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The Open-Access Journal for the Basic Principles of Diffusion Theory, Experiment and Application

Hot colloids in polymer networks: Cage formation and transient network deformation

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Laser-heated gold colloids are highly localized heat sources that allow for heat release on length scales well below the optical diffraction limit. When embedded in a binary matrix, the temperature field around the particle couples to the matrix composition via the Soret effect. In case of a polymer solution with a positive Soret coefficient, e.g. polystyrene in toluene, the polymer is depleted near the particle surface and a transient solvent-rich cage of low viscosity is formed around the colloid on the characteristic diffusion time scale of the polymer. Depending on chain length, concentration, and temperature, the polymer depletion can either be amplified by a positive or damped by a negative feedback loop. Under favorable conditions the polymer depletion is quantitative and a pure solvent bubble of approximately one micrometer in diameter is created around the particle. At high polymer concentrations the viscosity strongly depends on concentration and temperature due to the proximity of the glass transition. For semidilute solutions of high polymers, entanglements are decisive. In the latter case the deformation of the transient polymer network by the radial thermodiffusion processes can be visualized via video microscopy of 'the other' colloids that are trapped in the meshes of the network on the disentanglement time scale of the polymer.

References

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