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Solvatochromic Absorbance Probe Behavior within Mixtures of the Ionic Liquid 1-Butyl-3-methylimidazolium Bis(trifluoromethylsulfonyl)imide + Molecular Organic Solvents

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ABSTRACT: The solvent mixtures made up of ionic liquid and molecular solvents have been studied using solvatochromic absorbance probe molecules. These, on the partner ends, the role of the cation and anion in changing the behavior of the solvatochromic absorbance probe within binary solvent mixtures of 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide. The behavior of the probes is explained with the help of solute−solvent and solvent−solvent interactions. The solvatochromic absorbance probe molecules 4-nitroaniline, 2-methyl-4-nitroaniline, 2-methoxy-4-nitroaniline, 2-methoxy-5-nitroaniline, 2-methyl-5-nitroaniline, 2-methoxy-4-methyl-5-nitroaniline, 2-methoxy-4-methoxy-5-nitroaniline, and N,N-dimethylnitroaniline have been selected for this investigation. The effect of the addition of molecular solvents to ionic liquids polarity parameters, the Kamlet−Taft solvatochromic parameters, namely, the solvent hydrogen-bond acceptor ability (β), and dipolarity/polarizability (π^*), is investigated. The solvatic parameters, β, and dipolarity/polarizability (π^*) of the solvatochromic probe molecules have been correlated with the composition of the binary solvent mixtures. The preferential solvation model has been used to provide insight on the solvent−solute interactions and interactions in the solvent mixtures.

1. INTRODUCTION

Ionic liquids (ILs), the potentially green solvents, are a subject of great interest in the last decade. Their unique properties lead to their emerged features and wet range of applications in various fields.[1−4] Due to a wide range of their organic cations and inorganic anions, ILs have been known to exhibit a wide range of physicochemical properties depending upon cation and anion, and so are called tunable solvents. ILs have been used as solvents for a wide range of organic, inorganic, and biochemical reactions.[5−8] As due to the almost field-independent electrical dielectric and have been used in several analytical fields such as ion-selective electrochemistry,[9] high performance liquid chromatography (HPLC), or mass spectrometry and in photovoltaics, in separation techniques, in batteries, in fuel cells, in electrochemical devices, and in electrochemical the enhancement of the ILs in changing the physicochemical and photophysical behavior of the solutes.[10−14] Many physicochemical properties of ionic liquids and their mixtures have also been determined by several groups.[15−17]

Besides the electrochemical, chemical, and biochemical applications of ILs, the study of solvation phenomena associated with these solvents, from crucial importance in the formal reliability of many reactions and energetic systems as these solvents are used in the solvent media, has been one of the most important fields.[18−20] Thus, altering the physicochemical properties of the ionic molecular solvents is an area of interest. The solvent reliability may enhance in several reactions modified IL systems, and the addition of cosolvents may alter the solvation of the solute molecules in the solvent media. In flexible manner IL, crude, the researchers have varied the ratio of IL + molecular solvent mixtures as solvent media for the solvatochromic probe. Many IL−molecular solvent research groups have studied the changes in the solvatochromical properties and also explored solute−solvent and solvent−solvent interactions in the solvent media.[21−24] Recently, Ali et al.[25] studied Fischer and Fischer explored the behavior of the solvatochromic probes in the $[emim][Tf_2N]$ + ethanol and a mixture of $[emim][Tf_2N]$ + water. Ali et al.[26] explored the probe behavior in mixtures of IL with methanol, water, and dimethoxyethane.[27] Chalmers et al. explored the solvent-induced spectral shifts of solvatochromic probes in mixtures of ionic liquids with water, methanol, and ethanol.[28] In another study, Chalmers et al. investigated probe behavior in binary mixtures of ionic liquids with molecular solvents using 2,6-N,N-diethylaminonitrile, dimethyl amino, and dimethyl vinyl substituted 4-nitroaniline probes. Chalmers et al. explored the probe behavior of the 4-nitroaniline and substituted 4-nitroaniline and dimethyl-4-nitroaniline. Preferential solvation is of especial importance in the molecular level behavior of the

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