IMPACT OF THE MAGNETIC FIELD ON THE PHYSICAL PROPERTIES OF MAGNETIC IONIC LIQUIDS

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Keywords: Modulation of ionic liquids properties, Magnetic ionic liquids, Magnetic field

Introduction: Ionic Liquids (ILs) have been recognized as novel solvents, which are comprised entirely by ions and are liquids over a wide temperature range including room temperature. The ILs have low melting points, high thermal stability and thermal capacities, are non volatile, non-flammable, renewable and reusable. Additionally, their physico-chemical properties can be modified by changing their cationic and anionic composition and thus be designed according to their application [1].

Due to their particular features, ILs have gained interest for various applications such as: solvents for organic and catalytic reactions, solvents for separation and extraction processes, carriers in transport and separation of materials, novel electrolytes for electrochemical devices and processes and in enzyme catalysis/multiphase bioprocess operation [1].

Recently, a new generation of magnetic sensitive ionic liquids - magnetic ionic liquids (MILs) has been discovered which shows a strong response to magnetic field [2,3].

The MILs are comprised by anions containing transition metal complexes, having physical properties, such as: solubility, viscosity, surface tension and molecular orientation, which may be influenced by the presence of an applied magnetic field [2,3,4].

Actually, magnetically induced changes of IL solubility were confirmed by the dependence found between the concentration of binary MIL/water mixtures and the applied magnetic field strength [2].

This work aims at performing a comprehensive study in order to determine the influence of magnetic fields of different intensities and orientation vectors on the structural organization of MILs network. It is expected that the presence of local structures play a key role in the magnetic behaviour of MILs physico-chemical properties [4]. Therefore, studies were also performed in order to evaluate the impact of the magnetic field on the intrinsic physico-chemical properties of MILs, such as solubility, rheological behaviour, solvation capacity and on the diffusion mechanisms of solvents/solutes through MILs.

Experimental and Discussion: The viscosity and solubility of different MILs, such as: $AliquatFeCl_4$, $C_4mimFeCl_4$, $C_8mimFeCl_4$, $P_{66614}FeCl_4$, $(C_8mim)_2CoCl_4$ and $(Aliquat)_2MnCl_4$ was determined in the absence and presence of a magnetic field intensity ranging between 0.5 and 2.5 T.

It was found that the increase of the magnetic field intensity from 0.5 to 2.5T led to the decrease of the MIL viscosity. In the case of $P_{66614}FeCl_4$ the magnetic field induced a decrease of it viscosity from 877.5 cSt to 755.5 cSt, whereas the viscosity of AliquatFeCl4 decreased from 583.5cSt to 462.5 cSt in the presence of the same magnetic field intensity. In contrast and accordance to that observed by. *S. Lee et all* [2] the solubility of MILs in water increased in the presence of the magnetic field with intensities ranging 0.5-2.5 T.

In order to understand how the magnetic behaviour of the macroscopic properties of MILs are related with their structural rearrangement under different magnetic fields, 1H-NMR – Proton nuclear magnetic ressonance relaxometry measurements were performed. This technique provides direct information about the molecular dynamics in a system. A study of the proton spin relaxation was conducted in order to understand the influence of the motions and orientations of the MILs anion molecules on the local structure, and on the cation's molecular dynamics.

The ^{1}H-NMR results showed the existence of a specific relaxation mechanism associated with the presence of the magnetic anions. The additional para-magnetic relaxation [5] is clearly observed on the high Larmor frequency part of the spin-lattice relaxation time (T_1) dispersion. The effect of the local order changes due to the magnetic anions is also detected in the rotations/reorientations and self-diffusion of cation motions, in comparison with molecular dynamics in non-magnetic counter part ionic liquids.

Conclusions: Ultimately, our goal is to use the knowledge about the magnetic behavior of MILs to direct their molecular design, allowing the implementation of optimized MILs synthesis procedures, which may generate MILs with highest magnetic susceptibility and the most efficient magnetically induced switch of their properties, regarding their final application.

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