Thermophysical Properties of Tetracyanoborate Based Ionic Liquids in Dependence on Temperature at Atmospheric Pressure

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This work represents a continuation of former investigations where dynamic viscosity, interfacial tension, density, and refractive index of ionic liquids (ILs) composed of systematically varied cations and anions were studied. Here, five ILs based on the anion $[B(CN)_4]^-$ (tetracyanoborate) and carrying a homologous series of [alkyl-MIM]$^+$ (1-alkyl-3-methylimidazolium) cations [EMIM]$^+$ (ethyl), [BMIM]$^+$ (butyl), [HMIM]$^+$ (hexyl), [OMIM]$^+$ (octyl), and [DMIM]$^+$ (decyl) were investigated by using conventional techniques and surface light scattering (SLS) at atmospheric pressure. For these ILs currently discussed regarding their potential use in solar cell applications or gas separation processes, an Abbe refractometer was used for the measurement of the refractive index in the temperature range from (283.15 to 313.15) K. The density was measured between (283.15 and 363.15) K with a vibrating tube densimeter, while the self-diffusion coefficients of the cation and the anion were obtained from nuclear magnetic resonance (NMR) spectroscopy from (273.15 to 318.15) K. The interfacial tension was measured with the pendant drop technique at room temperature. Based on this datum and the temperature dependence of the density, the interfacial tension for all relevant temperatures was estimated via an appropriate prediction model. For the ILs studied within this work, the ratio of dynamic viscosity to interfacial tension could be directly accessed by SLS in a first order approximation. Combining the results from SLS with those for density and interfacial tension from conventional methods, the dynamic viscosity could be obtained in the temperature range from (283.15 to 363.15) K with an estimated expanded uncertainty (k = 2) of less than 3%. All results were compared with literature data and show the influence of the varying alkyl chain length in the cation on the thermophysical properties of $[B(CN)_4]^-$-based ILs.