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Abstract

Phase behavior of sticky hard spheres

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Sticky hard spheres show a complex phase behavior with gas-liquid phase separation as well as percolation (gelation) that crosses the gas-liquid coexistence curve. This phase behavior is not only of relevance for colloidal model systems showing gelation [1] or a glass transition but also for biological systems such as proteins with short range attraction [2]. From the theoretical side, sticky hard spheres are conveniently described using the Baxter model, which depends on only one parameter, τ_B, being inversely proportional to the stickiness [3].

A model system of sticky hard spheres based on silica particles and grafted stearyl alcohol in toluene is presented. The particle composition, their polydispersity, their interaction, and the phase behavior in the homogenous liquid phase up to the percolation line are characterized by small-angle neutron scattering (SANS). It is presented how SANS measurements done at several temperatures and pressures allow to obtain the interaction parameter τ_B, which can be used to predict the phase diagram of the system including the percolation line for any pressure and temperature. Furthermore, the behavior of the SANS I(q) data close to the critical point is discussed.

Dynamic light scattering (DLS) and dynamic wave scattering (DWS) were applied to gain further insight about the phase diagram by determining the gas-liquid binodal line, the spinodal line, as well as the percolation line. The transition from ergodic to non-ergodic behavior can be obtained directly using DWS. The DLS and DWS measurements were found to be in good agreement with the SANS results, and they give valuable information about the particle dynamics.

In addition to an overview of the phase behavior of sticky hard spheres as a typical soft matter system, the used light- and neutron-scattering methods are introduced. Special emphasis is given to SANS.

References

[1] P. J. Lu et al., Nature 453, 499-504 (2008).
[2] F. Cardinaux et al., Phys. Rev. Lett. 99, 118301 (2007).
[3] R. J. Baxter, J. Chem. Phys. 49, 2770 (1968).