Influence of Different Gases and Molecular Catalysts on Interfacial Tension and Viscosity of Ionic Liquids

Ziwen Zhai[1, S] and Thomas M. Koller[1, C]

[1]*Institute of Advanced Optical Technologies - Thermophysical Properties (AOT-TP), Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany*
thomas.m.koller@fau.de

Ionic liquids (ILs) are interesting working fluids for various fields of chemical engineering. One of these fields is related to catalysis, where industrially relevant reactions like hydrogenation or hydroformylation can be realized using Supported Ionic Liquid Phase (SILP) systems. Here, a thin IL film containing a dissolved molecular catalyst is coated onto the surface of a porous solid support to provide a large surface area for the gaseous reactants and products that are dissolved in the liquid phase. A new paradigm in SILP technology aims to perform catalysis preferentially at the gas-liquid interface by achieving a strong surface enrichment of the catalyst. For the design and optimization of SILP systems, knowledge of their thermophysical properties at process-relevant conditions is needed, yet often lacking regarding interfacial tension and viscosity.

The present contribution discusses the influences of dissolved gases and molecular catalysts on the interfacial tension and viscosity of ILs relevant for SILP systems. To characterize the gas-liquid interface at macroscopic thermodynamic equilibrium, a combination of surface light scattering (SLS) and the pendant-drop (PD) method within one setup has been realized. By analyzing the very same sample under identical conditions, the interfacial tension obtained by the PD method is used to determine the viscosity by SLS for fluids of relatively high viscosity such as ILs. Corresponding measurement results are shown for different imidazolium-based ILs at temperatures between (303 and 473) K. The influence of representative gases dissolved in an IL at pressures up to 10 MPa is discussed for argon or hydrogen of low solubility and for carbon dioxide of high solubility. In ongoing investigations, the system complexity is further increased by adding a molecular catalyst to the IL system. Here, relationships between the interfacial tension and the surface enrichment of the catalyst accessible from, e.g., X-ray photoelectron spectroscopy will be analyzed.