

From the LCST Transition to Aquamelts: Type-II Phase Transitions in Polymers

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The lower critical solution temperature (LCST) transition is introduced as type-II transition which results in many cases from competing effects of hydrogen bonding and hydrophobic behaviour of water-soluble polymers such as PEO and PNIPAm. As a consequence of the new type of phase separation a switch-like temperature response and phase coexistence is predicted for immobilized polymers such as polymer brushes or gels. I will give an introduction to simple theoretical concepts related with the type-II transition. Furthermore, I will demonstrate that mixed solvents can lead to type-II transitions with the prominent example of so-called co-nonsolvency [1]. Computer simulations and experiments confirm the basic conclusions from the theoretical model for polymer brushes [2,3]. Moreover, this phase transition is most likely driving the formation of protein-RNA-droplets in living cells. Using atomistic simulations it is shown for the example of PEO that stretching of the conformations can induce a phase transition far below the LCST which can be explained by the release of hydrogen bonds in the stretched state of PEO [4]. An aquamelt is introduced in general as a system where stretching/flow induces phase separation and subsequent crystallization, very similar to the process of spider-silk spinning in Nature. Aquamelts break the paradigm that solution properties of polymers are independent of conformation statistics.

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