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Simultaneous Study of Molecular and Micelle Diffusion in Microemulsions by Dynamic Light Scattering

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Microemulsions are of interest for many technical applications, e.g., in the form of polyol-based systems with nanometer-sized supercritical CO_2-swollen micelles as a starting point for the production of high-performance insulation foams. In this example, dissolved CO_2 as well as CO_2-swollen micelles diffuse inside the continuous phase of the microemulsion. These processes can be described with a molecular and a micelle diffusion coefficient, respectively.
While the determination of molecular diffusion coefficients of gases dissolved in various kinds of liquids by dynamic light scattering (DLS) is well established at our institute since about four years, we have only recently shown that a proper use of this method also gives access to the micelle diffusion coefficient. In the given technical example, the latter diffusion coefficient is of particular interest for the insulation foam production because it can be used to get information on the micelle size via the Stokes-Einstein equation.
For the measurement of both diffusivities in a reliable way, a superposition of the scattered light with defined reference light is necessary. As the diffusion process of micelles is much slower than that of molecular solutes, the corresponding DLS signals analyzed in the form of correlation functions appear on different timescales and can be separated by an appropriate data evaluation procedure.
In the present contribution, it is shown for the first time that the simultaneous study of both diffusion processes in microemulsions can be successfully realized by DLS. Besides other experimental details, it is demonstrated that also colored samples can be investigated by implementing a newly developed backscattering technique as well as by a careful selection of the laser wavelength to minimize the effect of local sample heating due to laser light absorption.