

The Phase Behavior of Solutions of Ionic Liquids

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A comprehensive review about the liquid-liquid phase behavior (LLE) of solutions of Ionic liquids of mixtures of different ILs with alcohols and aprotic polar and non-polar liquids will be given. The review focuses on different classes of systems, where in particular the influence on the LLE by a variation of the chain or even side chain length of the components has been examined, mainly mixtures of 1-alkyl-3-methylimidazolium bis((trifluoromethyl)sulfonyl)amides ($C_x\text{mimNTf}_2$; $1 \leq x \leq 14$) with n -alkyl alcohols ($C_n\text{OH}$; $1 \leq n \leq 20$) are considered. Partial miscibility with upper critical solution temperatures (UCST) is usually observed increasing with the chain lengths of the alcohols and decreasing with the length of the side chain of the cation. In water and diols, however, the UCSTs increase with the length of the alkyl-chains of the ILS. The numerical analysis of the phase diagrams is consistent with Ising criticality. Concepts for the description of the asymmetry of the phase diagram presuming the validity of universal scaling behavior as given by the theory of complete scaling are applied. This concept does not only allow for perfect description of the phase diagrams with a minimum of parameters but enables predictions of phase diagrams in regions that are not explored. The systematic trends of the phase behavior and the results of the analysis (UCST, critical composition, width and diameter of the phase diagrams) are discussed in detail. Comparison with the predictions of the model systems of charged hard spheres is made. The application of corresponding phase behavior on the systems investigated so far yields one single master-curve. Furthermore simple empirical relationships are formulated, that allow for the description or estimate of UCSTs of the IL-alcohol family. A simple mean-field lattice model enables rationalizing the observed regularities between size and shape of the ILs and the solvents.