

Mutual Diffusion in Ionic Liquid Co-solvent Mixtures by Dynamic Light Scattering (DLS)

Thomas Sponfeldner^S and Julia Lehmann

Erlangen Graduate School in Advanced Optical Technologies, University of Erlangen-Nuremberg, Erlangen, Germany

Alfred Leipertz

Department of Engineering Thermodynamics, University of Erlangen-Nuremberg, Erlangen, Germany

Andreas Paul Fröba^C

Erlangen Graduate School in Advanced Optical Technologies, University of Erlangen-Nuremberg, Erlangen, Germany

The diffusion coefficient is a key quantity in engineering practice for process design when liquid mixtures are used as working fluids. In diverse potential fields of technical application ionic liquids (ILs) are often used in binary mixtures with co-solvents. At present, for binary IL co-solvent mixtures a scarce data situation especially for the mutual diffusivity is found. This may be due to the fact that conventional techniques for measuring mutual diffusion coefficients, e.g., Taylor dispersion, are restricted to only a small range in viscosity. In the last two decades, dynamic light scattering (DLS) was developed as a unique measurement technique for the determination of various transport properties, including mutual diffusivity in binary mixtures. In contrast to conventional techniques DLS gives access to transport properties in macroscopic thermodynamic equilibrium analyzing microscopic fluctuations. Until now, mostly mixtures with high degree of scattering, thus facilitating signal detection, were investigated by DLS. At SAOT-Erlangen, for the first time – to the best of our knowledge – we have demonstrated the feasibility of the DLS-technique for the determination of the mutual diffusion coefficient in IL co-solvent mixtures. For selected binary mixtures of 1-ethyl-3-methylimidazolium ethylsulfate [EMIM][EtSO₄] with acetone, acetonitrile, water and ethanol we evidenced that the signals associated with the fluctuations in species concentration are related to true molecular binary diffusion. Mutual diffusion coefficients of these mixtures were measured over a wide composition range from the salt-rich region to the diluted one. The sensitivity of DLS was tested and the accuracy was proven to be between 1 % and 3 % for the intermediate region. The DLS data for the mutual diffusion coefficient were compared with NMR data for the self-diffusion coefficient and fit well into the current picture of self- and mutual-diffusion in IL co-solvent mixtures.