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Temperature-Dependent Behavior of Bicontinuous Microemulsions in Pores

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Microemulsions are thermodynamically stable solutions composed of water, oil, and amphiphilic components such as a surfactant. They show a fascinating variety of structures and properties that have been explored over the past few decades. Numerous applications in areas such as pharmaceuticals, cosmetics, enhanced oil recovery, the food industry and many more make the relevance of this research clear [1]. The properties of microemulsions in porous materials are relevant for many of these applications. In our work we therefore focus on the sponge phase of a ternary microemulsion based on a surfactant of the type CE in controlled porous glasses (CPG) as a model system. CE Surfactant-based microemulsions are well-characterized model systems, and the porous material CPG is available in a variety of pore sizes. Preliminary work on the behavior of this microemulsion at planar glass interfaces showed a structure-directing influence of the glass surface, which led to a lamellar structure near the interface, which gradually transformed into the sponge structure in the volume phase with increasing distance from the glass surface [2]. This effect is present in both hydrophilic and hydrophobic interfaces. [3] To study the structural changes within the pores, we use small-angle X-ray/neutron scattering (SAXS/SANS). By measuring the temperature-dependent phase behavior of the microemulsion in the pores compared to the temperature-dependent phase behavior in the bulk with SAXS, we have already obtained detailed information about the effects of confinement on the structure. This was accomplished by measuring the correlation length of the microemulsion in the pores, which is indicative of the size of the microemulsion droplets. For pore diameters from 1000 nm to 240 nm in the temperature range from 5 to 55 °C we observe a behavior similar to that in the bulk phase. At low temperatures, where the main microemulsion would consist of two separate phases, the microemulsion droplets are small. With increasing temperature, the curvature of the droplet interface decreases, resulting in larger droplets overall. After reaching the zero curvature limit, a further increase in temperature leads to inverse droplets that become smaller with increasing temperature. For small pore diameters of 184 nm we observe the same size over the entire temperature range. Overall, we observed a high influence of the pore walls at small pore diameters. Based on these results, experiments with the contrast matching SANS method are planned to get more information about the actual structure of the microemulsion in the pores.

Participation

In-Person

References

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