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Editorial

Ionic Liquids – A Survey of Recent Developments and Applications

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The history of ionic liquids (ILs) started almost a hundred years ago with interest in some low temperature melting organic salts as new electrolytes. Two more things had to happen before ILs were recognized broadly as interesting media possessing great possibilities for broad application. Firstly, the revelation that salts could be synthesized which remained liquid at room temperature and, secondly, air- and water-stable ILs that were discovered only 15 years ago. These were true breakthroughs and ILs were no longer treated a curiosity of interest only to a small group of scientists.

Currently, ILs are defined as salts with melting points below 100°C and form an attractive area of research. This is evidenced in the exponentially growing number of publications on the topic. The search in SciFinder yields almost three new papers per day at the current time. Further indication for the importance of ILs is found in the creation of a new, international biannual conference series two years ago – the Congress on Ionic Liquids (COIL), and two communities dealing with liquid salts at different temperatures were brought together last year in a conference (EUCHEM2006) to facilitate knowledge transfer from the molten salt community to the IL community, and *vice versa*.

The growing interest in ILs is primarily due to their specific properties (fluid over a broad temperature range, non-flammable, non-explosive, non-coordinating, non-solvating, not very corrosive, extremely low vapor pressure, miscibility or non-miscibility with water and other solvents, dissolving ability, polarity, viscosity, density, electric conductivity, high electrochemical stability) which can be tuned by an appropriate choice of the anion and the cation. Ionic liquids can be considered as ''designer solvents'' that can be synthesized rather easily and many ILs are already available commercially. Knowledge about the relationship between ion structures and properties of ILs is growing little by little and scientists are using more systematic approaches based on models to design new ILs nowadays. In terms of designer solvents, however, further work is needed to fill the gaps in this knowledge to develop a comprehensive approach for the design of ILs.

In addition to the advantages offered by their physical properties, ILs usually afford higher reaction rates, higher yields, and better selectivities compared to conventional organic solvents when used in organic synthesis. They have been applied in a wide number of reactions, especially in catalysis, particularly in biocatalysis and biochemical technology because many enzymes retain their activity in these solvents. Last but not least, ILs can bear specific functional groups creating the area of task specific ionic liquids (TSILs) which has gained recent attention.

In order to better inform readers of Monatshefte für Chemie about this actual topic and to provide them with a perspective on current trends and applications of ILs, experts in different areas of ILs have been invited to contribute to this special issue. We were very pleased and grateful that so many responded and sent outstanding contributions in the form of reviews as well as original papers.

In the list of authors there are young researchers and experienced ones who remember the beginning

of the ''ionic liquids era'' in chemistry, when these salts with low melting points were considered as very peculiar substances and there were published only 5–10 papers per year.

The special issue starts with a review on nanostructural organization of ILs and provides evidence of aggregations in ionic liquids. A second review deals with estimating of the structure of ILs based on *Raman* spectroscopy and *ab-initio* molecular orbital calculations. But not only the structures of ILs are important, also their acid–base properties are interesting to know for prediction of the influence of the media on reactions. Numerous examples of *Brønsted* acid catalyzed organic reactions in ILs are presented and compared with processes in more established systems in this review. Next, non-conventional methods such as microwave and/or ultrasound are reviewed in a search to replace classical syntheses of ILs which are usually time-consuming. The reviews on asymmetric synthesis and resolution of enantiomers in ILs and particularly on secondary chiral alcohols are complemented with several studies on certain reactions where ILs are used as reaction media and/or catalyst at the same time. This area is complemented with some examples of research on TSILs and possibilities to modify ILs yielding for *e.g.*, hydroxy-functionalized TSILs. Several papers are devoted to the use of ILs as separation media. There is seen a wide range of applications, among them the separation of gases on one side and the selection of metals on the other side. The kosmotropic (water-structuring) or chaotropic (water-structure-breaking) nature of ILs can be used to modify the liquid–liquid extraction process. Changes on the fluid phase behavior of polyethylene glycol (*PEG*) aqueous solutions – *viz.* critical solution temperature shifts at atmospheric pressure – are produced by the addition of different ILs.

Thus, a broad spectrum of theoretical studies and possible applications of ILs is covered and we hope that this special issue will serve the large community of chemists by stimulating interest in ionic liquids as a field of study that provides real challenges and opportunities.

Finally we would like to thank all the contributing authors for their efforts and Prof. Dr. *Heinz Falk*, Editor in Chief of Monatshefte für Chemie, for his unlimited support and invaluable help in publishing this special issue.

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