Rheology of stimuli-responsive polymers

Sami Hietala

University of Helsinki, Finland

Polymers and polymer solutions that exhibit a drastic and discontinuous change of their physical properties with a external stimulus, such as temperature, pH, ionic strength or light, are called stimuli-responsive. [1] A great deal of these polymer systems exist in aqueous solutions, dispersions and as hydrogels, where typically the change in the polymer solubility triggers a change in the properties and enables new functionalities.

Temperature-responsive systems are the most studied ones, typically showing either so called Lower Critical Solution Temperature (LCST) or Upper Critical Solution Temperature (UCST) type behavior, see Figure 1. [2] LCST type systems form a one-phase system at lower temperatures and phase separate upon heating, while UCST-type systems do the opposite. More complex phase behavior and application of multiple stimuli are increasingly studied.[3]

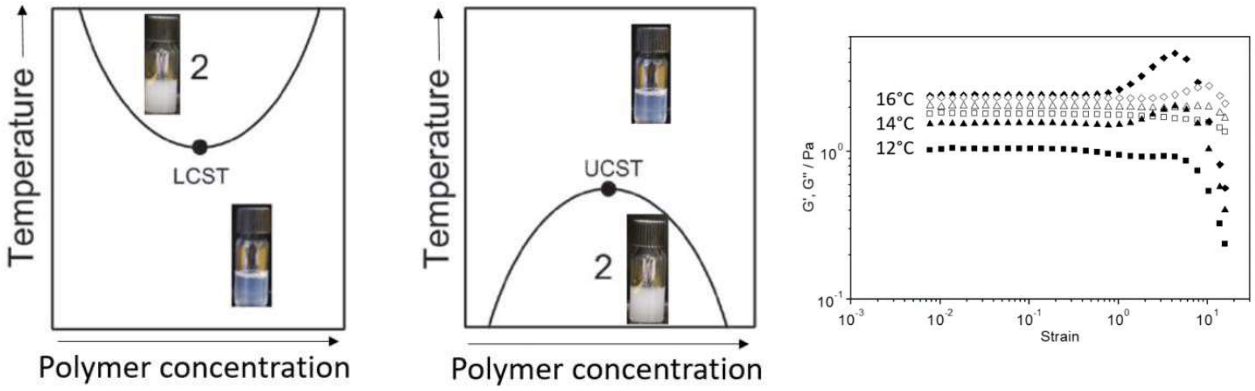

Figure 1. Schematic of LCST and UCST-type solution behavior upon the phase transition and example of thermothickening aqueous solution.

Rheological characteristics are among the important properties that are influenced by the responsive behavior. Depending on the system in question, viscosity or modulus changes may occur over several orders of magnitude involving changes in the viscoelastic properties or introduction of non-linear or non-Newtonian behaviour. Simultaneously these may be accompanied for example by sol-gel transitions, change in optical properties or self-healing capabilities. Stimuli-responsive polymers are increasingly utilized for example in drug delivery, diagnostics and other applications.

References

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