Diffusion Coefficients in Fluid Mixtures and Particulate Systems by Using Dynamic Light Scattering

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At present, the most frequent application of dynamic light scattering (DLS) is the study of diffusion coefficients for the characterization of macromolecular or particle size and size distribution. In contrast, only a few research groups use DLS to a greater or lesser extent for the determination of molecular diffusion coefficients. A fundamental advantage of DLS is the access to diffusion coefficients without applying macroscopic concentration gradients. DLS analyzes microscopic statistical fluctuations in concentration which, according to Onsager's regression hypothesis, can be related to diffusion coefficients.

This contribution highlights research activities carried out at AOT-TP of FAU mainly during the past five years for the determination of diffusion coefficients in fluid mixtures and particulate systems by using DLS. Examples are presented for various corresponding systems, which represent, besides model or reference systems, especially systems relevant for process and energy technology. With the help of results for model systems, limitations of the method regarding the thermodynamic state and achievable uncertainties will be discussed in detail. The broad applicability of DLS is demonstrated by a compilation of selected technology-relevant systems. They include electrolytes, aqueous solutions of polyethylene glycol, liquids with dissolved gases like liquid organic hydrogen carriers with hydrogen or polymer melts with nitrogen acting as blowing agent for foam formation, as well as particle dispersions based on ionic liquids and their mixtures with dissolved carbon dioxide. For the latter systems and microemulsions containing micelles swollen with carbon dioxide, even the simultaneous determination of molecular and particle diffusion coefficients is demonstrated. Recent activities also show the applicability of DLS for the characterization of particle aggregation kinetics by studying particle diffusion coefficients in evaporating single droplets. Moreover, its application to the study of particle diffusion coefficients under the influence of confinement in porous materials without using any refractive index matching fluid is demonstrated.