Ionic Liquids Today

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Issue 1-10, Wednesday, 1st December, 2010.

Worldwide more than 6’500 recipients!

>>> Ionic Liquids as Battery Electrolytes

>>> Recent Developments in Biomass Dissolution

Content:

1 Editorial

by Thomas J. S. Schubert.

Presumably you missed a new issue of Ionic Liquids Today this year. Indeed we were not able to release a new one, as our complete team was deeply involved in the move of our complete site from Denzlingen to Heilbronn, which is 80 km north of Stuttgart. At our new headquarters, which are interestingly located at the "Salzstraße", which means "salt street" in English, we made big steps in terms of large volume production. In addition to our continuous flow microreaction systems, we have also access to a 1 ton and a 25 tons batch reactor.

Furthermore, in April 2010 IOLITEC started its operations at Tuscaloosa/Alabama in the United States. The new subsidiary is headed by Tom F. Beyersdorff, surely one of the most experienced people in the ionic liquids business. From Tuscaloosa he is able to deliver ionic liquids, key intermediates and nanomaterials to the US, Canada and Mexico at much better conditions to his customers.

I like to highlight that our company is now part of the Facebook social network. If you have some time, you are cordially invited to visit our website there and to discuss with us topics of actual ionic liquids research on this freshly founded new group at Facebook called "Ionic Liquids". In addition, you can also get in contact with our experts via Skype. This might be also interesting if you have some more detailed questions about our products and services. Please take a look who is responsible for your region (see: Chapter 8 "Community"). If you like to be informed about latest news about IOLITEC, our products or about conferences, fairs etc. you can also receive these information via RSS feeds.

Best regards,

Thomas J. S. Schubert, CEO & Founder, IOLITEC Ionic Liquids Technologies GmbH.

2 Good Things Come to Those Who Wait

By Tom F. Beyersdorff, IOLITEC Inc.

In the first issue of our bulletin Ionic Liquids Today in 2009 we announced the foundation of IOLITEC's US subsidiary for the first quarter of 2009. However, as many of you know, there are always hurdles to overcome that you did not expect in the first place. But finally we succeeded and started operating from our US subsidiary, which is located at the *Business Technology Incubator* at The University of Alabama in Tuscaloosa, with a one year delay in April 2010.

The driving force for the incorporation of our US subsidiary was to improve our services for customers in the NAFTA region with respect to shorter delivery times, pricing that is not influenced by varying exchange rates, reduced shipping costs and elimination of duties and other custom charges.

The first issue of our "NAFTA catalogue", which was published in March 2010, contained 40 selected ionic liquids in the well known IoLiLyte quality, that are in stock in the US in quantities from 25 g to 1 kg and that can be shipped within a few business days. A new version of the catalogue with an increased number of in stock products will be published in the beginning of 2011. In addition to the in-stock-products all IOLITEC products are available with slightly longer delivery times and of course larger quantities of all products are also available on request. Just in case you cannot find the ionic liquid you are looking for in our catalogue, we encourage you to contact us anyway. We offer custom manufacturing of patent free ionic liquids at reasonable prices and in short delivery times.

Furthermore, a selected portfolio of nanomaterials (nano metals, nano metaloxides/-carbides/-nitrides, carbon based nanomaterials and nanoparticle dispersions) is offered. We also welcome our customers to get in contact with us whenever they need to discuss their problems with ionic liquid research or they need a recommendation of an ionic liquid for a special application.

Please direct all inquiries to me (Dr. Tom F. Beyersdorff):
Email: Beyersdorff@iolitec.com
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3 Energy Storage, Part I: Ionic Liquids – Novel Electrolytes for Energy Storage Applications

By Thomas J. S. Schubert, IOLITEC GmbH.

3.1 Introduction

Just before the world wide crisis in 2008/2009, the rising oil prices, which reached their all-time-high levels in view of the so called "oil-peak", accelerated the search and the development of alternative concepts for drives of cars. While at the beginning of the 21st century concepts based on PEM fuel cells were favored, the success of Toyota's hybrid technology, the mix of a common combustion engine together with a battery powered electric motor, put more and more pressure on the development of lighter batteries with higher storage densities, to optimize the operating distance of such vehicles.

While in the USA and Europe only a few battery producers are left, the situation in ASIA is completely different: Japan and South Korea, once the leading countries in Battery innovation, see themselves confronted with China, which intensively invests in the development of sustainable technologies, not only for novel types of batteries for consumer electronic, but also for automotive applications. In the past, Nickel-Cadmium-batteries were used in hybrid cars, but in terms of energy densities Lithium-ion-batteries may be the more attractive systems. The first commercially available completely battery powered car, the Tesla, showed impressively that just by using packages of common notebook Lithium-ion-batteries, which are connected to each other and equipped with a smart battery management, it is possible to drive a car with an operating distance of about 300 km.

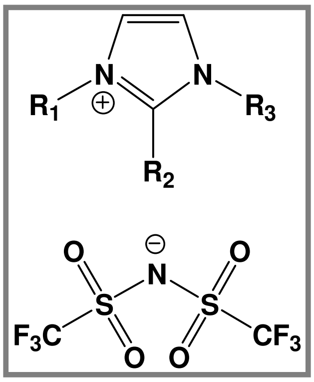
Nevertheless, the use of Lithium-ion-batteries includes also some risks, which came into our minds, when a series of problems with notebook and cell phone batteries caused trouble by short circuits, resulting in low speed detonations or at least overheating combined with the evolution of hazardous gases. To avoid these unlikely problems different strategies are possible: The first one is a clever battery management that leads to a shut down, if a certain temperature is reached. Another important solution is the use of advanced membranes dividing the two semi cells from each other, the so called separator. In this context, the most prominent technology was developed by Evonik, resulting in a high performing, mechanically robust separator which is commercialized under the brand Separion®. The third approach is to use novel types of electrolytes, leading to both, better performance *and* to increased safety. In this context, ionic liquids may be promising candidates, because of their interesting electrochemical properties together with their negligible vapor pressures.

3.2 A brief history of Ionic liquids as electrolytes

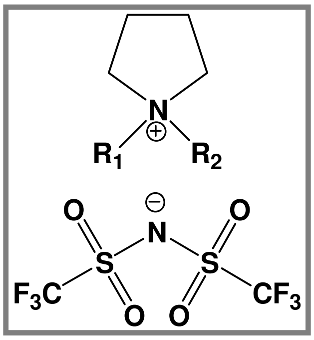
The idea to use ionic liquids as novel types of electrolytes for batteries is definitely not new. The story that is well described in *Welton* and *Wasserscheids* book "Ionic Liquids in Synthesis"[1] began at a time, when the term ionic liquid was not introduced into the language of science and when salts melting at low temperature were named just "molten salts". One of the earliest electrolytes being close to fall under today's common definition of ionic liquids was Sodium tetrachloroaluminate with a melting point of 107 °C. At that time researchers around Dr. L. King at the U.S. Air Force Academy tried to replace molten salts based on LiCl-KCl that were used in thermal batteries. Later they recovered a patent that described mixtures of 1-ethylpyridinium halides with $AlCl_3$ being ionically conductive. Later *Hussey* and *Wilkes* replaced the alkylpyridinium cation, which can be reduced too easy, by the dialkylimidazolium cation, which today dominates ionic liquids research. Nevertheless, the tetrachloroaluminate anion has the intrinsic problem, that it is not stable in the presence of humidity.

Another milestone was introduced by *Zawarotko*, who found in 1992 that a number of different anions such as tetrafluoroborates, hexafluorophosphates, nitrates, sulfates, or acetates formed ionic liquids being more or less stable against hydrolysis. In particular the BF_4 and PF_6 surely caused the hype about ionic liquids, but later they were found not to be the best candidates for the use in batteries, which is remarkable, since $LiPF_6$ is used in Li-ion-batteries as Li-salt. At least today tetrafluoroborate-based ionic liquids are used for electric double layer capacitors (or "Supercaps", "Ultracaps" etc.). They also are still interesting as solvents in organic synthesis or catalysis if they are used in a water free environment.

One of the most important steps was made, when *Koch et al.* as well as *Bonhote* and *Grätzel* identified independently from each other the bis(trifluoromethylsulfonyl)imide anion to be the first anion resulting in hydrophobic, air and water stable ionic liquids, when combined with suitable imidazolium or pyridinium cations. This class of materials is today surely one of the most important groups of ionic liquids, since it combines a suitable electrochemical stability with an ECW of 4.5 V with a sufficient to good viscosity and conductivity. A drawback of the 1,3-dialkylimidazolium salts is the acidity of the C-2 proton which limits their application in some cases.



In 1999 *Sun, MacFarlane and Forsyth* introduced the pyrrolidinum cation into ionic liquids research, which led, when combined with the bis(trifluoromethylsulfonyl)amide anion (BTA or TFSA; TFSI of NTf_2), to a novel type of ionic liquids that had on the advantage a wider electrochemical window of approx. 6.0 V when compared to the salts of imidazolium cations. As a consequence, *N,N'*-Dialkylpyrrolidinium bis(trifluoromethyl-sulfonyl)amides are more stable against reduction, e.g. by Lithium, than imidazolium analogues.



3.3 Ionic Liquids for Lithium-ion batteries

A Lithium-ion-battery is a complex device with a lot of material interactions. In a common device, typically Graphite or amorphous Silicon is used for the negative electrode. Recently, also Carbon Nanotubes or Graphene were also suggested as novel electrode materials. The positive electrode typically consists of $LiCoO_2$ or as $LiFePO_4$ as described in newer concepts. The most commonly used Lithium-salt is $LiPF_6$, but also, according to our information, more stable Lithium bis(trifluoromethylsulfonyl)amide may already be used in high-performance batteries, which are said to have a much higher cycle-stability

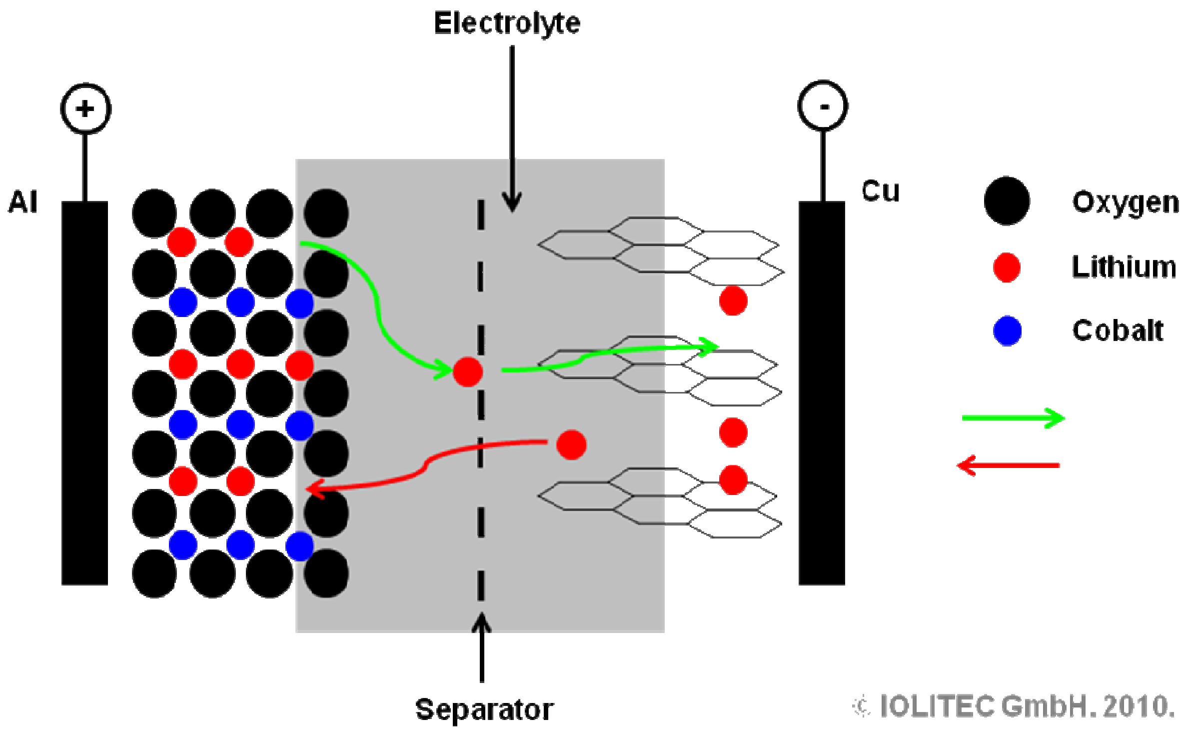


Fig. 1. Common design of a Lithium-ion-battery.

The most common types of electrolytes are ethylen- or diethylcarbonates (EC or DEC), Propylcarbonates (PC) and also mixtures of these. In contrast to alkylcarbonates ionic liquids are typically much more viscous, but they show comparable or even better conductivities (Table 1).

Table 1. Viscosities and conductivities of selected ionic liquids compared to EC:DEC (3:7).

Electrolyte	η [mPa s]	σ [mS cm^{-1}]
EC-DEC (3:7)	7.68 (20°C)	7.24 (20°C)
PMPyrr BTA	46.8 (20°C)	3.816 (20°C)
EMIM BF_4	34 (25°C)	12 (25°C)
AllylMIM BTA	35 (25°C)	2.76 (25°C)
EMIM BTA	39.4 (20°C)	6.634 (20°C)

The conductivity itself is not as important as the specific Lithium-ion-conductivity, since Lithium, as the carrier of charge, has to be transported from one electrode to the other.

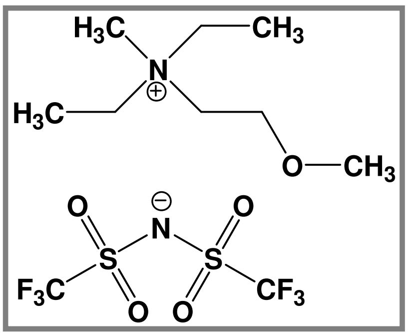
The design of a novel electrolyte is thus a real challenge, because it is not done just by switching from one electrolyte to another and hoping or even praying to get a better performance. Furthermore, in a novel electrolyte at the electrode, a solid electrolyte interface (SEI) has to be formed within the first cycles that works well together with both, the separator *and* the chosen Lithium-salt.

In the joint project "LiBNano" funded by the German Federal Ministry of Education and Research, we investigate together with our partners from the Karlsruhe Institute of Technology (KIT) how to enhance the important *lithium-ion-diffusivity*. To reach this goal, first the basics of transport mechanisms of Lithium ions inside an ionic liquid have to be understood more deeply.

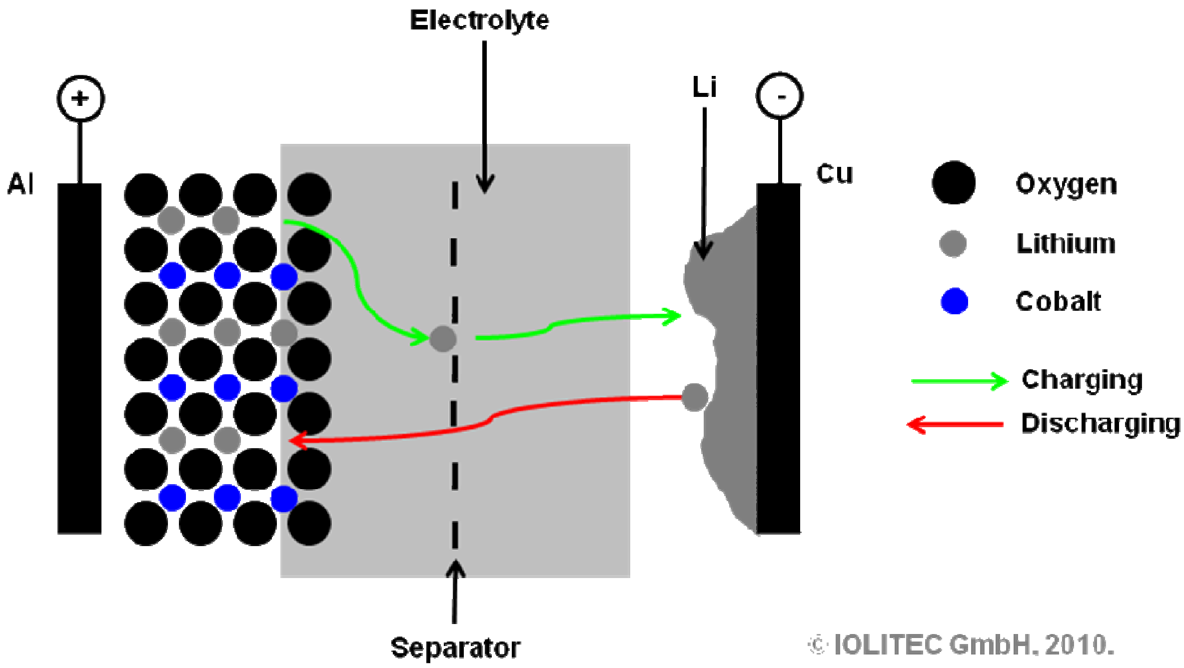
3.4 Ionic Liquids for Lithium-batteries

Lithium-batteries are typically primary batteries that use lithium metal as negative electrode. In contrast to lithium-ion-batteries they are *not rechargeable*. Since lithium has the highest negative standard potential of all chemical elements, it seems to be the ideal material for negative electrodes. The high reactivity of lithium causes problems, since e.g. water reacts vigorously with lithium. As a consequence, only aprotic, non aqueous solvents or solid-state electrolytes can be used for lithium-batteries.

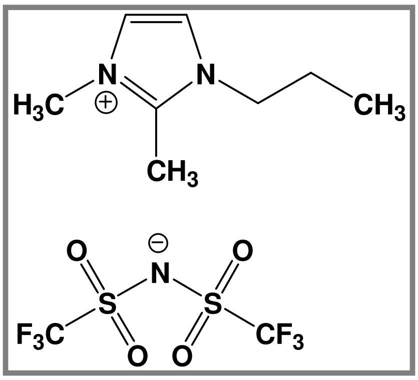
Over the past decade, the idea of designing rechargeable lithium-batteries, or, *lithium-secondary-batteries*, by using ionic liquids was more and more developed. In this context, the first problem to overcome was the stability of ionic liquids against the reduction by lithium. A milestone was reached, when *Seki et al.* used a mixture of *N*,*N*-diethyl-*N*-methyl-*N*-2-methoxyethyl-ammonium bis(trifluoromethylsulfonyl)amide (DEME BTA) with Lithium bis(trifluoromethyl-sulfonyl)amide as



electrolyte. The initial discharge capacity was found to be 145 mAh g^{-1}, dropping to just 118 mAh g^{-1} after 100 cycles. The charge-discharge tests were performed at 3.0 – 4.2 V vs. Li/Li^+.[1]



In 2006 the same group used 1,2-dimethyl-3-propyl-imidazolium bis(trifluoromethylsulfonyl)imide instead of DEME BTA. After 100 cycles the capacity remained at a high level of above 100 mAh g^{-1} (start: 143 mAh g^{-1} end: 113 mAh g^{-1} after 100 cycles) which was better compared to the corresponding 1-ethyl-3-methyl-imidazolium bis(trifluoromethylsulfonyl)-amide-based electrolyte. Short circuit dendritic growth of the lithium on the electrodes was not observed.[2]



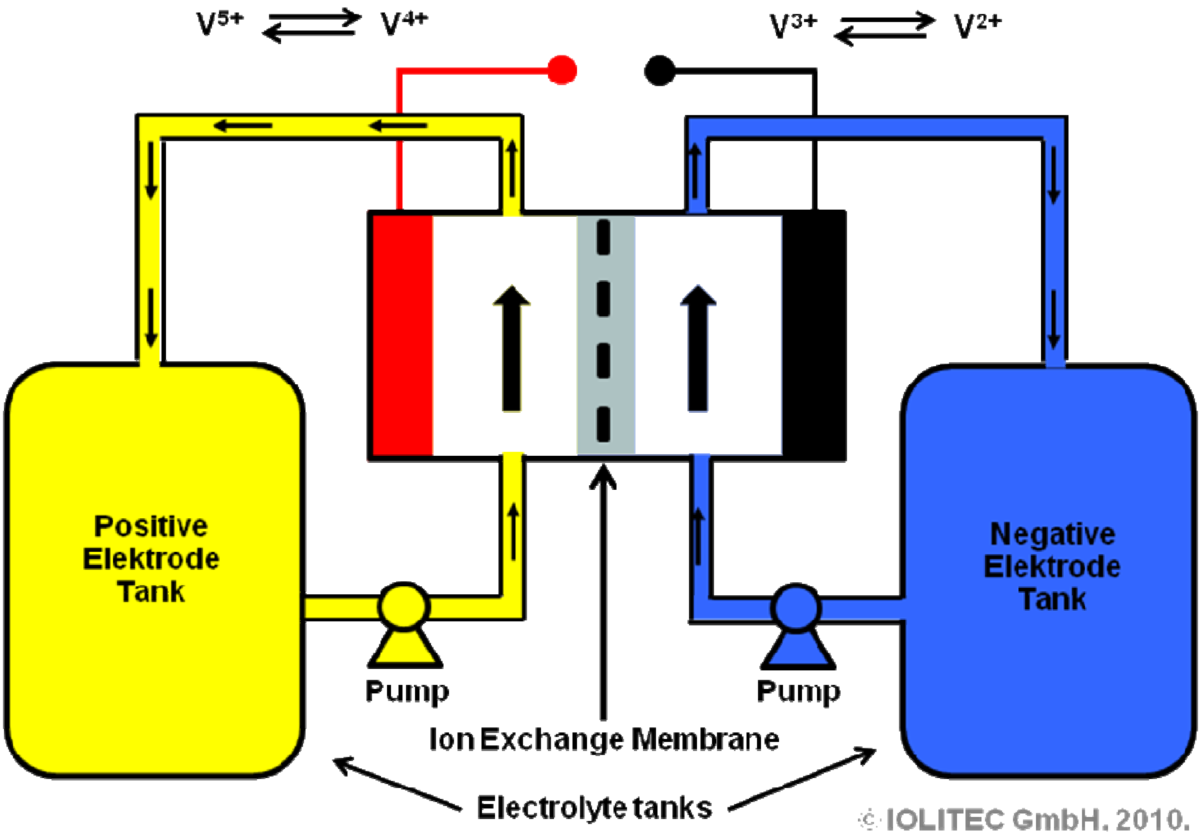
3.5 Flow Batteries

A flow battery is a kind of rechargeable battery in which an electrolyte containing one or more electroactive species flows through an electrochemical cell that converts

1 S. Seki, Y. Kobayashi, H. Miyashiro, Y. Ohno, Y. Mita, A. Usami, N. Terada, M. Watanabe, *Electrochemical and Solid-State Letters* **2005**, 8, A577.
2 S. Seki, Y. Kobayashi, H. Miyashiro, Y. Ohno, A. Usami, Y. Mita, N. Kihira, M. Watanabe, N. Terada, *J. Phys. Chem. B* **2006**, *110*, 10228.

chemical energy directly to electricity. The main advantage of a flow battery is that it can be easily recharged just by changing the electrolyte.

Recently flow batteries attracted more and more interest because of the possibility to use them for storing energy from renewable resources. In this context, also ionic liquids came into focus because of their often wide electrochemical windows and their negligible vapor pressures. An interesting material may be 1-ethyl-3-methylimidazolium trifluoromethylsulfonate, because it leads to a low cathode polarization during the charging process.[3]



In part II, which will be released in the next issue of ionic liquids today, I'll put some light on other battery concepts, but also on supercaps. Please note that all of the ionic liquids describes in this article are available from our standard portfolio from grams to 5 ton.

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[3] Noack, Jens; Tuebke, Jens; Pinkwart, Karsten (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung e.V., Germany). PCT Int. Appl. (2010), 30pp.

4 Ionic Liquids as a Solvent for Dissolution, Fractioning, Cracking and Reprocessing of Biomass and Biopolymers

By Dr. Marcin Smiglak, IOLITEC GmbH.

4.1 What is biomass and how is it a great resource

Biomass, composed mostly of such biopolymers like cellulose, hemicellulose, lignin, starch and chitin is currently one of the most underutilized renewable resource available to humans, if we just realize that nature produces as much biomass in a few days as we, humans, can consume/process in a whole year. So where is the main problem with utilizing this virtually endless resource? This state is mostly due to two major factors: (i) strong position of petroleum-based industry in the production of polymers (thus difficult to compete with) and (ii) difficulty with processing biomass itself, with a limited number of common solvents in which the biopolymers can be dissolved and fractioned.

4.2 But first, what is the biomass composed of?

Cellulose: Cellulose is an organic compound with the formula $(C_6H_{10}O_5)_n$, a polysaccharide consisting of a linear chain (100-10'000) of β (1→4) linked D-glucose units. Cellulose is the structural component of the cell wall of green plants, many forms of algae, and also some species of bacteria. It is the most common organic compound on Earth. About 33 percent of green matter is composed of cellulose (the cellulose content of cotton is 90 percent and that of wood is 40-50 percent).

For industrial use, cellulose is mainly obtained through pulping of wood and cotton. It is mainly used to produce paperboard and paper. Cellulose is also converted to derivative products such as cellophane and rayon. More recently, due to the renewable character of biomass, converting cellulose from energy crops into biofuels, such as cellulosic ethanol, became one of the top topics under investigation in the field of alternative fuels.

Lignin: Lignin is a complex chemical compound and an integral part of the secondary cell walls of plants and some algae. Lignin is one of the most abundant organic polymers on Earth, exceeded only by cellulose. It is containing over 30% of non-oil origin organic carbon and if utilized successfully could be the main source of aromatic products derived not from oil. As a biopolymer, lignin is unusual because of its heterogeneity and lack of a defined primary structure.

Starch: Starch is a carbohydrate, in structure similar to cellulose, consisting of a large number of glucose units connected by glycosidic bonds. This polysaccharide is produced by all green plants as an energy store. Starch, as the most important carbohydrate in the human diet, is contained in food products as potatoes, wheat and rice.

Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol. It consists of two types of molecules: the linear and helical amylose and the branched amylopectin. Starch is processed to produce many of the sugars in processed foods. When dissolved in warm water, it can be used as a thickening, stiffening or gluing agent.

4.3 The main difference between cellulose and starch

Starch and cellulose are very similar polymers. Both are made from the same glucose monomer, and both have the same repeat units. The main difference comes from the orientation of the repeat unit against each other; in starch the repeat units of glucose are unidirectional (orientated in one direction), and in cellulose successive repeat units of glucose rotate 180 degrees relative to the last repeat unit of cellulose. Thus, the units of glucose in starch are connected by alpha linkages, while in cellulose by beta linkages.

As a result, starch can be eaten and broken down to glucose by enzymes, but cellulose is not digestible by humans. Such enzymes that convert cellulose into glucose are found in the bodies of animals like termites, which feed on wood, and cattle, which eat grass.

On the other hand, while starch does not have any practical uses beside dietary, cellulose is used to make fibers. Thanks to its water insolubility and better stability cellulose is used to make materials that are used to make many useful products starting from paper, through clothing, ending on wooden elements for construction.

4.4 Current methods for separation of biomass

Current methods for the separation of lignocellulosic biomass and recovery of pure fractions of individual components like cellulose and lignin, in most cases still involve chemical pulping, which accounts for almost ¾ of worldwide production of pulp. Such processes like Kraft and Organosolv beside being chemically and economically expensive (multiple reactors, caustic chemicals, large amount of water use, bleaching) are very often associated with production of large amount of waist and thus being non-eco friendly.

4.5 About ILs and the discovery of their dissolution power

Recent developments in the research on ionic liquids and their use in dissolving, processing, and fractioning of biomass led to the recognition of large amounts of various ionic liquids capable to process biomass (often directly without pretreatment) with additional advantage of a possible recycling of these solvents. Currently, the most vigorous research efforts in processing biomass utilizing ionic liquids is lead by the group of Professor Dr. Robin D. Rogers (The University of Alabama), the person behind the discovery of the ionic liquids' cellulose dissolution power[4]. More recently Dr. Rogers et al.reported on the dissolution of chitin from shrimp shells[5] and direct dissolution of wood.[6] Moreover multiple research groups and industrial companies like BASF are currently investing their time in biomass-ionic liquids related research and this broad topic was recently very thoroughly reviewed by MacFarlane *et al.*[7] We all believe that this revolutionary discovery will lead to the development of biomass fractioning and "cracking" technology in the future that will allow to compete and maybe even replace current petroleum-based chemical and polymer industry,

4 Swatloski, R. P; Spear, S. K.; Holbrey, J. D.; Rogers, R. D. *J. Am. Chem. Soc.* **2002** *124*, 4974.
5 Qin, Y.; Lu, X.; Sun, N.; Rogers, R. D. *Green Chem.*, **2010**, *12*, 968.
6 Fort, D. A.; Remsing, R. C.; Swatloski, R. P.; Moyna, P.; Moyna, G.; Rogers, R. D. *Green Chem.* **2007**, *9*, 63.
7 Tan, S. S. Y.; MacFarlane, D. R.; *Top Curr. Chem.* **2009**, *290*, 311.

especially as the prices of those chemicals are fast approaching prices of commodity chemicals.

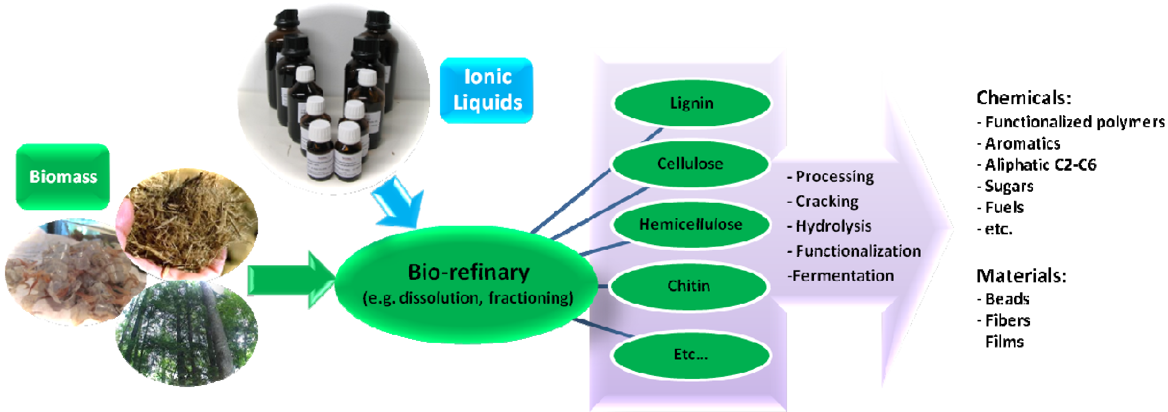


Fig. 1. Vision of Ionic Liquid-based bio-refinary.

Our tests on IL Matrix

Even though there is over 1'000 literature reports on the dissolution and reprocessing of biomass utilizing ionic liquids, screening for new ILs capable of dissolution and reprocessing of biomass is far from over. This is mostly due to the enormous amount of ion combinations that can be prepared as ILs. In our laboratory we have a privilege of being able to test hundreds of ILs at the same time as our ILs catalogue contains over 300 IL products and we posses most of them in stock. Utilizing our know-how and available literature reports we have selected a matrix of 48 ionic liquids composed of various cations and anions (Figure 1) and tested their dissolution power toward three biopolymers: cellulose, lignin and starch. The IL selection criteria involved considerations of: (i) kind of cation core (pyrrolidinium, imidazolium, aromatic, aliphatic, cyclic), (ii) length of alkyl chains, (iii) functional groups on alkyl chains and (iv) anion kind.

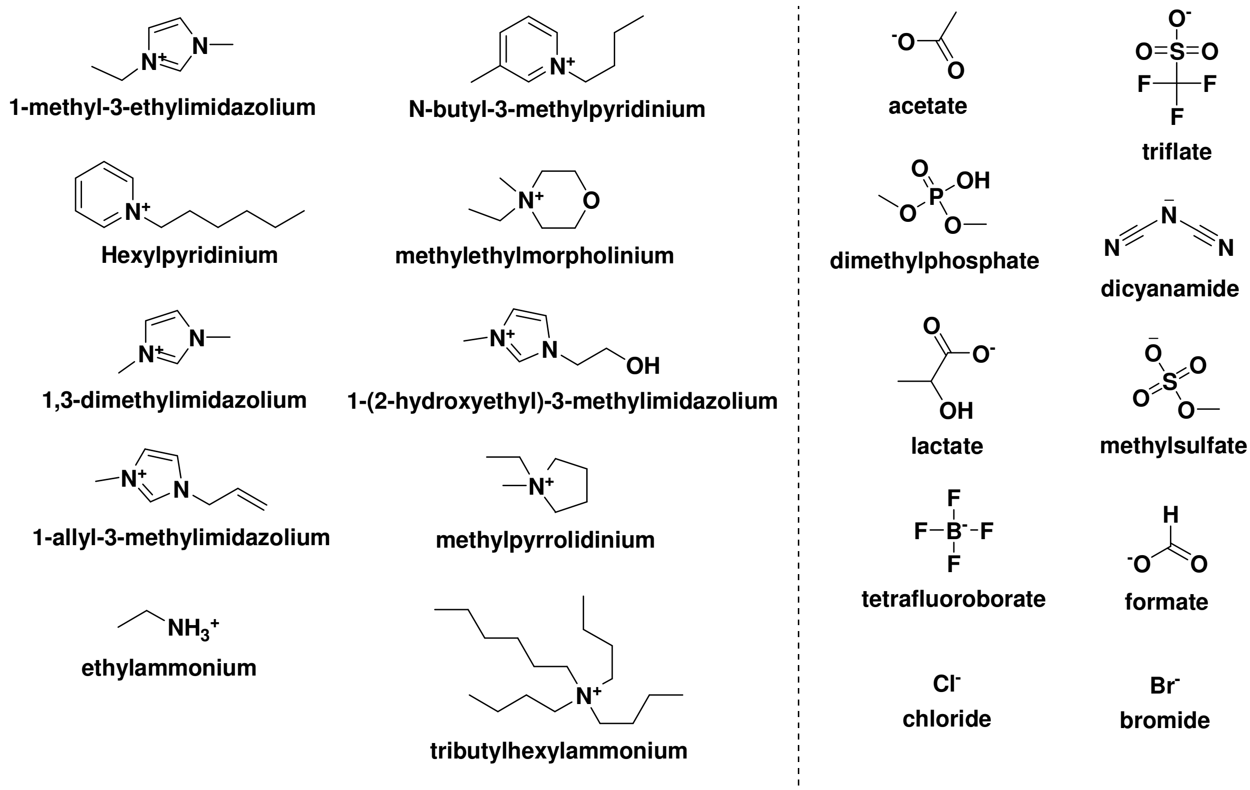


Fig. 2. Examples of classes of cations (on the left) and anions (on the right) used for the biopolymers dissolution studies.

All of the experiments were carried out in the same fashion, placing 4-5 g of IL in a glass vial and initially heating up the ILs in the heating block for the period of 60 min at 80 °C. After that time, biomass was added to the preheated ILs and the mixture was vigorously stirred for 1 min after which the vial was placed back in the heating block. The following amounts of particular biomaterial were added to ILs:

i. For the experiments with cellulose, 10 % w/w of cellulose was added

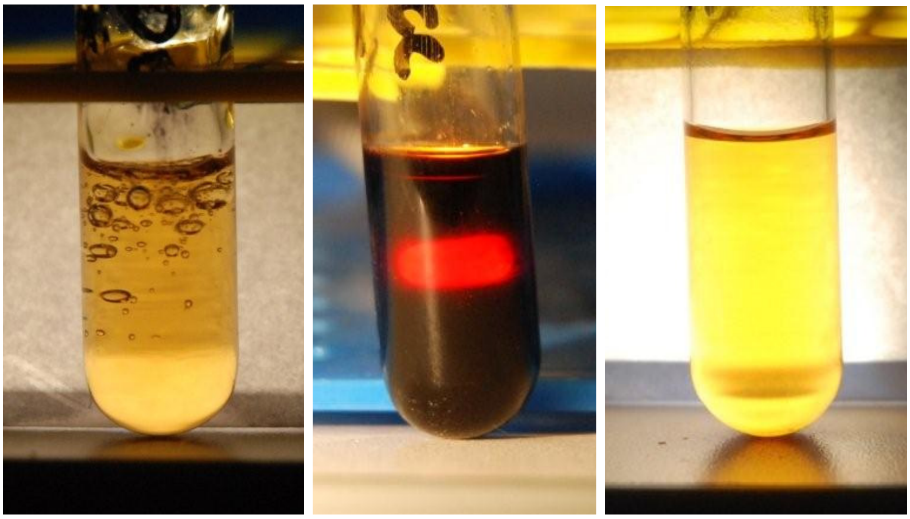
ii. For experiments with lignin, 5 % w/w of lignin was added

iii. For experiments with starch, 5 % w/w of starch was added

The samples were left in the heating block for additional 60 min occasionally stirring. After that time, visual analysis was performed to evaluate the results of the dissolution experiments.

Out of all performed experiments

i. nine salts were found to dissolve cellulose completely (including commonly know EMIM OAc, HexPy Cl, EMIM DEP, BMIM Cl) (Figure 3a)
ii. almost all of the salts were found to dissolve lignin, forming homogeneous, deeply colored solution (Figure 3b)
iii. one example of IL that did not dissolve lignin at all
iv. one IL was found to dissolve starch completely (Figure 3c).



a. b. c.

Fig. 3. Successful examples of dissolution of biopolymers in ILs; a. 10% cellulose in IL; b. 5% lignin in IL (with light in background to show homogenicity and color of the sample); c. 5% starch in IL.

Our initial results support our hypothesis that tuneability of ionic liquid properties by means of modification of the structure of the cation and anion allows to select particular IL for specific application, as in the presented case, dissolution of biomaterials. We are pleased to present these initial results as a showcase of our R&D capabilities and to encourage anyone interested in similar studies to be performed on larger set of ILs to contact our company to discuss the possibilities of collaboration research. With our expertise, capabilities, know-how, and availability of large amounts of various ionic liquids (>300), IoLiTec is able to help you with your research on various IL projects!

5 Conferences & Fairs

Impressions from the DSC-IC 2010,

Colorado Springs, Co, USA, November 1st-4th, 2010.

By Tom F. Beyersdorff, IOLITEC Inc.

From November 1st-4th 2010 almost 200 attendees from 24 countries gathered for the first DSC-IC conference in the USA. The conference was organized in cooperation between Dyesol and IntertechPira and was held at the Cheyenne Mountain Resort in Colorado Springs. The DSC-IC is the world's only conference focused exclusively on the commercialization of dye-sensitized solar cells.

After the pre-symposium on November 1st 36 speakers presented their efforts in the commercialization of ionic liquids and the improvement of the technology. The opening presentation was given by the father of DSSC technology Prof. Graetzel from EPFL who gave an introduction into the technology, reported recent developments and gave an outlook on markets and prices for DSSCs.

Presentations from G24i, Solarprint, Solaronix and other companies focused on their work to commercialization of DSSCs. Several companies presented their strategy for the installation of larger production lines in the next years. In this context Dr. Bari's comment "Apply or Die" caused a controversial discussion, since G24i has already produced a first series of flexible DSSCs that are commercially available in different consumer products but the next more important step to building integrated DSSCs has not yet been completed yet.

A subject that had been addressed by many speakers from industry was the goal in pricing for DSSCs, in order for these products to be competitive compared to other technologies on the market. The mentioned prices for glass modules reached from 70-100$/m^2 and approx 1$/Wp which was regarded by most speakers as challenging but possible. By far the largest portion (>90 %) of the price still comes from the coated glass plates, the TiO_2 and of course the dye. It was also questioned if the price requirements can be met with new more complex dyes that have recently been developed.

A lot of research is still dedicated to improve the light harvesting properties of the dyes. In particular higher extinction coefficients and a higher absorption in the IR region are of interest. Dr. Berlinguette from Calgary University gave a lecture on the design of new Ru-dyes and presented fundamental insights into the development of dyes with higher light harvesting efficiencies. His intention was to replace the SCN-ligands in the Ru-complex' by bidentate C-N-Ligands in order to influence the oxidation potential of the dye. A similar approach was presented by Dr. Han who replaced the SCN-ligands by an Acetylacetonato- derived ligand in order to increase the IR absorption of the dyes. In addition to new Ru-dyes several modifications of organic dyes as well as alternative anchoring groups have been presented.

Another important part of the DSSCs that still needs development is the electrolyte. In most cases a Iodide-Triiodide-redox shuttle is still used but many speakers expressed the demand for non-corrosive alternatives. Not surprisingly the almost 10-year-old idea of using $Co(bipy)_3^{3+/2+}$ (bipy= bipyridyl) came up as a solution in several presentations. The poster award honored a similar approach in which Ni-carboborane complexes where used as redox-system. Dr. Desilvestro from Dyesol pointed out in his presentation that the Iodide-Triiodide system is a relatively slow system with a high driving force and therefore the overall energy gain is relatively low even though the system is relatively small compared to the $Co^{3+/2+}$ system. He also predicted that the maximum efficiency that can be achieved with an optimized Iodide-Triiodide system will be in the range of 14% whereas with optimized hole-conductors efficiencies in the range of 19% will be possible. During the DSSC-electrolyte session Dr. Beyersdorff presented IOLITEC's work in the scale-up of the manufacturing of ionic liquids in his presentation "Large Scale Production of Ionic Liquids as Electrolytes for DSSCs" with a focus on iodide based ionic liquids.

A whole session was dedicated to modeling and measuring of DSSC performances. Especially the accurate measurement and comparison of measurements was a topic since consistent standards are not yet set in place.

As it is well known from IntertechPira conferences, the DSC-IC offered plenty of time for networking besides the presentations and the poster session during breakfast, coffee breaks and evening receptions. The exhibition that accompanied the conference hosted companies like IOLITEC, Dyesol, Solaronix, EMD, Everlight, Organica and several more.

IOLITEC would like to thank and congratulate the organizers of the conference for their excellent choice of the location. Most of the rooms at the conference hotel offered a spectacular mountain view which was even more amazing during sunrise. I should not forget to mention the deer that was standing on the side of the parking lot when I returned to my room the evening of November 1st.

Additional thanks to all participants in the conference who made the DSC-IC an exciting event with a very promising outlook on the commercialization of DSSCs in the near future.

Impressions from the fair "Nanotech 2010"
Tokyo, Japan, February 17-19, 2010.

By Boyan Iliev and Frank Stiemke, IOLITEC GmbH.

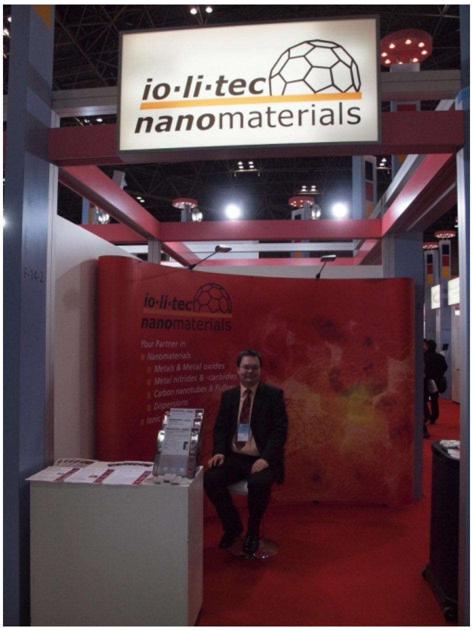
Please contact science@iolitec.de if you like to receive a PDF-version of IOLITEC's presentation ***"Ionic Liquids as novel media for the synthesis and dispersion of nanomaterials"***

During the 9th edition of one of the biggest nanotechnology exhibitions worldwide, 654 exhibitors from 19 countries presented the latest nanotechnologies and products to a crowd of 45,000 visitors. This year's main theme was Green Nanotechnology, and Iolitec, with its 300 ionic liquid and almost 150 nano-particle products with application for fuel cells and solar cells also took part in the special symposium and a poster session (**Ionic Liquids – Green Solvents for Preparation of Nanoparticles and Safe-to-handle Nanoparticle Dispersions**) dedicated to the topic of Green Nanotechnology.

We identified a large interest in applications of nanotechnology like oil discovery, solar energy, or storage of energy, but also the interest in safety issues of nanoscaled materials was also surprisingly high. Furthermore, the use of ionic liquids as electrolytes for DSSC and Li-ion batteries attracted a lot of concern. In this context, we presented with great success our ionic liquid-based dispersion-technology at our booth and during the poster session.

IOLITEC's presentation at the "Seeds & Needs Seminar" gave an overview about the synthesis of ultra small nanoparticles and how nanoparticles, which were synthesized by other methods, can be redispersed in solvents like water by using ionic liquids as additives. Furthermore, it was pointed out on the poster, how this method allows the safer handling of nanoparticles. Many - mostly non-Japanese - customers joined Dr. Stiemke at IOLITEC´s poster during the poster sessions and asked for more information about the properties of the ionic liquids and the PCCS measurement, which was used for the stability determination of the dispersions.

Nanotech 2010 – not only a fair for nanomaterials, but for ionic liquids, too!



Impression from the Chemspec Europe 2010
Berlin, June 09 – 10, 2010.
By Dr. Sven Sauer, IOLITEC GmbH.

Please contact science@iolitec.de if you like to receive a PDF-version of IOLITEC's presentation **"Ionic Liquids & Nano-Particles – Novel Materials for Cleantech Applications"**.

Chemspec Europe is the leading exhibition of the fine and speciality chemicals industry. After the poor year for the chemical industry in 2009, the Chemspec in

2010 had around 15% more exhibitors and approx. 10% more visitors than the year before and most of the major players in Europe were present as exhibitors. This year not only classical companies offering fine chemicals were part of the exhibition but also companies from the field of personal care, industrial cleaning, water treatment, dyes and colours, electronics, speciality additives, photovoltaics, polymers and general industrial chemicals presented their products and developments. The mood of exhibitors and visitors was optimistic and the interest in new products and materials was high.

IOLITEC as fast growing producer of ionic liquids and nano-materials was also part of this fair. We presented new products and the latest developments in the field of fine chemicals and green technologies.

To emphasize the importance of ionic liquids and nano materials for future application Dr. Thomas Schubert presented an overview about applications of ionic liquids and nano-materials and even combinations of both in the area of Clean Technologies in the exhibitors showcase at Chemspec Europe.

IOLITEC's booth was well visited and a lot of fruitful and open discussions about new opportunities and applications for ionic liquids and nano-materials took place. It was also noticeable that a lot of visitors at our booth demanded larger quantities of Ionic Liquids for industrial applications since the price of ionic liquids continuously dropped, making them more and more attractive to replace old conventional technologies. IOLITEC therefore is well prepared to deliver larger amounts of ionic liquids to satisfy our customers' demands.

Impressions from the Conference Green Solvent for Synthesis, October 10 -13, 2010, Berchtesgaden, Germany.

By Thomas J. S. Schubert.

The fourth conference of the Green Solvents Series took place at the wonderful city of Berchtesgaden in Bavaria/Germany. This time the focus was on synthesis and application of green solvents, which are supercritical CO_2, water and ionic liquids.

In the opening lecture *Phil Jessop* compared different classes of solvents in terms of their greenness. Surely one of the most important points in this context was the number of steps that are necessary to synthesize common solvents compared to ionic liquids. The result is in this context of course no surprise: it takes more reaction steps to synthesize ionic liquids than to synthesize e.g. acetone. But Jessop's conclusion, that ionic liquids are as a consequence not green solvents, was from my, but also from the point of view of many other participants of the conference only completely wrong, because it was only one part of the story. If one look just in the rear view mirror, it not possible to see what might happen in front of you:

1. He considered not that ionic liquids haven't a significant vapor pressure, which reduces the problems with common VOCs.
2. He considered not that ionic liquids can be recycled easily and be reused many times. E.g. IOLITEC received at the Informex 2010 the "Profiles in Sustainable Chemistry Award" for the "Rent-an-Ionic-Liquid" business model.
3. Ionic Liquids enable a number of cleantech applications (batteries, supercaps, solvents for catalysis & biomass dissolution etc.), so one has to look carefully at the CO_2-balance of the *whole process*, or, in other words, one has to account also the *CO_2 reduction effected by the use of ionic liquids* in a process.

Anyway, though one could think that the point of view of somebody who founded a company named Ionic Liquid Technologies might be a little bit influenced in this concern, but isn't Jessop's view, who stands for research with supercritical CO_2 also a little bit prejudiced?

Wasserscheid reported about impressive results based on the Supported-Ionc-Liquid-Phase concept (SILP): His fruitful co-operation with Südchemie AG led to another example of a commercialization of an ionic liquid based application (commercialization in 2011).

In my own talk, I presented how ionic liquids can be used successfully for the synthesis and for the dispersion of *nano-scaled materials*. If you are interested in this talk please send us an e-Mail to science@iolitec.de.

From my point of view the highlight of the conference was *Jess'* talk about the "Analysis of evaporation and thermal decomposition of ionic liquids by thermogravimetry at ambient pressure and UHV". In his contribution *Jess* showed impressively how to determine the thermal stability and the vapor pressure. The low vapor pressure is surely the most important property of ionic liquids, because this property marks the difference to other liquids and enables in many cases novel applications. Until today only a few papers gave a sufficient answer to the question, how large vapor pressures of typical ionic liquids are. But by using his method, *Jess* was able to estimate that it will take a billion years until just 1% of a common ionic liquid is evaporated!

View from the Kongresshaus Berchtesgaden: Unfair weather to sit inside, but the excellent presentations made it easy!

Competence in ionic liquids:
Dr. Maria Taige at our booth.

At the conference diner Professor Leitner provided to the participants some background information about the Bavarian lifestyle.

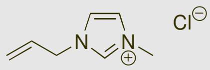
At BASF' booth: the famous table kicker! (location of many IOLITEC's defeats).

6 Special Offers

Now, for limited time **we offer 15% discount**, from our standard catalogue prices, for the ionic liquids listed below in the packing sizes 25 g, 50 g, and 100 g. Hurry, this offer is valid only till the end of January 2011 or till the supplies last. While ordering please mention Promo Code: **WINTER2010**

1-Allyl-3-methylimidazolium chloride, >98% — **Take off 15%**

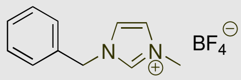
IL-0022-HP [65039-10-3] $C_7H_{11}N_2Cl$ MW 158.63



25 g	60.00 €
50 g	80.00 €
100 g	105.50 €

1-Benzyl-3-methylimidazolium tetrafluoroborate, 99% — **Take off 15%**

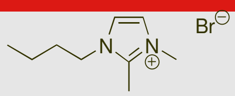
IL-0193-HP [500996-04-3] $C_{11}H_{13}BF_4N_2$ MW 260.04



25 g	65.00 €
50 g	85.00 €
100 g	130.00 €

1-Butyl-2,3-dimethylimidazolium bromide, 99% — **Take off 15%**

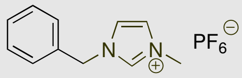
IL-0055-HP [475575-45-2] $C_9H_{17}BrN_2$ MW 233.15



25 g	67.50 €
50 g	90.00 €
100 g	120.00 €

1-Benzyl-3-methylimidazolium hexafluorophosphate, 99% — **Take off 15%**

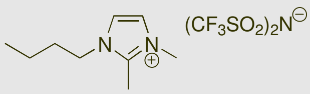
IL-0187-HP [433337-11-2] $C_{11}H_{13}F_6N_2P$ MW 318.20



25 g	65.00 €
50 g	85.00 €
100 g	127.50 €

1-Butyl-2,3-dimethylimidazolium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

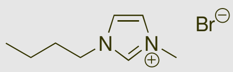
IL-0104-HP [350493-08-2] $C_{11}H_{17}F_6N_3O_4S_2$ MW 433.39



25 g	85.00 €
50 g	110.00 €
100 g	158.00 €

1-Butyl-3-methylimidazolium bromide, 99% — **Take off 15%**

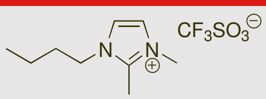
IL-0037-HP [85100-77-2] $C_8H_{15}BrN_2$ MW 219.12



25 g	45.00 €
50 g	60.00 €
100 g	80.00 €

1-Butyl-2,3-dimethylimidazolium trifluoromethanesulfonate, 99% — **Take off 15%**

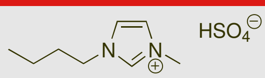
IL-0059-HP [765910-73-4] $C_{10}H_{17}F_3N_2O_3S$ MW 302.32



25 g	127.50 €
50 g	170.00 €
100 g	255.00 €

1-Butyl-3-methylimidazolium hydrogen sulfate, 99% — **Take off 15%**

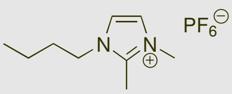
IL-0060-HP [262297-13-2] $C_8H_{16}N_2O_4S$ MW 236.29



25 g	70.00 €
50 g	92.50 €
100 g	145.00 €

1-Butyl-2,3-dimethylimidazolium hexafluorophosphate, 99% — **Take off 15%**

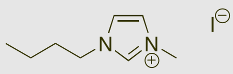
IL-0057-HP [227617-70-1] $C_9H_{17}F_6N_2P$ MW 298.21



25 g	72.50 €
50 g	97.50 €
100 g	145.00 €

1-Butyl-3-methylimidazolium iodide, >98% — **Take off 15%**

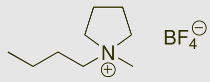
IL-0051-HP [65039-05-6] $C_8H_{15}IN_2$ MW 266.12



25 g	80.00 €
50 g	107.50 €
100 g	170.00 €

1-Butyl-1-methylpyrrolidinium tetrafluoroborate, 99% — **Take off 15%**

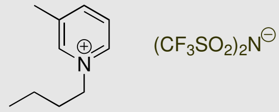
IL-0077-HP [345984-11-4] $C_9H_{20}BF_4N$ MW 229.07



25 g	85.00 €
50 g	105.00 €
100 g	150.00 €

1-Butyl-3-methylpyridinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

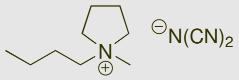
IL-0216-HP [344790-86-9] $C_{12}H_{16}F_6N_2O_4S_2$ MW 430.39



25 g	97.50 €
50 g	132.50 €
100 g	222.50 €

1-Butyl-1-methylpyrrolidinium dicyanamide, >98% — **Take off 15%**

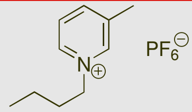
IL-0041-HP [370865-80-8] $C_{11}H_{20}N_4$ MW 208.30



25 g	125.00 €
50 g	165.00 €
100 g	250.00 €

1-Butyl-3-methylpyridinium hexafluorophosphate, 99% — **Take off 15%**

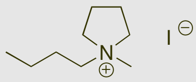
IL-0080-HP [845835-03-2] $C_{10}H_{16}F_6NP$ MW 295.21



25 g	82.50 €
50 g	110.00 €
100 g	147.50 €

1-Butyl-1-methylpyrrolidinium iodide, >98% — **Take off 15%**

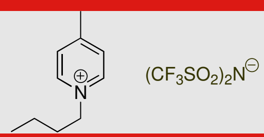
IL-0050-HP [56511-17-2] $C_9H_{20}IN$ MW 269.17



25 g	107.50 €
50 g	142.50 €
100 g	215.00 €

1-Butyl-4-methylpyridinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

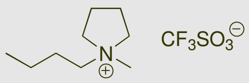
IL-0219-HP [475681-62-0] $C_{12}H_{16}F_6N_2O_4S_2$ MW 430.39



25 g	99 €
50 g	132.50 €
100 g	225.00 €

1-Butyl-1-methylpyrrolidinium trifluoromethanesulfonate, 99% — **Take off 15%**

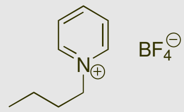
IL-0113-HP [367522-96-1] $C_{10}H_{20}F_3NO_3S$ MW 291.33



25 g	130.00 €
50 g	172.50 €
100 g	262.50 €

1-Butylpyridinium tetrafluoroborate, 99% — **Take off 15%**

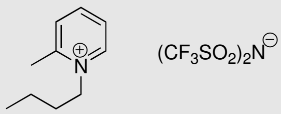
IL-0089-HP [203389-28-0] $C_9H_{14}BF_4N$ MW 223.02



25 g	117.50 €
50 g	157.50 €
100 g	210.00 €

1-Butyl-2-methylpyridinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

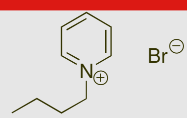
IL-0228-HP [384347-09-5] $C_{12}H_{16}F_6N_2O_4S_2$ MW 430.39



25 g	105.00 €
50 g	140.00 €
100 g	237.50 €

1-Butylpyridinium bromide, 99% — **Take off 15%**

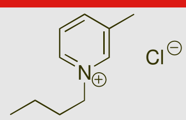
IL-0086-HP [874-80-6] $C_9H_{14}BrN$ MW 216.12



25 g	95.00 €
50 g	127.50 €
100 g	170.00 €

1-Butyl-3-methylpyridinium chloride, >98% — **Take off 15%**

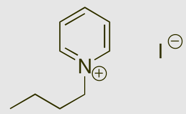
IL-0079-HP [125652-55-3] $C_{10}H_{16}ClN$ MW 185.69



25 g	117.50 €
50 g	155.00 €
100 g	205.00 €

1-Butylpyridinium iodide, >98% — **Take off 15%**

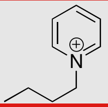
IL-0176-HP [874-81-7] $C_9H_{14}IN$ MW 263.12



25 g	125.00 €
50 g	165.00 €
100 g	220.00 €

1-Butylpyridinium bis(trifluoromethylsulfonyl)imide, 99%
Take off 15%

IL-0213-HP [187863-42-9] $C_{11}H_{14}F_6N_2O_4S_2$ MW 416.36

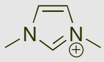


$(CF_3SO_2)_2N^{\ominus}$

25 g	105.00 €
50 g	140.00 €
100 g	240.00 €

1,3-Dimethylimidazolium dimethyl phosphate, >98%
Take off 15%

IL-0053-HP [654058-04-5] $C_7H_{15}N_2O_4P$ MW 222.18

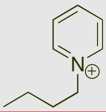


$(MeO)_2PO_2^{\ominus}$

25 g	77.50 €
50 g	100.00 €
100 g	165.00 €

1-Butylpyridinium hexafluorophosphate, 99%
Take off 15%

IL-0088-HP [186088-50-6] $C_9H_{14}F_6NP$ MW 281.18

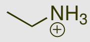


$PF_6^{\ominus}$

25 g	95.00 €
50 g	127.50 €
100 g	170.00 €

Ethylammonium nitrate, >97%
Take off 15%

IL-0043-SG [22113-86-6] $C_2H_9N_2O_3$ MW 108.11

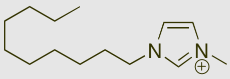


$NO_3^{\ominus}$

25 g	57.50 €
50 g	75.00 €
100 g	127.50 €

1-Decyl-3-methylimidazolium bromide, >98%
Take off 15%

IL-0064-HP [188589-32-4] $C_{14}H_{27}BrN_2$ MW 303.28

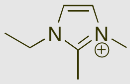


$Br^{\ominus}$

25 g	72.50 €
50 g	95.00 €
100 g	155.00 €

1-Ethyl-2,3-dimethylimidazolium bis(trifluoromethylsulfonyl)imide, 99%
Take off 15%

IL-0106-HP [174899-90-2] $C_9H_{13}F_6N_3O_4S_2$ MW 405.34

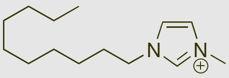


$(CF_3SO_2)_2N^{\ominus}$

25 g	95.00 €
50 g	130.00 €
100 g	225.00 €

1-Decyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, >98%
Take off 15%

IL-0100-HP [433337-23-6] $C_{16}H_{27}F_6N_3O_4S_2$ MW 503.53

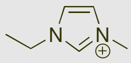


$(CF_3SO_2)_2N^{\ominus}$

25 g	107.50 €
50 g	145.00 €
100 g	245.00 €

1-Ethyl-3-methylimidazolium bromide, 99%
Take off 15%

IL-0015-HP [65039-08-9] $C_6H_{11}BrN_2$ MW 191.07

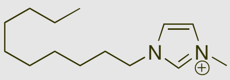


$Br^{\ominus}$

25 g	62.50 €
50 g	82.50 €
100 g	110.00 €

1-Decyl-3-methylimidazolium chloride, >98%
Take off 15%

IL-0065-HP [171058-18-7] $C_{14}H_{27}ClN_2$ MW 258.83

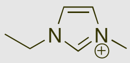


$Cl^{\ominus}$

25 g	77.50 €
50 g	102.50 €
100 g	165.00 €

1-Ethyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, 99%
Take off 15%

IL-0023-HP [174899-82-2] $C_8H_{11}F_6N_3O_4S_2$ MW 391.31

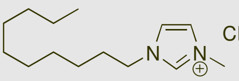


$(CF_3SO_2)_2N^{\ominus}$

25 g	55.00 €
50 g	75.00 €
100 g	120.00 €

1-Decyl-3-methylimidazolium trifluoromethanesulfonate, 99%
Take off 15%

IL-0068-HP [412009-62-2] $C_{15}H_{27}F_3N_2O_3S$ MW 372.45

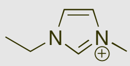


$CF_3SO_3^{\ominus}$

25 g	127.50 €
50 g	170.00 €
100 g	255.00 €

1-Ethyl-3-methylimidazolium ethyl sulfate, 99%
Take off 15%

IL-0033-HP [342573-75-5] $C_8H_{16}N_2O_4S$ MW 236.29

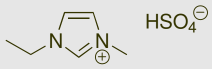


$EtOSO_3^{\ominus}$

25 g	30.00 €
50 g	40.00 €
100 g	70.00 €

1-Ethyl-3-methylimidazolium hydrogen sulfate, 99% — **Take off 15%**

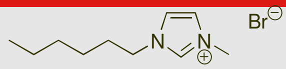
IL-0091-HP [412009-61-1] $C_6H_{12}N_2O_4S$ MW 208.24



25 g	57.50 €
50 g	77.50 €
100 g	102.50 €

1-Hexyl-3-methylimidazolium bromide, 99% — **Take off 15%**

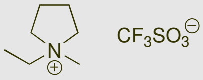
IL-0069-HP [85100-78-3] $C_{10}H_{19}BrN_2$ MW 247.18



25 g	77.50 €
50 g	102.50 €
100 g	135.00 €

1-Ethyl-1-methylpyrrolidinium trifluoromethanesulfonate, 99% — **Take off 15%**

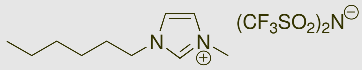
IL-0168-HP [893443-18-0] $C_8H_{16}F_3NO_3S$ MW 263.28



25 g	150.00 €
50 g	197.50 €
100 g	300.00 €

1-Hexyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0098-HP [382150-50-7] $C_{12}H_{19}F_6N_3O_4S_2$ MW 447.42



25 g	85.00 €
50 g	110.00 €
100 g	175.00 €

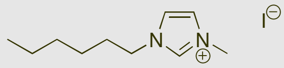
1-Ethylpyridinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0211-HP [712354-97-7] $C_9H_{10}F_6N_2O_4S_2$ MW 388.31

25 g	105.00 €
50 g	137.50 €
100 g	235.00 €

1-Hexyl-3-methylimidazolium iodide, >98% — **Take off 15%**

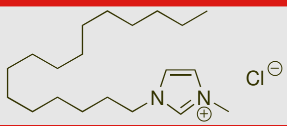
IL-0026-HP [178631-05-5] $C_{10}H_{19}IN_2$ MW 294.18



25 g	77.50 €
50 g	102.50 €
100 g	165.00 €

1-Hexadecyl-3-methylimidazolium chloride, >98% — **Take off 15%**

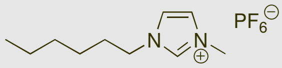
IL-0115-HP [61546-01-8] $C_{20}H_{39}ClN_2$ MW 343.00



25 g	87.50 €
50 g	105.00 €
100 g	147.50 €

1-Hexyl-3-methylimidazolium hexafluorophosphate, 99% — **Take off 15%**

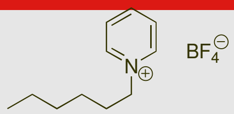
IL-0018-HP [304680-35-1] $C_{10}H_{19}F_6N_2P$ MW 312.24



25 g	47.50 €
50 g	65.00 €
100 g	110.00 €

1-Hexylpyridinium tetrafluoroborate, 99% — **Take off 15%**

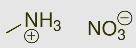
IL-0108-HP [474368-70-2] $C_{11}H_{18}NBF_4$ MW 251.07



25 g	112.50 €
50 g	147.50 €
100 g	197.50 €

Methylammonium nitrate, >97% — **Take off 15%**

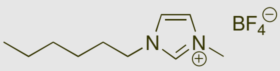
IL-0124-SG [22113-87-7] $CH_6N_2O_3$ MW 94.07



25 g	60.00 €
50 g	77.50 €
100 g	132.50 €

1-Hexyl-3-methylimidazolium tetrafluoroborate, 99% — **Take off 15%**

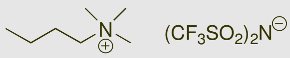
IL-0019-HP [244193-50-8] $C_{10}H_{19}BF_4N_2$ MW 254.08



25 g	50.00 €
50 g	67.50 €
100 g	105.00 €

Butyltrimethylammonium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0032-HP [258273-75-5] $C_9H_{18}F_6N_2O_4S_2$ MW 396.37

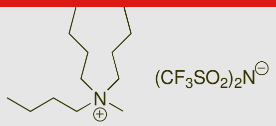


25 g	75.00 €
50 g	97.50 €
100 g	175.00 €

Tributylmethylammonium bis(trifluoromethylsulfonyl)imide, 99%

Take off 15%

IL-0117-HP [405514-94-5] $C_{15}H_{30}F_6N_2O_4S_2$ MW 480.53

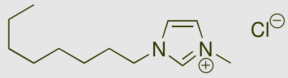


25 g	90.00 €
50 g	117.50 €
100 g	195.00 €

1-Methyl-3-octylimidazolium chloride, >98%

Take off 15%

IL-0072-HP [64697-40-1] $C_{12}H_{23}ClN_2$ MW 230.78

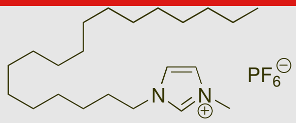


25 g	110.00 €
50 g	145.00 €
100 g	195.00 €

1-Methyl-3-octadecylimidazolium hexafluorophosphate, >98%

Take off 15%

IL-0159-HP [219947-96-3] $C_{22}H_{43}F_6N_2P$ MW 480.55

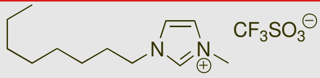


25 g	145.00 €
50 g	190.00 €
100 g	285.00 €

1-Methyl-3-octylimidazolium trifluoromethanesulfonate, 99%

Take off 15%

IL-0073-HP [403842-84-2] $C_{13}H_{23}F_3N_2O_3S$ MW 344.40

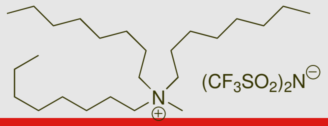


25 g	107.50 €
50 g	150.00 €
100 g	270.00 €

Methyltrioctylammonium bis(trifluoromethylsulfonyl)imide, 99%

Take off 15%

IL-0017-HP [375395-33-8] $C_{27}H_{54}F_6N_2O_4S_2$ MW 648.85

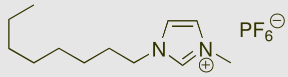


25 g	75.00 €
50 g	97.50 €
100 g	165.00 €

1-Methyl-3-octylimidazolium hexafluorophosphate, 99%

Take off 15%

IL-0020-HP [304680-36-2] $C_{12}H_{23}F_6N_2P$ MW 340.29

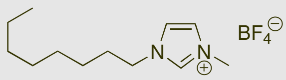


25 g	62.50 €
50 g	85.00 €
100 g	137.50 €

1-Methyl-3-octylimidazolium tetrafluoroborate, 99%

Take off 15%

IL-0021-HP [244193-52-0] $C_{12}H_{23}BF_4N_2$ MW 282.13

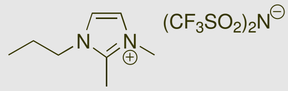


25 g	57.50 €
50 g	85.00 €
100 g	125.00 €

1,2-Dimethyl-3-propylimidazolium bis(trifluoromethylsulfonyl)imide, 99%

Take off 15%

IL-0134-HP [169051-76-7] $C_{10}H_{15}F_6N_3O_4S_2$ MW 419.36

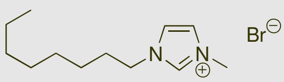


25 g	95.00 €
50 g	127.50 €
100 g	220.00 €

1-Methyl-3-octylimidazolium bromide, 99%

Take off 15%

IL-0071-HP [61545-99-1] $C_{12}H_{23}BrN_2$ MW 275.23

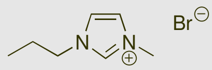


25 g	87.50 €
50 g	117.50 €
100 g	155.00 €

1-Methyl-3-propylimidazolium bromide, 99%

Take off 15%

IL-0096-HP [85100-76-1] $C_7H_{13}BrN_2$ MW 205.10

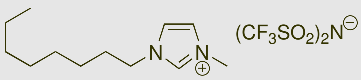


25 g	55.00 €
50 g	72.50 €
100 g	117.50 €

1-Methyl-3-octylimidazolium bis(trifluoromethylsulfonyl)imide, 99%

Take off 15%

IL-0099-HP [178631-04-4] $C_{14}H_{23}F_6N_3O_4S_2$ MW 475.47

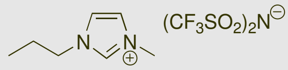


25 g	95.00 €
50 g	115.00 €
100 g	195.00 €

1-Methyl-3-propylimidazolium bis(trifluoromethylsulfonyl)imide, 99%

Take off 15%

IL-0024-HP [216299-72-8] $C_9H_{13}F_6N_3O_4S_2$ MW 405.34



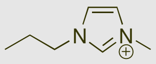
25 g	70.00 €
50 g	95.00 €
100 g	160.00 €

Ionic Liquids Today, 01-10

Wednesday, December 6th, 2010

1-Methyl-3-propylimidazolium iodide, >98% — **Take off 15%**

IL-0025-HP [119171-18-5] $C_7H_{13}IN_2$ MW 252.10

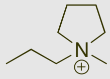


$I^{\ominus}$

25 g	70.00 €
50 g	95.00 €
100 g	150.00 €

1-Methyl-1-propylpyrrolidinium hexafluorophosphate, 99% — **Take off 15%**

IL-0148-HP [327022-58-2] $C_8H_{18}F_6NP$ MW 273.20

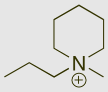


$PF_6^{\ominus}$

25 g	137.50 €
50 g	182.50 €
100 g	240.00 €

1-Methyl-1-propylpiperidinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0045-HP [608140-12-1] $C_{11}H_{20}F_6N_2O_4S_2$ MW 422.41

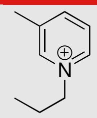


$(CF_3SO_2)_2N^{\ominus}$

25 g	70.00 €
50 g	90.00 €
100 g	150.00 €

3-Methyl-1-propylpyridinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0215-HP [817575-06-7] $C_{11}H_{14}F_6N_2O_4S_2$ MW 416.36

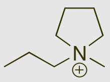


$(CF_3SO_2)_2N^{\ominus}$

25 g	105.00 €
50 g	137.50 €
100 g	235.00 €

1-Methyl-1-propylpyrrolidinium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0044-HP [223437-05-6] $C_{10}H_{18}F_6N_2O_4S_2$ MW 408.38

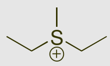


$(CF_3SO_2)_2N^{\ominus}$

25 g	65.00 €
50 g	85.00 €
100 g	125.00 €

Diethylmethylsulfonium bis(trifluoromethylsulfonyl)imide, 99% — **Take off 15%**

IL-0031-HP [792188-85-3] $C_7H_{13}F_6NO_4S_3$ MW 385.37



$(CF_3SO_2)_2N^{\ominus}$

25 g	145.00 €
50 g	205.00 €
100 g	275.00 €

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Additional costs for shipping as well as duties and taxes may apply and are payable by the customer. This offer is not valid for customers in the USA, Canada and Mexico.

7 Selected Applications of Ionic Liquids

By Boyan Iliev, Sven Sauer, Dr. Frank M. Stiemke, and Thomas J. S. Schubert, IOLITEC GmbH.

Hydrolysis of Tetrafluoroborate and Hexafluorophosphate Counter Ions in Imidazolium-Based Ionic Liquids

M. Freire, C. Neves, I. Marrucho, J. Coutinho, A. Fernandes, *J. Phys. Chem. A,* **2010***, 114,* 3744–3749.

Ionic liquids based on tetrafluoroborate and hexafluorophosphate anions are among the oldest and best studied ones, because of their low viscosity and commercial availability. The biggest problem is their relatively low stability in water, which has now been studied in detail under different conditions, including temperature and pH. The results obtained by ESI-MS, NMR and pH measurements clearly indicate that $[PF_6]^-$ is much more stable than $[BF_4]^-$ and decomposition becomes significant (> 0,5%) only under acidic conditions (pH 3) or high temperatures (343 and 373 K). On the other hand, hydrolysis of $[BF_4]^-$ was observed under all of the experimental conditions used, even at room temperature. Furthermore, hydrolysis becomes more significant for both anions with increase of the cation alkyl chain length due to a decrease of the cation-anion interaction strength that further facilitates the interaction of water molecules with the anion.

Ionic Liquids for Aromatics Extraction. Present Status and Future Outlook

G. Meindersma, A. Hansmeier, A. de Haan, *Ind. Eng. Chem. Res.* **2010***, 49,* 7530–7540.

Extraction of aromatics and especially their separation form aliphatic compounds with similar boiling points is a complicated and expensive task. The separation techniques typically used depend strongly on the aromatic content of the mixture and vary from liquid-liquid extraction, suitable for the range of 20-65 wt % aromatic content; extractive distillation for the range of 65-90 wt % aromatics; and azeotropic distillation for high aromatic content. The current liquid/liquid extraction processes mainly use solvents like sulfolane, *N*-methylpyrrolidone (NMP), *N*-formylmorpholine, ethylene glycols or propylene carbonate, which require extra distillation steps. This could be avoided by the use of ionic liquids.

The authors have studied more than 20 ILs for the separation of different aromatics/aliphatic mixtures. They showed that the most suitable ILs for the separation of Toluene/*n*-Heptane as well as for Benzene/*n*-Hexane and *p*-Xylene/*n*-Octane are BMIM DCA and BuPic$_3$ DCA (DCA= dicyanamide).

The aromatic distribution coefficients of these ILs are 1.2 - 2.5 factors higher and the aromatic/aliphatic selectivities are up to a factor of 1.9 higher than those of currently used sulfolane.

Ionic liquids in TiO_2-(anatase)-Nanoparticle Solvothermal Synthesis.

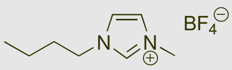
H. Lin, P. W. de Oliveira, I. Grobelsek, A. Haettich, M. Veith, *Z. Anorg. Allg. Chem.* **2010**, *636,* 1947–1954.

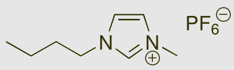
Titanium oxide nanoparticles are of great interest for applications in sensors, dye sensitized solar cells, as pigments or photocatalyts. Particle size, morphology and crystalline modification influence the physical and chemical properties of the TiO_2. In this paper Prof. Veith and coworkers presented the synthesis of pure anatase TiO_2 nanoparticles in imidazolium-based ionic liquids like BMIM Cl, BMIM BTA, BMIM $MeSO_4$, BMIM DCA or BMIM Trifate by hydrolysis of $Ti(O\textit{i}\text{-}Pr)_4$ in a mixture of IL/ethanol. These ILs control the hydrolysis of the titanium complex without chemical bonding between the IL and the resulting $Ti_7O_4(OEt)_{20}$-complex. These titanium oxo clusters play a key role in the formation of anatase nanostructures. Furthermore, the influences of the water content and different alcohols were investigated. IOLITEC´s ILs **BMIM Cl**, **BMIM Br** and **BMIM BTA** were stable under these reaction conditions and could be reused up to five times. In contrast, BMIM BF_4 or BMIM PF_6 formed $[BMIM]_2[Ti(OH)_6]$ by anion exchange under this solvothermal conditions.

DSSC electrolytes: dispersed Cu/C nanoparticles in RTILs.

F.-L. Chen, A. Letortu, C.-Y. Liao, C.-K. Tsai, H.-L. Huang, I-W. Sun, Y.-L. Wei, H. P. Wang, *Nuclear Instruments and Methods in Physics Research A* **2010**, *619,* 112–114.

Dye sensitized solar cells (DSSCs) play an important role as an alternative to silicon cells in renewable energy systems. Room temperature ionic liquids with their unique properties such as negligible vapor pressure, high stability and conductivity are used instead of volatile solvents as electrolytes in DSSCs. In order to enhance the efficiency of DSSCs, Wang and coworker focused on the improvement of the conductivity of the electrolyte. Therefore, they used Copper/Carbon core shell nanoparticles (7 and 18 nm) prepared from copper(II)nitrate and starch and dispersed them in **BMIM BF_4** or **BMIM PF_6.** The conductivity of the IL in the presence of 0.1% Cu/C-particles (without application of solar energy) is 8-15% higher than for the "normal" IL at room temperature. Wang *et al.* assumed, that the reported 47-60% increase of the DSSC efficiency is due to the fact that under solar energy oxidation and dissolution of copper, which provides additional electrons (Cu-Cu^{2+} +2e$^-$), takes place.

1-Butyl-3-methylimidazolium tetrafluoroborate, 99%		
IL-0012-HP [174501-65-6]	$C_8H_{15}BF_4N_2$	MW 226.02
	25 g	40.00 €
	50 g	57.50 €
	100 g	92.50 €
	250 g	145.00 €
	500 g	250.00 €
	1 kg	450.00 €
	5 kg	1'695.00 €

1-Butyl-3-methylimidazolium hexafluorophosphate, 99%		
IL-0011-HP [174501-64-5]	$C_8H_{15}F_6N_2P$	MW 284.18
	25 g	40.00 €
	50 g	60.00 €
	100 g	95.00 €
	250 g	180.00 €
	500 g	325.00 €
	1 kg	585.00 €
	5 kg	2'225.00 €

Continuous gas-phase desulphurization using supported ionic liquid phase (SILP) materials

F. Kohler, D. Roth, E. Kuhlmann, P. Wasserscheid, M. Haumann, *Green Chem.* **2010**, *12*, 979-984.

In this article *Wasserscheid* et al. introduce a new application field of supported ionic liquid phase technologies besides catalysis, gas-phase and fix bed-reactions. They describe the use of supported ionic liquid phase (SILP) materials to desulphurate gases. It is known that 1-Alkyl-3-methylimidazolium chloride (C_2,C_4)/ $AlCl_3$ mixtures are capable to remove sulphur from different systems. To further improve this effect Wasserscheid used aluminia coated with 1-Dodecyl-3-methylimidazolium chloride/$SnCl_2$. He showed that this system is able to remove n-butyl mercaptan from n-heptane vapour. The SILP material could then be regenerated by applying a temperature and pressure swing.

Cleaning raw and exhaust gases are important steps towards an environmentally friendly industry and more efficient technologies, since impurities could cause corrosion and disturb running processes. The use of the unique properties of ionic liquids in combination with porous materials with huge surface areas may improve a whole range of technologies.

Iodine-free high efficient quasi solid-state dye-sensitized solar cell containing ionic liquid and polyaniline-loaded carbon black (SS)

C.-P. Lee, P.-Y. Chen, R. Vittala, K.-C. Ho, *J. Mater. Chem.* **2010**, *20*, 2356-2361.

The authors of this article describe an alternative approach to DSSCs without using additional Iodine in the electrolyte. In common DSSCs iodine is added to complete the I^-/I_3^-redox-system. In this special system the cell consists of an incombustible and non-volatile paste with polyaniline loaded carbon black, a conducting polymer and the ionic liquid 1-buty-3-methylimidazolium iodide (BMIM I) or 1-methyl-3-propyl imidazolium iodide (PMIM I). To complete the cell common dye-sensitized porous TiO_2 and a Pt counter electrode were used. The authors showed that this DSSC has an efficiency of up to 5.81% which is the highest reported for DSSCs without the addition of Iodine. Also a high thermal stability was achieved with this system.

DSSCs are still one of the most exiting fields in new technologies. The use of ionic liquids as electrolytes for DSSCs was proved but is still in the progress of investigations. Looking at the publications in this field there is a lot of research and progress. The breakthrough for this technology is only a matter of time.

8 Community

Social Media

By Thomas J. S. Schubert.

Just a few weeks ago Facebook had for the first time more clicks per day than Google. The enormous potential of social media might be not obvious for Web 1.0 users like me and surely for many others. But the simple fact that today more than 500 Mio. Facebook-accounts are already existing, convinced our team at IOLITEC to start with our own account. Please type in "social media revolution" at Youtube and you'll quickly be also convinced that even for B2B social media will have an enormous impact, soon. As a consequence, IOLITEC is now present at *Facebook* and *LinkedIn*. At Facebook we just founded the new group "Ionic Liquids". We define ourselves as an open minded community and thus, we'd like to discuss with you about actual topics around ionic liquids, but also about curiosities or your experiences with ionic liquids and their interesting properties.

Finally, we would like to put some light on our RSS feeds: If you like to be informed about news like new products or upcoming conferences and fairs, your cordially invited to subscribe our RSS feeds!

Upcoming Exhibitions and Conferences:

June 15th-18th, 2011: 4th International Congress on Ionic Liquids (COIL-4), Washington, DC, USA (www.coil-4.org)

For the first time the world's largest biannual conference on ionic liquids will take place in the USA. We invite all customers to attend the conference and to exchange highlights in ionic liquid research with scientists from all over the world. Companies are invited to attend the exhibition during COIL-4 to present their products to the elite of ionic liquids researchers. Because of the importance for our company of this event, we took the opportunity to become GOLD-Sponsor.

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