INNOVATIVE MATERIALS FOR RESEARCH AND INDUSTRY

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ABSTRACT
Research, development and implementation of products and innovative technologies that aim to reduce or eliminate the use and generation of hazardous substance for human health and the environment are found more often in last years in researchers concerns. The proof of this is the number of studies appeared in a relatively short period of time, confirming the importance of ionic liquids.
In this regard, the paper shows the main applications of ionic liquids and the main physico-chemical properties for two pure ionic liquids 1-ethyl-3 metilimidazoliu tetrafluoroborate and 1-butyl-3metilimidazoliu tetrafluoroborate, for which there are poor or no data in the literature. These properties are very important in their areas of application.

KEYWORDS: *1-ethyl-3 metilimidazoliu tetrafluoroborate, 1-butyl-3 metilimidazoliu tetrafluoroborate, ionic liquids, ecological solvents*
JEL CLASSIFICATION: *O32*

1. INTRODUCTION

In the last decade, a new class of materials came to the researchers'attention due to their outstanding properties. These materials are ionic liquids.
Ionic liquids, also called molten salts at room temperature or liquid organic salts are a new class of substances with physicochemical properties in many attractive areas: chemical, biochemical, photochemical and pharmaceutical as reaction media for organic and inorganic synthesis, catalysts, electrolytes for batteries and components in electro synthesis.
With improved solvent properties compared to traditional organic ones, they are used in separation processes by distillation or steam stripping, can be easily recovered and purified.
Currently is known a large number ionic liquids, but their number is increasing, as revealed to synthesize new materials. Study of ionic liquids useful in different areas is a continuing concern of researchers.
Until now there are a large number of experimental results organized in databases. The accumulation of these data highlighted the problem reproducible measurements due to the presence of impurities and different measurement techniques.
From this point of view, the obtaining of properties data for ionic liquids with high purity and the establishment of its own methodology are discussed in topical issues of many researchers.

2. STRUCTURE, APPLICATIONS AND PROPERTIES OF IONIC LIQUIDS

Ionic liquids are based on a large number of anions and cations that allow a large number of combinations, each of them with specific properties. Armed with reliable database for properties, it

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foresees the development of new prediction strategies for properties of ionic liquids from data about the structure of component ions. (Gordon, 2008)
Thus, it is expected a new approach to ionic liquids, a "design" of them by selecting suitable anion or cation to obtain an ionic liquid with the desired properties. Hence, the need to accumulate a large number of experimental data on the properties of this class of substances. This shows interest in theoretical and practical thermodynamic calculations in chemical and biochemical technologies.
From the point of view of fundamental research, systematic study of mixtures of ionic liquids on broad areas of concentration and temperature it is an important objective of thermodynamics solutions.
The rapid development of methods of correlation and prediction of properties based on information on intra and intermolecular interactions requires rigorous experimental data for evaluation. This information is given by the thermodynamic properties, especially the volumetric and transport properties and enthalpies of mixing.
Theoretical aspects concerning the thermodynamics of mixtures with ionic liquids are still far from being fully elucidated. Property values for ionic liquids, different from those for molecular fluids and electrolytes, are due to their structure. Ionic liquids are made up of an extensive network of cations and anions connected by hydrogen bonds. The nature and strength of interactions in ionic liquids is different from organic fluids and in liquid crystals, which is important for structural and thermodynamic approach of ionic liquids. (Wasserscheid, 2003).
Ionic liquids are characterized by a number of special properties such as: high chemical and electrochemical thermal stability, relatively easy to obtain, low vapor pressures under normal conditions of temperature and pressure, good opportunity of solvation to both polar and nonpolar species and high ionic conductivity. They are non-volatile liquids, non-flammable, shows high thermal and chemical stability and from electrochemical point of view they show a good ionic conductivity and extended potential window.(Wilkes, 2004)
For the non-volatile and solvation properties, ionic liquids have been proposed to be used as an ecological solvent in place of or in combination with classical organic solvents. (Welton, 1999).
Property values are very important in chemical process design and technology that uses ionic liquids.
Interest to study ionic liquids increased greatly in recent years. From about 100 articles published in 1990, has reached 1,500 articles in 2004, and in recent years have published about 4,000 articles per year, as shown in Figure 1.

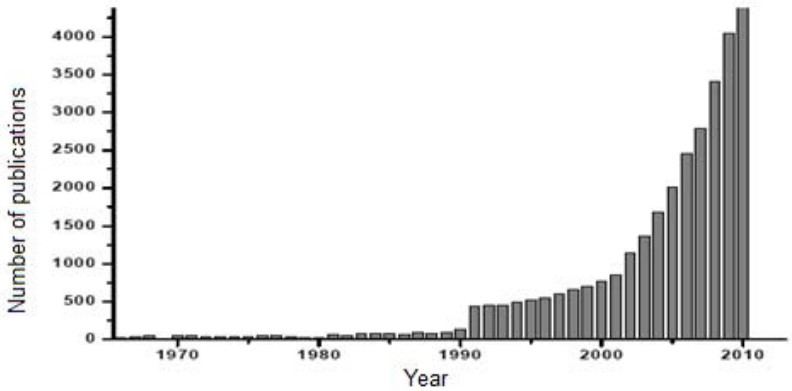

Figure 1. Dynamics of publications in the field of ionic liquids
Source: adapted from Porzsolt (2011)

The use of ionic liquids in various fields has many advantages, helping to maintain environmental quality and also to obtain new materials with improved properties. The application and their weight are shown in Figure 2.

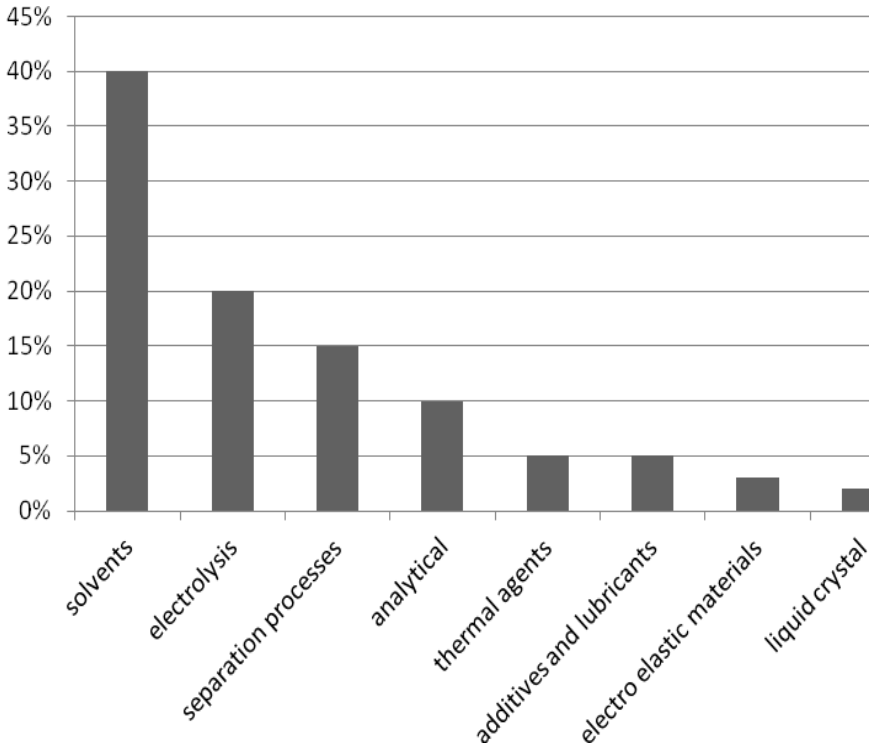

Figure 2.Fields of application of ionic liquids
Source: adapted from Croitoru O. (2013)

Ionic liquids are used in fields such as engineering extraction, separation, distillation, adsorption, gas storage, fluid technology, membrane technology, fine chemistry for organic synthesis, inorganic synthesis, catalysis, polymers, and petrochemicals. Due to the large potential window, ionic liquids have electrochemical applications as electrolytes in batteries and super capacitors. (Wasserscheid, 2003).

Ionic liquids, especially those based on imidazolium, can be used for gas purification, e.g. fossil fuel power plants to treat contaminated soil, in industrial wastewater treatment, extraction of noble metals, obtaining hydrogen from ammonia and borate the photovoltaic cells.

Using ionic liquids confer benefits primarily related environmental aspects, but also yield the reaction rate, getting the structures controlled catalytic efficiency.

Currently, ionic liquids have a high price due to their small scale production, but expansion of studies in this area, making fundamental theories of ionic liquids and prove the possibility of replacing volatile organic solvents in various technologies currently highly polluting, resulting in maintenance air quality will lead to increased production of ionic liquids and thereby decrease their price.

We studied two imidazole ionic liquids, 1-butyl-3-metilimidazoliutetrafluoroborate, [Bmim] [BF4] and 1-ethyl-3-metilimidazoliu tetrafluoroborate, [Emim] [BF4], ionic liquids stable in air and water, with multiple uses.

Table 1. Density, viscosity, refractive index, and electrical conductivity of [Emim] [BF4] and [Bmim] [BF4] at different temperatures

T, K	ρ, g cm^{-3}	η, mPa s	n_D	λ, mS cm^{-1}	ρ, g cm^{-3}	η, mPa s	n_D	λ, mS cm^{-1}
	[Emim][BF$_4$]				**[Bmim][BF$_4$]**			
293.15	1.29063	50.538			1.20444	136.8654		2.00
298.15	1.28682	41.452	1.4111	3.16	1.20089	104.6533	1.4215	2.43
303.15	1.28302	34.5318	1.4100		1.19734	81.397	1.4202	
308.15				3.67				3.28
313.15	1.27545	24.8292	1.4073		1.19027	51.7917	1.4179	
318.15				4.17				4.13
323.15	1.26797	18.6243	1.4051		1.18324	38.0435	1.4153	
328.15				4.68				4.98
333.15	1.26055	14.5401			1.17625	24.969		
343.15	1.25318	11.711			1.16932	18.4914		
353.15	1.24587	9.5804			1.16244	14.3715		

*Source***:** adapted from Croitoru O. (2013)

For the two pure ionic liquids were determined properties of density, (ρ), viscosity, (η), refractive index, (n_D), and electrical conductivity (λ) in a temperature range between 293.15 and 353.15 K, both pure and in mixtures with different organic solvents.

The data obtained are important in research, and in areas of use are shown in Table 1. Experimental results for the two pure ionic liquids. (Croitoru, 2013, Croitoru, 2011, Ciocirlan, 2011)

These properties give them a great advantage over other commonly used solvents. For example, in the process of processing of cellulose, using ionic liquid as solvent instead of carbon disulfide, is not necessary to heat at high temperature, ionic liquid having a melting point below 100 degrees Celsius. This leads to significant energy savings and thus the cost of production of cellulose great.

The high electrochemical stability of ionic liquids allows electrochemical deposition of less noble metals like aluminum or titanium, which is not possible with conventional aqueous electrolytes.

Due to their low vapor pressure ionic liquids that can replace water as the electrolyte in metal-air batteries. Ionic liquids have great appeal because they evaporate at much lower rates than water, increasing battery life by drying slower.

A relatively low-viscosity, non-flammable liquid showing electric conductivity and wide electrochemical window is a combination of properties not achievable with any other material than ionic liquids.

3. CONCLUSIONS

In summary, the ionic liquid are representing a new materials class, with the potential for usage in various market segments as pharmaceutical, biochemical and chemical industries, biotechnology, microelectronics, electro-technology, aerospace, medicine, nanotechnology, as solvents and reaction media. By developing green technologies based on ionic liquids we can reach eco-compatible materials design with wide field of use. It also aims to promote innovative chemical technologies to reduce or eliminate the using and generating toxic substances in the design, manufacture and usage of chemical products.

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