Dynamic Viscosity of Tricyanomethanide and Tetracyanoborate Based Ionic Liquids and Their Mixtures with Carbon Dioxide by using Dynamic Light Scattering

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Low-viscosity ionic liquids (ILs) based on the anions $[C(CN)_3]^-$ (tricyanomethanide) and $[B(CN)_4]^-$ (tetracyanoborate) are currently discussed as possible working fluids, e.g., for solar cell applications or gas separation processes. In the present study, the dynamic viscosity of such ILs carrying a homologous series of $[alkyl\text{-}MIM]^+$ (1-alkyl-3-methylimidazolium) cations was investigated via the determination of the translational particle diffusion coefficient by using dynamic light scattering (DLS). For a successful determination of the dynamic viscosity, the long-term stability of silica, melamine resin, and polystyrene particles dispersed in the ILs as well as their particle diameters ranging between 100 and 500 nm were analyzed. For the semi-transparent $[C(CN)_3]^-$-based ILs, also the influence of the applied laser power on the measured particle diffusion coefficient was studied. The dynamic viscosity of the four pure ILs forming stable particle dispersions was obtained with an uncertainty of about 5% (k = 2) for temperatures from 283.15 to 353.15 K at atmospheric pressure and agrees well with literature data. Absorption of CO_2 in the IL at pressures up to about 10 bar induced a distinct decrease in the dynamic viscosity. Differences between the viscosities of the different systems can be explained by varying strength of molecular interactions and structural effects. In a further step, the simultaneous determination of the dynamic viscosity and mutual diffusivity of binary mixtures of ILs with dissolved CO_2 is proved. Here, scattered light governed by fluctuations in the particle concentration as well as in the molecular composition is analyzed simultaneously.