Characterization of Multiphase Systems in Chemical and Energy Engineering

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Multiphase systems are important in many areas of chemical and energy engineering such as catalysis, separation technology, and energy storage and transport. For the design of corresponding processes and apparatuses, but also for a fundamental understanding of the fluid behavior, knowledge of the thermophysical properties in multiphase systems is necessary. The present contribution highlights current and planned research on multiphase systems at AOT-TP, which aims at the determination of their equilibrium and transport properties as well as the development of corresponding experimental and theoretical methods. For dispersions of nanoparticles in liquids, measurement results for the effective thermal conductivity could confirm theoretical predictions that changes in the property by the addition of nanoparticles are only moderate. For mixtures of ionic liquids, viscosities and interfacial tensions obtained by surface light scattering (SLS) and pendant drop experiments could reflect the nanosegregated structure in the bulk and at the surface of the fluids. In future, such approach should be further developed to provide information about surface enrichment of homogeneous catalysts dissolved in ionic liquids in presence of a gas atmosphere. In this connection, SLS allowed to probe the influence of gases dissolved in liquids on viscosity and interfacial tension, which agrees with predictions from molecular dynamics (MD) simulations. For three-phase systems containing a vapor phase and two liquid phases, it was demonstrated by SLS that the viscosities of the two liquid phases and the vapor-liquid and liquid-liquid interfacial tensions can be determined simultaneously. The aim of a new project idea is to study moderating effects of alcohols on the interfacial tension in mixtures with hydrocarbons and carbon dioxide by applying SLS and MD simulations. In summary, the research activities could contribute to an improved understanding of multiphase systems via the determination of their thermophysical properties and the development of advanced methods including prediction models.