributes, including viscoelasticity, becomes paramount. Yet, a comprehensive molecular comprehension of this viscoelasticity remains elusive, largely due to challenges in experimentally gauging bond lifespans and the varied structures in standard transient networks. Notably, these networks possess both static and dynamic heterogeneities. Static ones encompass elements like dangling chains, inconsistent lengths of network strands, and branching figures. In contrast, dynamic heterogeneity emerges from a blend of the network components' gradual movements and the rapid dynamics intrinsic to micellar or unimer constructs within the system. Such complexities make it challenging to quantify these heterogeneities, thus hindering a molecular grasp of the transient networks' physical traits.

Recently, we pioneered a model system of transient networks featuring meticulously controlled structures, namely the Tetra-PEG slime, to address the aforementioned challenges.[1] This material is constituted of mutually reactive four-armed polyethylene glycol (tetra-PEG) polymer units. These precisely distributed star-shaped precursors facilitate the generation of a network with consistent structures, ensuring uniform functionality and strand length. Moreover, employing symmetrical precursors of identical diffusibility curtails the dynamic heterogeneity typically seen in traditional transient networks. Nonetheless, the correlation between structural alterations and deformation remains elusive, hindering a profound understanding of viscoelasticity's molecular basis. In this upcoming SANS study, our objective is to elucidate the structural variations in the Tetra-PEG slimes with various connectivity [2] and concentration conditions.

Figure 1 displays the intensity profiles of multi-branched PEG embellished with diol end groups, immersed in D2O. These profiles exhibit excellent overlap and align seamlessly when mapped to the Orenstein Zernike (OZ) functions. Such outcomes indicate that the measurements were successfully conducted. Currently, we are in the process of analyzing the data and drafting the manuscript.

[1] T. Katashima *et al*., ACS Macro Lett. **11**, 753-759 (2022).
[2] T. Katashima *et al*., Front. Soft. Matt. **2**, 1059156 (2022).

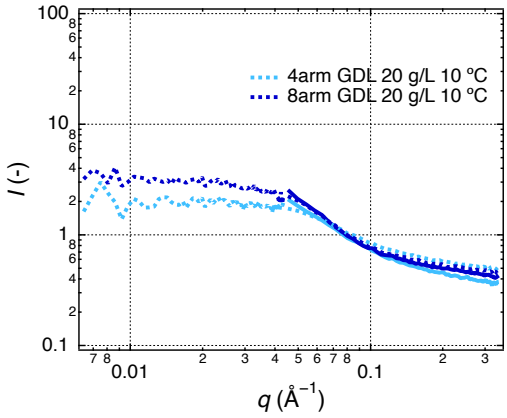

Fig. 1. SANS profiles of multi-branched PEG solutions with diol end groups using D2O as solvent, at sample-to-detector (SDD) distances of 2 m and 8 m.