Synthesis and Characterization of Supramolecularly-bonded Soft Matter

Florian J. Stadler

Department of Chemical Engineering, Interdisciplinary Research Center for Refining and Advanced Chemicals, King Fahd University of Petroleum and Minerals, Dhahran 31261, Saudi Arabia

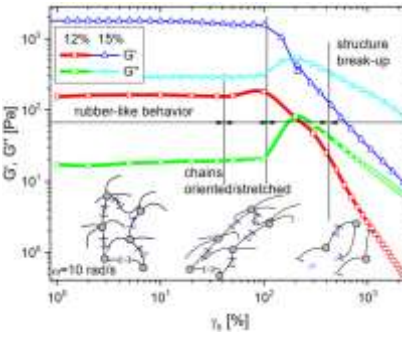

Figure 1: Strain sweep of 12-w/v% Ni^{2+} and 15-w/v% Ni^{2+} hairy micelle samples in EtOH

Supramolecular polymers have strong (up to almost covalent bond strength), directed interactions additionally to the standard polymer physics interactions, making their analysis complex and exciting at the same time. The high complexity of the interactions in supramolecular polymeric systems makes understanding of their physical properties difficult. This presentation will summarize several different research directions from the last ten years revolving around the question of how supramolecular interactions influence the rheological properties of these systems.

Polymer solutions containing terminal terpyridine groups strongly complex with suitable metal ions. Due to the use of selective solvents, these terpyridine groups are terminating the chain ends of hairy micelles, a particular type of soft colloidal assembly. These materials are self-healing (Fig. 1) and possess moduli, which are identical to significantly lower than their theoretical values based on viscoelastic theory, depending on the type of counterion.[1,2]

Water-soluble copolymers of N-isopropylacrylamide and dopamine methacrylate were synthesized with 1, 2.5, and 5 mol% dopamine methacrylate content. At acidic pH, aqueous copolymer solution behaves like an unentangled copolymer solution, but at basic pH, these catechol functionalities form a dicomplex with H_3BO_3, thereby cross-linking two chains, proven by ^{11}B-NMR and gelation. If 2 or more functionalities per chain are present, a gel is formed that is self-healing with quick recovery from sustained damage (Fig. 2).[3-4]

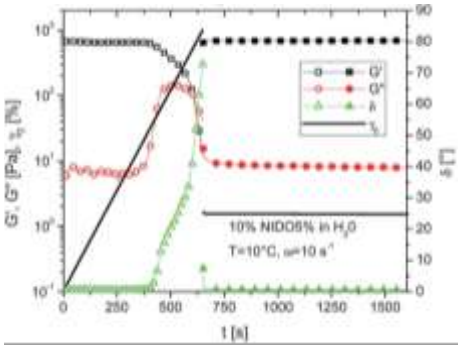

Figure 2: strain sweep and subsequent self-healing of NIDO5% at 10 °C.

References:

1. Guillet, P.; Mugemana, C.; Stadler, F. J.; Schubert, U. S.; Fustin, C.-A.; Bailly, C.; Gohy, J.-F. Soft Matter 2009, 5, (18), 3409-3411.

2. Yan, Z. C.; Stadler, F. J.; Guillet, P.; Mugemana, C.; Fustin, C. A.; Gohy, J. F.; Bailly, C. Polymers (Basel) 2019, 11, (10), 1532.

3. Vatankhah-Varnoosfaderani, M.; Ghavaminejad, A.; Hashmi, S.; Stadler, F. J. Chemical communications 2013, 49, (41), 4685-7.

4. Vatankhah-Varnoosfaderani, M.; Hashmi, S.; GhavamiNejad, A.; Stadler, F. J. Polym Chem-Uk 2014, 5, (2), 512-523.