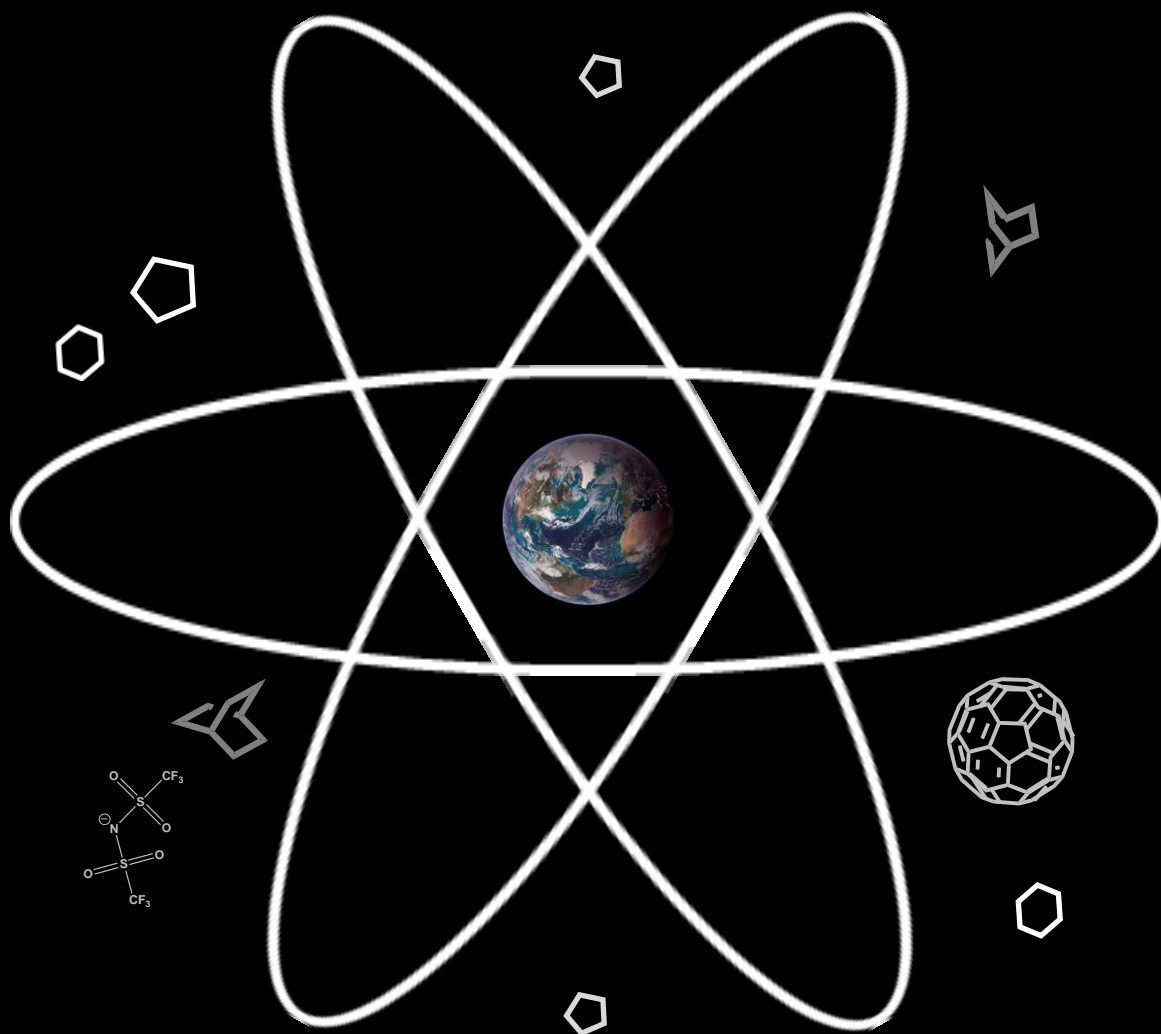


# Chemistry? - Unlimited!

The new bulletin about state-of-the-art chemistry.

Issue No. 1, Friday, December 1<sup>st</sup>, 2017.

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- >>> **Tech-Transfer: The BACCARA-Project**
- >>> **Thermal Stability of Ionic Liquids**
- >>> **IOLITEC's QM at HQ Heilbronn now ISO 9001:2015 certified**

## CONTENT

<b>Editorial</b> .....	<b>3</b>
<b>Thermal Stability of Ionic Liquids</b> .....	<b>4</b>
<b>Science &amp; Applications</b> .....	<b>8</b>
<b>Business News</b> .....	<b>15</b>
<b>Community</b> .....	<b>16</b>
<b>Christmas sale of selected ionic liquids</b> .....	<b>20</b>
<b>Christmas sale of selected nanomaterials</b> .....	<b>22</b>
<b>Imprint</b> .....	<b>23</b>

***io-li-tec***  
**Ionic Liquids Technologies**



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### Editorial

"*Chemistry: Unlimited!*" follows our former newsletter "*Ionic Liquids Today*". We decided to do so, because the name "Ionic Liquids Today" as a vehicle for information about hot topics of today's chemistry, in the meantime might appear a bit misleading, since next to ionic liquids IOLITEC reports also about nanomaterials, fluorinated compounds and in general about many fields of technical and industrial chemistry and its applications.

With "Chemistry? - Unlimited!" we created a similar concept, where the emphasis is still on ionic liquids. But in addition to that, we'd like to inform about selected aspects taken from the exciting world of chemistry and its applications.

In this context I'd like to stress that we of course also like to inform and to promote our products and services. You'll surely understand that at the end of the day, we have to pay our bills...

Finally, I'd like to inform you that the quality management at our headquarters at Heilbronn, Germany, is now ISO 9001:2015 certified (TÜV Süd).

Sincerely Yours,



Thomas J. S. Schubert, CEO & Founder, IOLITEC.

## Thermal Stability of Ionic Liquids

By Boyan Iliev.

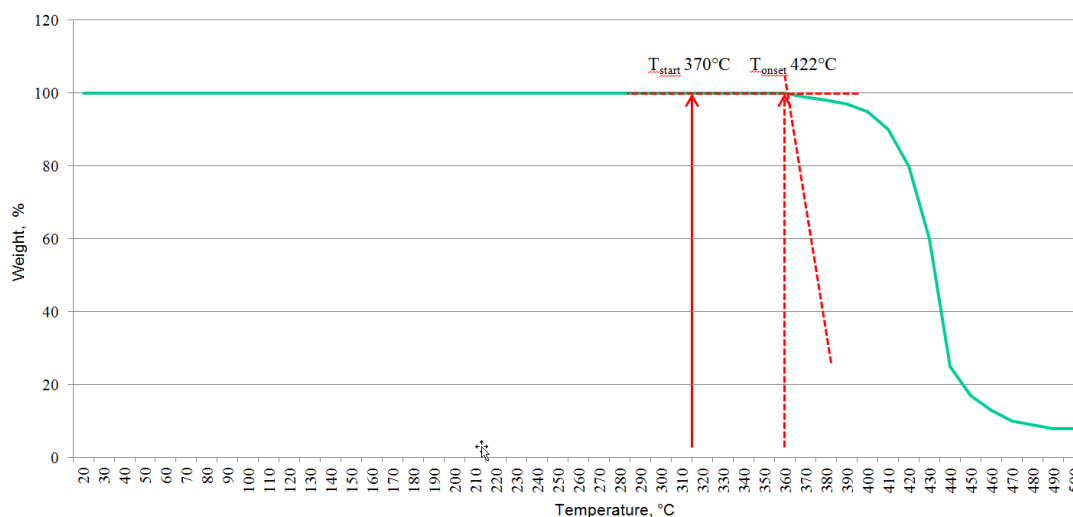
### Introduction

When ionic liquids became at the beginning of the 2000s more and more popular, next to their use as solvent or as electrolyte also the use as thermal fluid was investigated. It was in particular the combination of an ultra-low vapor-pressure with a sufficient to good heat capacity and a high thermal stability which marked a significant advantage over other liquid materials. In the following I'd like to discuss what "high" thermal stability under real-life condition does mean.

### Determining the decomposition temperature of ILs

In the past there were quite a lot of publications stating thermal stabilities for ionic liquids of up to 450°C. But how realistic are those values? The most widely used method to determine thermal stability is thermogravimetric analysis (TGA). As for most analytical methods, a correct interpretation of results is essential to the validity of the conclusions.

IL 1

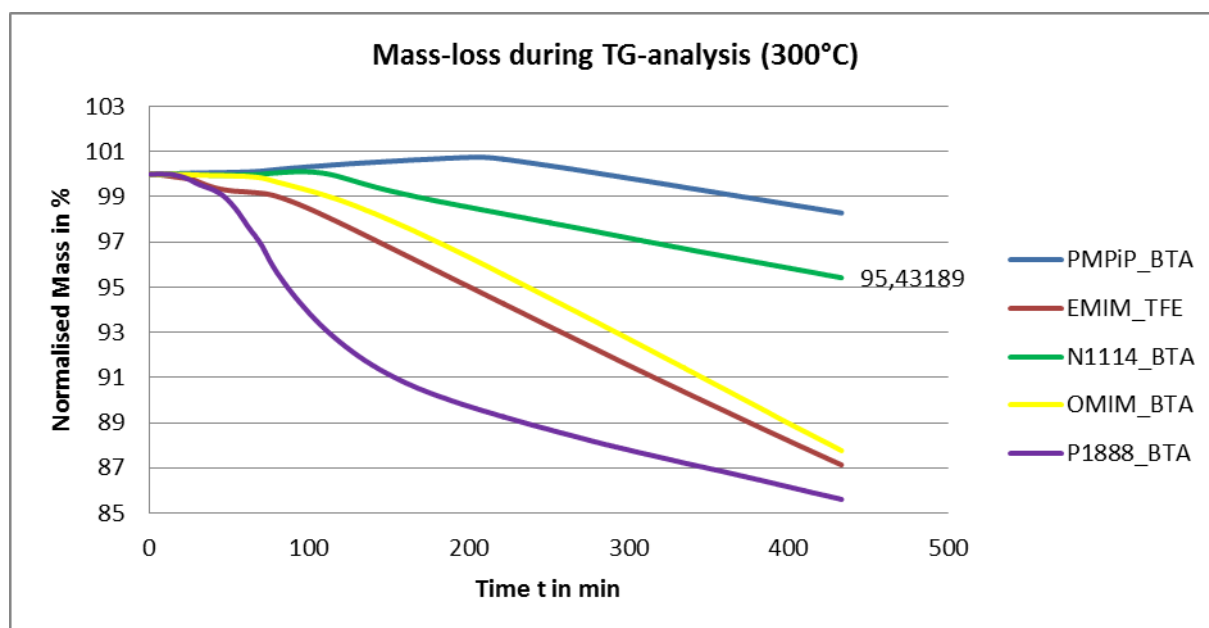


**Figure 1.** Onset and decomposition start temperatures for a specific IL.

Many of the values you will find cited in literature are based on measurements using high heating rates (usually 10 K/min) under an inert atmosphere such as Argon. Such measurements give up to three different values,  $T_{onset}$ ,  $T_{start}$ , and  $T_{peak}$ .  $T_{onset}$  is the intersection of the baseline weight and the tangent of the weight dependence on the temperature curve as decomposition occurs (Figure 1).

This is (unfortunately) the most often stated value and sometimes falsely interpreted as “thermal stability”.  $T_{\text{start}}$  is the temperature at which the decomposition of the sample just starts and  $T_{\text{peak}}$  is the temperature at which the sample has maximum rate of degradation, which could be obtained from the peak in the DTG curves. In fact because of the high heating rate at an inert atmosphere, the decomposition of each IL sample starts with a specific delay. As a consequence, the effective stability, especially under real life conditions, is much lower. Even for the same IL, you can get quite different values, depending of course on purity, but also on the interpretation of the TGA. For BMIM BTA (our IL-0029-HP) you can get  $T_{\text{onset}}$  values ranging from 365°C to 450°C.<sup>[1]</sup> Additionally, the  $T_{\text{start}}$  temperature of the same batch varies for BMIM BF<sub>4</sub> from 274°C to 319°C, depending on the heating rate.<sup>[1]</sup>

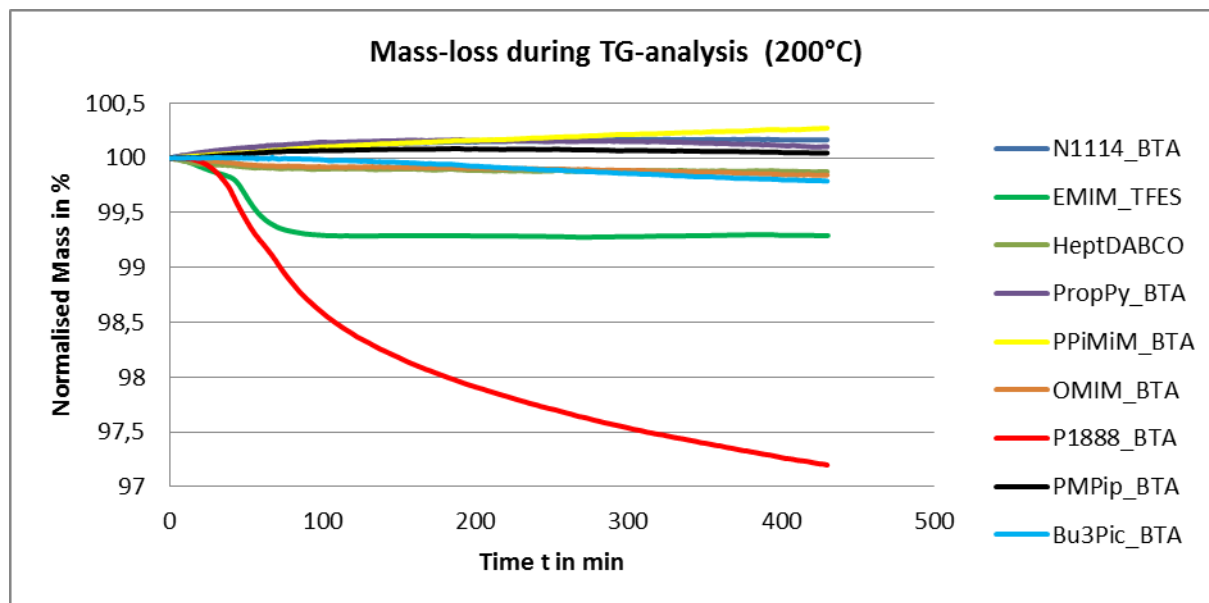
There are a few processes that actually take place under nitrogen and at such heating rates and for such short times. So all this data can only suggest the potential of one ionic liquid, but not really determine its thermal stability. For that we need a prolonged measurement at the same elevated temperature in order to see what really happens with the IL.



**Figure 2.** Thermal stability of selected ionic liquids at 300°C for 7 h.

In recent years though more and more researchers stumble across this problem and as a result we see each year more publications, where long term stability measurements at a constant temperature (so-called isothermal TGA) are made.<sup>[1][2]</sup> Our own results in this matter were published a while ago, where long term stability of some ionic liquids at temperatures up to 300°C.

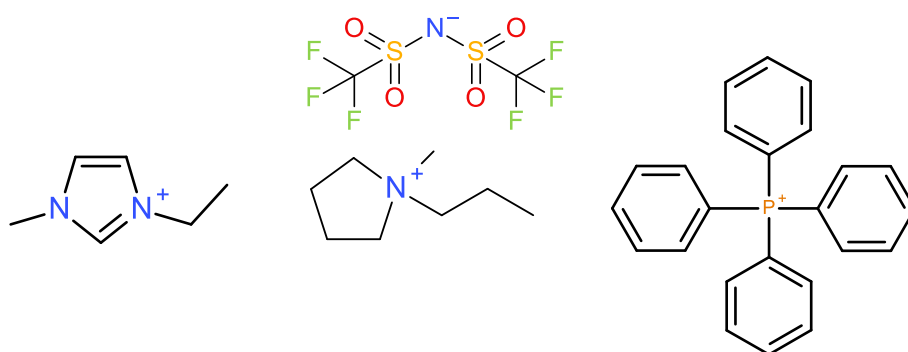
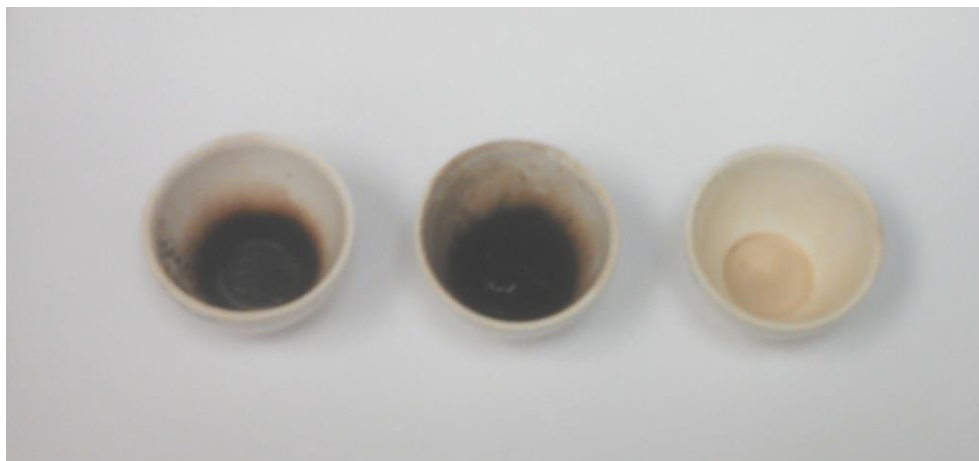
As you can see from Figure 2, at 300°C after 7 hours even PMPip BTA (our IL-0045-HP) has lost about 2% and all other tested ILs perform even worse. At 200°C things look much better and a number of different ILs are stable for more than 7 hours (Figure 3).



**Figure 3.** Thermal stability of selected ionic liquids at 200°C for 7 hours.

As can be seen in Figure 3, almost all of the tested compounds showed negligible mass loss at 200°C for up to 7 hours. So if your process runs at 200°C under an inert atmosphere, such as nitrogen, you have plenty of candidates to choose from.

But what if you need air stability, or even higher temperatures? A new class of ionic liquids based on tetraphenylphosphonium bis(trifluoromethylsulfonyl)imide was published recently and has been gaining popularity rapidly. These compounds, published initially by Prof. Jim Davis of University of South Alabama<sup>[3]</sup> have long term stability (96 h) at 350°C even in normal air atmosphere. The ionic liquids, even those which have proved successful in the tests at 200°C under nitrogen (Scheme 2) decompose on a prolonged exposure to 350°C under normal air in a drying furnace (Figure 2).



**Figure 4.** Thermal stability of selected ionic liquids at 350°C for 96 h on air.

In order to further lower the melting point of these compounds additional modifications are possible, which allow for a melting point of below 100°C.<sup>[4]</sup> These compounds are currently available as custom synthesis, but will be included in our next catalogue. Please contact us for further information!

[1] Feng et al, *J Therm. Anal. Calorim.* **2016**, *125*, 143.

[2] Cao et al, *Ind. Eng. Chem. Res.* **2014**, *53*, 8651.

[3] Cassity et al, *Chem. Comm.* **2013**, *49*, 7590.

[4] Scheuermeyer et al, *New J. Chem.* **2016**, *40*, 7157.

## Science & Applications

### Polyoxometalate Ionic Liquids as Self-Repairing Acid-Resistant Corrosion Protection

S. Herrmann, M. Kostrzewa, A. Wierschem, C. Streb\*, *Angew. Chem. Int. Ed.* **2014**, 53, 13596 – 13599, DOI: 10.1002/anie.201408171.

**C**orrosion represents a major problem for metallic materials, especially for industrial usage. Nowadays typical corrosion protection coatings are based on sacrificial coatings (coating with a second metal e.g. zinc), polymer coating, ceramic coatings or protection oils based on paraffinic or naphthenic mineral oils.<sup>1</sup> However, still 3% of the global gross domestic product (GDP) is lost due to corrosion.

A novel approach is to apply a ionic liquid (IL) layer as the coating material. C. Streb and coworkers developed polyoxometalate based ionic liquids (POM-ILs) that showed noticeable corrosion protection ability. These POM-ILs are constituted by ammonium ions of the type  $(C_nH_{2n+1})_4N^+$  with  $n = 7-8$  and transition metal functionalized Keggin anions of the type  $[SiW_{11}O_{39}TM(H_2O)]^{n-}$  with  $TM = CuII$  or  $FeIII$ . Corrosion protection experiments were carried out on a copper disk drop-coated with the novel POM-ILs. The results were significantly better when compared to coating with a solid POM salt  $(C_5H_{11})_4N^+ [^-SiW_{11}O_{39}Cu(H_2O)]^-$  and the commercially available IL 1-hexyl-3-methylimidazolium bromide (HMIM Br) as the reference.

Besides POM based ILs, great anti-corrosion effects are obtained by subtle tuning of the IL structure. For instance, applying stable bis(trifluoromethylsulfonyl)imide (BTA) anions, instead of metal invasive halides drastically improves the anti-corrosion properties.

IoLiTec has tested several ILs as promising corrosion inhibitors. Best results were obtained with methyltrioctylammonium acetate. In addition, 1-butyl-1-methylpyrrolidinium acetate and 1-ethyl-3-methylimidazolium acetate have convenient corrosion protection properties.

We provide methyltrioctylammonium acetate (CS-0442) and 1-butyl-1-methylpyrrolidinium acetate (CS-0377) as a custom synthesis. You can find 1-ethyl-3-methylimidazolium acetate (IL-0189) in our standard catalogue (s. also page 10!).

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<sup>1</sup> [http://www.substech.com/dokuwiki/doku.php?id=corrosion\\_protection\\_coatings](http://www.substech.com/dokuwiki/doku.php?id=corrosion_protection_coatings) [13.10.2016].



### **Induction of lignin solubility for a series of polar ionic liquids by the addition of a small amount of water (Svetlana Tšupova)**

T. Akiba, A. Tsurumakia, H. Ohno, *Green Chem.* **2017**, *19*, 2260-2266.

Lignin is a phenolic polymer that constitutes to up to one third of the mass of dry wood. It is common by-product of cellulose pulp extraction and since it is quite heavily contaminated by saccharides, it is normally just burnt as fuel. However one can imagine that the phenol-derivative rich material can be upgraded to value-added chemicals, given suitable purification technics.

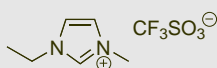
The current publication by *Ohno et. al.* explores use of ILs as solvents for lignin extraction. The authors show, that while pure ILs either don't dissolve lignin, or dissolve it only in small amounts, they become much better solvents when water is added. Sometimes, the change in solubility is drastic. EMIM OAc ([https://iolitec.de/products/ionic\\_liquids/catalogue/imidazolium-based/il-0189-tg](https://iolitec.de/products/ionic_liquids/catalogue/imidazolium-based/il-0189-tg)), for example, has around 40 wt% solubility of lignin while dry; and it increases to 50% with addition of 10-30% of water. In contrast to that, dry EMIM OTf is not able to dissolve lignin, but addition of 10-20% water enables dissolution of around 40 wt% of lignin. The further addition of water decreases lignin solubility again. P<sub>4444</sub> TFA also showed increase in lignin solubility with water addition, and it staid constant around 40% in tested range (up to 40% water added). However, ILs with BTA- and BF<sub>4</sub>- anions did not dissolve lignin at all and their hydrophobic nature obscured any effect from water addition. The authors also show that lignin can be extracted selectively from ground biomass, and affinity of ILs towards cellulose can be suppressed by adding water. Therefore, water addition to ILs shows orthogonal modulation of solubilities of different renewable feedstocks.

Furthermore, the authors addressed the change in solubilizing properties of different ILs in connection with Kamlet–Taft parameters. It seems that both  $\alpha$  (describing proton donating abilities) and  $\beta$  (describing proton accepting abilities) values of the ILs together affect the solubility of lignin, whereas for dissolution of the cellulose,  $\beta$  values are more important. Addition of water decreases the  $\beta$  values of tested ILs while simultaneously increasing their  $\alpha$  values, therefore favouring lignin dissolution.

IOLITEC offers ILs, that shown to be good for biomass dissolution. If you are interested, please contact us.

## 1-Ethyl-3-methylimidazolium trifluoromethanesulfonate, 99%

IL-0009-HP [145022-44-2] C<sub>7</sub>H<sub>11</sub>F<sub>3</sub>N<sub>2</sub>O<sub>3</sub>S MW 260.24

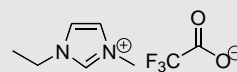


25 g  
50 g  
100 g  
250 g  
500 g  
1 kg  
5 kg

m.p.: -9 °C    η (25 °C): 39.8 cP    σ (30 °C): 9.84 mS/cm    ρ (25 °C): 1.39 g/cm<sup>3</sup>

## 1-Ethyl-3-methylimidazolium trifluoroacetate, >97%

IL-0027-SG [174899-65-1] C<sub>8</sub>H<sub>11</sub>F<sub>3</sub>N<sub>2</sub>O<sub>2</sub> MW 224.18

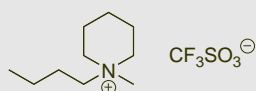


25 g  
50 g  
100 g  
250 g  
500 g  
1 kg  
5 kg

m.p.: -14 °C    η (25 °C): 28.7 cP    σ (25 °C): ~ mS/cm    ρ (25 °C): 1.31 g/cm<sup>3</sup>

## 1-Butyl-1-methylpiperidinium trifluoromethanesulfonate, 99%

IL-0174-HP [1357500-93-6] C<sub>11</sub>H<sub>22</sub>F<sub>3</sub>N<sub>3</sub>O<sub>3</sub>S MW 305.36

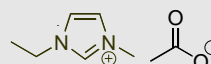


25 g  
50 g  
100 g  
250 g  
500 g  
1 kg  
5 kg

m.p.: 38 °C    η (25 °C): ~ cP    σ (25 °C): ~ mS/cm    ρ (25 °C): ~ g/cm<sup>3</sup>

## 1-Ethyl-3-methylimidazolium acetate, >95%

IL-0189-TG [143314-17-4] C<sub>8</sub>H<sub>14</sub>N<sub>2</sub>O<sub>2</sub> MW 170.21



25 g  
50 g  
100 g  
250 g  
500 g  
1 kg  
5 kg

m.p.: -45 °C    η (25 °C): 93.0 cP    σ (25 °C): 2.50 mS/cm    ρ (25 °C): 1.10 g/cm<sup>3</sup>

## **Enhanced tunability afforded by aqueous biphasic systems formed by fluorinated ionic liquids and carbohydrates** (Svetlana Tšupova)

A. M. Ferreira, P. D. O. Esteves, I. Boal-Palheiros, A. B. Pereiro, L. P. N. Rebelo, M. G. Freire, *Green Chem.* **2016**, *18*, 1070-1079

**A**queous biphasic systems (ABS) are formed by two water-miscible substances, for which above certain concentration the phase separation occurs. The phase separation process is possible, when one substance acts as salting out agent for the other. The two formed liquid phases are water rich, therefore preserving native conformations of biomolecules, which makes ABS systems good for extractions of cell parts and compounds of natural origin. In a view of developing more sustainable systems, ILs, that possess an outstanding dissolving capabilities for various solutes were considered.

The current work develops the combinations of sugars and ILs for ABS applications. While sugars are very weak salting out agents, most of tested mono-, di- and polysaccharides formed ABS with perfluoroalkylsulfonate-based ILs. It was shown, that the size of perfluoroalkyl-substituent on anion was crucial for the success of phase separation: OTf<sup>-</sup> was less prone to ABS formation, than ONf<sup>-</sup>. The longer chain makes IL more hydrophobic, enhancing the phase separation. Other factors that affect ability of ILs to for ABS are strength of interaction between cation and anion of ILs and steric hindrance of cations. It is important to have the cation not too hydrophilic and 6-membered rings (e.g. pyridinium and piperidinium) are more prone to ABS formation, than 5-membered rings, like imidazolium. Aromaticity of the ring is not playing the vital role in ABS formation. As expected, the more hydroxyl groups sugar has, the stronger salting-out effect it displayed.

After characterizing the sugar-IL solutions by phase diagrams, the extraction of four different dyes was performed. Most of the investigated dyes migrated into carbohydrate-rich phase after the phase separation, with extraction efficiencies reaching 94%. This is quite remarkable, as dyes were previously reported to migrate to IL-rich phase. Having dyes in carbohydrate phase makes their recovery easier.

As ILs show themselves as good partners for ABS formation and allow for easy tunability of different phase's properties, extraction efficiency of different molecules, IOLITEC offers a selection of ILs, suitable for ABS formation, like EMIM ONf (CS-0947-HP), HMIM ONf (IL-0311-HP), BMIM OTf (IL-0013-HP) and Et-3-Pic ONf (IL-0313-HP). If you are interested, please contact us.

## **Stable zinc cycling in novel alkoxy-ammonium based ionic liquid electrolytes** (Svetlana Tšupova)

M. Kar, B. Winther-Jensen, M. Armand, T. J. Simons, O. Winther-Jensen, M. Forsyth, D. R. MacFarlane, *Electrochimica Acta*, **2016**, 188, 461–471.

**Z**inc-air batteries consist of Zn anode and cathode, at which oxygen reduction occurs. On the anode, Zn(OH)<sub>2</sub> is formed during discharge, and when the solubility limit of Zn(OH)<sub>2</sub> in electrolyte is reached, ZnO starts to deposit. ZnO is difficult to convert into Zn during charge process and that contributes to decrease cycling of Zn-air batteries.

The authors of this report propose, that using ILs, specifically designed to dissolve Zn might help with the cycling. For this, ILs bearing functional groups that can coordinate to Zn were designed. Inspired by ethereal solvents, ILs bearing oligoether substituents were synthesized. The number of ether-groups per substituent and the number of substituents were chosen to minimize very strong crown-ether like interactions that would irreversibly trap Zn. As a result N<sub>222(20201)</sub> BTA, N<sub>22(20201)<sub>2</sub></sub> BTA and N<sub>2(20201)<sub>3</sub></sub> BTA were prepared and characterized. It was shown that ILs with one oligoether substituent are more stable with T<sub>onset</sub> = 350 °C. The viscosity of ILs decreased with the number of ether groups increasing. However, when ZnBTA<sub>2</sub> was added, the viscosity increased. Interestingly, the conductivity of the ILs followed opposite trend: the more oligoether substituents, the lower was conductivity. NMR studies of the three ILS showed that ILs are able to interact with water and ZnBTA<sub>2</sub>, but addition of water to IL- ZnBTA<sub>2</sub> mixtures didn't result in new interactions.

In electrochemical studies it was shown that addition of up to 2.5 wt% of water facilitates the deposition of Zn and also enhances the diffusion of Zn ions, resulting in higher currents. The mixture of N<sub>2(20201)<sub>3</sub></sub> BTA + 0.1 M ZnBTA<sub>2</sub> + 2.5% water resulted in the system that was stable for at least 750 cycles with average efficiency of 86%.

### Tech-Transfer – from science to applications

Project: BACCARA, funded by the European Union, #608491.

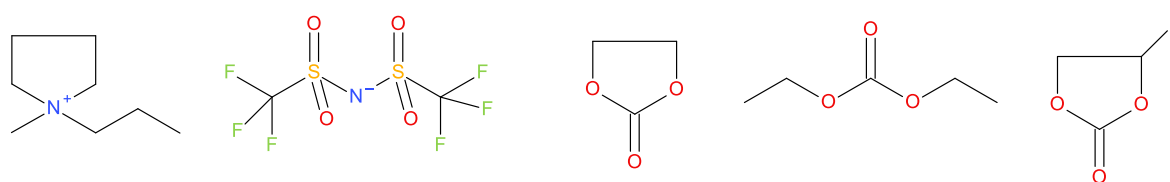
By Boyan Iliev.

On October 30<sup>th</sup>, 2016 another scientific project under the FP7 EU program ended for IOLITEC: The project BACCARA (<http://project-baccara.eu>) united industry and academia from 5 different countries. France was represented by the CEA in Grenoble, the IMN in Nantes as well as by the supercapacitor (What is a supercapacitor? See <https://iolitec.de/en/technology/energy-cleantech/supercaps>) producer Hutchinson. The Austrian R&D branch of Varta (Varta Microinnovation) participated as well Technion from Israel. Germany was represented by IOLITEC.

The main task of the project was to study the formation of the solid electrolyte interface (SEI) in batteries based on Si-anodes as well as in supercapacitors. Another goal was to define and create analytical tools to monitor processes within the operating device, to generate knowledge to understand the processes taking place within the first few cycles of every battery, which are important for their performance and durability.

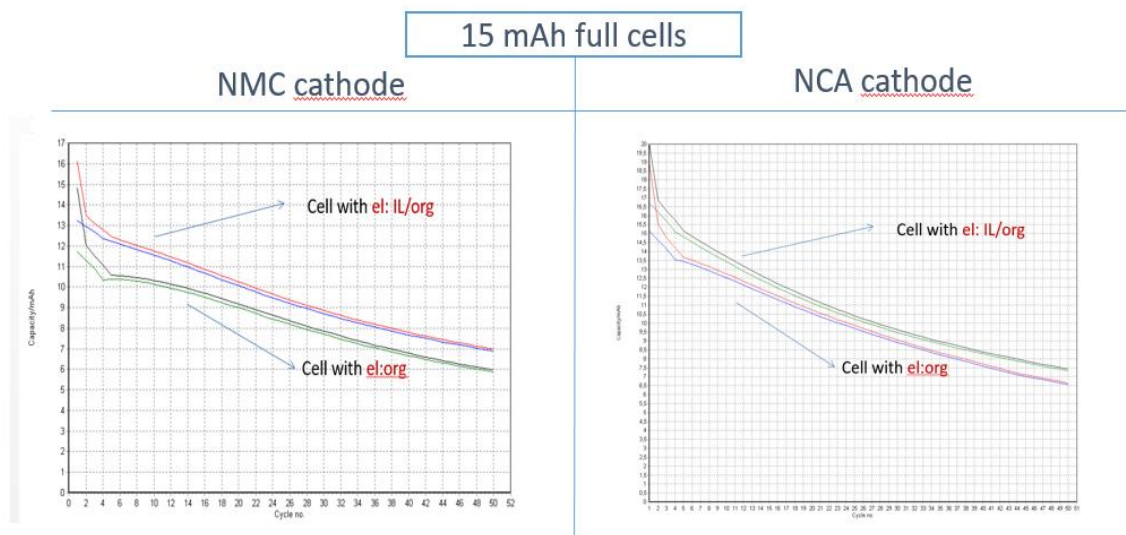
As you can guess by the presence of IOLITEC in the consortium one of research goals of the project was to study the effect of ionic liquids on the SEI formation. The ionic liquid chosen for the project was 1-methyl-1-propylpyrrolidinium bis(trifluoromethylsulfonyl)imide (our IL-0035-UP, [https://iolitec.de/products/ionic\\_liquids/catalogue/pyrrolidinium-based/il-0035](https://iolitec.de/products/ionic_liquids/catalogue/pyrrolidinium-based/il-0035)). Because of the very high purity requirements for battery applications, much higher than those for supercapacitors (the same ionic liquid in "normal" purity achieved 8 000 000 cycles without considerable loss of capacitance in a supercapacitor) a new synthetic procedure, excluding light, oxygen and moisture had to be developed.

Since the performance of the pure ionic liquid as electrolyte is not optimal, due to its high viscosity and low Li-ion transfer numbers, a mixture of ionic liquid and classical carbonate electrolyte was prepared. Fluoroethylene carbonate (FEC) was used as an SEI promoting agent (Figure 1).



**Figure 1.** Electrolyte composition

At cell voltages of 4.4 V though, as well as in 15 mAh pouch cells this IL-containing electrolyte performs better than the pure carbonate electrolyte both against NMC and NCA cathodes (Figure 2).



**Figure 2.** Comparison of carbonate and IL-containing electrolyte in 15 mAh pouch cells.

The most striking advantage of ionic liquids is their safety aspect. The IL-containing electrolyte shows a much lower hazard level, especially in the penetration tests (HZL level drops from 5 to 2), compared with the classical carbonate electrolyte (Figure 3).

Safety Test 1		Safety Test 2		Safety Test 3		Electrolyte
Nail Penetration Test		Heating Test		Overcharge Tests		
nSi vs. NCA (2x)	HZL: 5 HZL: 4	nSi vs. NCA (2x)	HZL: 2 HZL: 3-4	nSi vs. NCA (2x)	HZL: 6 HZL: 6	Organic Electrolyte
nSi vs. NCA (2x)	HZL: 2 HZL: 2	nSi vs. NCA (2x)	HZL: 2 HZL: 2	nSi vs. NCA (2x)	HZL: 5 HZL: 5	Organic+IL Electrolyte
nSi vs. NMC (2x)	HZL: 4 HZL: 3	nSi vs. NMC (2x)	HZL: 2 HZL: 2	nSi vs. NMC (2x)	HZL: 6 HZL: 5	Organic Electrolyte
nSi vs. NMC (2x)	HZL: 2 HZL: 2	nSi vs. NMC (2x)	HZL: 2 HZL: 2	nSi vs. NMC (2x)	HZL: 5 HZL: 5	Organic+IL Electrolyte

**Figure 3.** Safety tests on stacked 300 mAh pouch cells.

Further details and results from the project will be available as soon as the information is publically available. We would be glad to answer your questions on this and other electrolytes for batteries and supercapacitors, please do not hesitate to contact us!

### Business News

By Thomas J. S. Schubert

#### **Chevron will run a large-scale process using ionic liquids**

From C&EN | CEN.ACS.ORG | OCTOBER 3, 2016

**U.S.-**based company Chevron established in co-operation with also U.S.-based company Honeywell a process to perform alkylation reactions with ionic liquids as catalyst to replace the commonly used toxic hydrogen fluoride on an industrial scale. Chevron is investigating ionic liquids as catalyst for this purpose since 1999. For the past 5 years they had successfully run a pilot plant in Salt Lake City. Chevron started the construction of a full-scale alkylation plant with this technology in 2017 which should be in operation in 2020. By using the IL-based technique they are supposed to replace all HF related inventory. This process will be presumably the largest scale synthesis of ionic liquids up today. The Chevron technology could also have a big impact on how the refining industry carries out alkylation leading to an overall cheaper and environmental friendly HF-free economy. As catalyst for this process chloroaluminate ionic liquids with a proprietary composition are used.

### Community

**W**e define ourselves not only as a “usual chemical company”, instead we like to live chemistry and scientific thinking. As a consequence, we do not like just selling materials to our customers: we would like to guide our customers and partners through the complete process of innovation! In this context, social media provide an ideal, fast, and informal platform to discuss in an open-minded way.

**I**f you are already active in one or more of these social media, please feel free to contact our experts directly or join one of the groups, where IOLITEC is involved.

ResearchGate

**RESEARCH GATE:** Please discuss with IOLITEC’s experts Dr. Iliev and Dr. Schubert about actual challenges in the field of ionic liquids and nanomaterials!



**FACEBOOK:** Please follow IOLITEC and join the Ionic Liquids Group at Facebook! In particular students are welcome to highlight, to join and to post their opinions etc.



### **LinkedIn:**

Please connect yourself to IOLITEC’s team at LinkedIn! Within the Molten Salts Discussion Group, you’ll meet our experts to discuss the hottest topics!





## **YouTube: Interesting Videos**

### **Ionic Liquids - Explained**

<https://www.youtube.com/watch?v=XunLuNSaEM>

### **Separation of oil and tar from sand**

**(Penn State University, USA):**

<https://www.youtube.com/watch?v=sGDKxIW1ZoQ>

### **Mechanism for electrical conduction within ionic liquids**

**(EPFL, Lausanne, Switzerland):**

<https://www.youtube.com/watch?v=NYhOb9ZB9qY>

### **New Battery Technology using ionic liquids**

**(Keio University, Japan):**

<https://www.youtube.com/watch?v=J2WI5DdIfHk>

### **Ionic Liquid – Time Capsule**

**(Peter Licence, University of Nottingham, UK)**

<https://www.youtube.com/watch?v=YmsZxc8AxMU>

## **Upcoming conferences:**

### **21<sup>st</sup> International Colloquium Tribology, Ostfildern, Germany, January 9<sup>th</sup> - 11<sup>th</sup>, 2018**

Meet Iolitec's Lubrication expert Dr. Sebastian Plebst on the 21<sup>st</sup> International Colloquium Tribology – the colloquium on Industrial and Automotive Lubrication – and attend his talk "***Selected ILs and nanomaterials as high performance additives for lubricants & neat lubricants***" on January 9<sup>th</sup>, 16:00-16:30, in Session: Ionic Liquids, Room B3.

Further information is available at: [www.tae.de/go/tribology](http://www.tae.de/go/tribology)

### **Batterieforum, Berlin, Germany, January 24<sup>th</sup> – 26<sup>th</sup>, 2018**

IOLITEC will attend Batterieforum 2018 and present the poster "***Novel Electrolytes for Zinc/Air Batteries***" with our latest developments in the field ionic liquid-based electrolytes for zinc/air batteries. Part of this work is supported by the BMBF-funded project LuZi (03SF0499G): "*Zink/Luft-Batterien mit neuartigen Materialien für die Speicherung regenerativer Energien und die Netzstabilisierung*". The project idea itself will be present as well.

For further details please visit: <http://www.batterieforum-deutschland.de/kongress/anmelden/>

### **LUBMAT, San Sebastian, Spain, June 5<sup>th</sup>-6<sup>th</sup>, 2018**

The call for paper for this Sixth Congress in Lubrication, Tribology and Condition Monitoring is still open. Submission deadline is January 31<sup>st</sup>, 2018.

For details please visit: <https://www.lubmat.org/en/home>

### **ACHEMA 2018 Congress, Frankfurt, Germany, June 11<sup>th</sup>-15<sup>th</sup>, 2018**

During the ACHEMA, the leading show for all sectors of the process industry, the ACHEMA Congress will be held. Submission of Abstracts is already closed; the program will be published in January 2018. For further information please visit: <http://www.achema.de/en/congress/overview-and-topics/achema-congress-programme.html>

## **Chemistry: Unlimited!, Issue #1**

Friday, December 1<sup>st</sup>, 2017.

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### **Green Solvents - GS9 Advanced Reaction Media, Titisee, Germany, September 23<sup>rd</sup> -26<sup>th</sup>, 2018**

New name for a successful conference series! The Green Solvents is now the conference on *Advanced Reaction Media*, for everyone who is looking for innovative solvents. Papers will be accepted until April 16<sup>th</sup>, 2018. Details can be found here: <http://dechema.de/GS92018.html>

### **EuCheMSIL 2018 - 27<sup>th</sup> EuCheMS Conference on Molten Salts and Ionic Liquids, Lisbon, Portugal, October 7<sup>th</sup> -12<sup>th</sup>, 2018**

This biannual European event for the molten salt and IL community will be held this year in UNESCO world-heritage listed town of Lisbon. Paper for the conference program will be accepted until February 15<sup>th</sup>, 2018. Details can be found here: <http://www.euchemsil2018.org/>

### **COIL-8 - International Congress on Ionic Liquids, UK, 2019**

After cancelation of COIL 7 in 2017 in Canada, the congress will be held in 2019 again, this time in Great Britain. Details will follow.


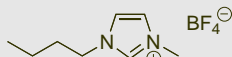
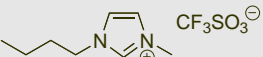
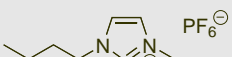

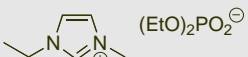
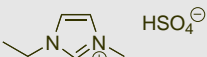
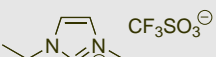
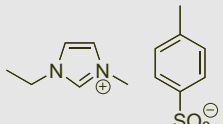
**Please keep us informed about other interesting events we could highlight in Chemistry unlimited.**

## Christmas sale of selected ionic liquids



A selection of ionic liquids in limited amounts and only for a short period of time is available for sale at **30% discount on list prices**. Please mind, this offer is valid only for the materials listed below in the below described quality. Following ionic liquids are available (price after discount):






<b>2-Hydroxyethylammonium formate, 95%</b>				<b>Ethylammonium nitrate, 95%</b>			
IL-0034-TG	[53226-35-0]	C <sub>3</sub> H <sub>9</sub> NO <sub>3</sub>	MW 107.11	IL-0043-TG	[22113-86-6]	C <sub>2</sub> H <sub>9</sub> N <sub>2</sub> O <sub>3</sub>	MW 108.11
		25 g	30.01 €			25 g	29.40 €
		50 g	38.50 €			50 g	42.00 €
		100 g	64.40 €			100 g	67.20 €
		250 g	138.60 €			250 g	142.80 €
		500 g	235.20 €			500 g	242.20 €
		1 kg	397.60 €			1 kg	412.30 €
<b>Octyltriethylammonium bis(trifluoromethylsulfonyl)imide, 96%</b>				<b>1-Butyl-1-methylpiperidinium bis(trifluoromethylsulfonyl)imide, 98%</b>			
IL-0328-TG	[210230-48-1]	C <sub>16</sub> H <sub>32</sub> F <sub>6</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	MW 494.56	IL-0154-TG	[623580-02-9]	C <sub>12</sub> H <sub>22</sub> F <sub>6</sub> N <sub>2</sub> O <sub>4</sub> S <sub>2</sub>	MW 436.44
		25 g	56.70 €			25 g	51.10 €
		50 g	75.60 €			50 g	69.30 €
		100 g	126.00 €			100 g	114.10 €
		250 g	260.40 €			250 g	231.00 €
		500 g	425.60 €			500 g	418.60 €
		1 kg	766.50 €			1 kg	753.20 €
<b>1-Butyl-1-methylpiperidinium hexafluorophosphate, 98%</b>				<b>1-Butyl-1-methylpyrrolidinium trifluoromethanesulfonate, 97%</b>			
IL-0156-TG	[1257647-66-7]	C <sub>10</sub> H <sub>22</sub> F <sub>6</sub> NP	MW 301.25	IL-0113-TG	[367522-96-1]	C <sub>10</sub> H <sub>20</sub> F <sub>3</sub> NO <sub>3</sub> S	MW 291.33
		25 g	96.60 €			25 g	98.70 €
		50 g	128.80 €			50 g	130.20 €
		100 g	170.10 €			100 g	198.80 €
		250 g	354.20 €			250 g	410.90 €
		500 g	583.10 €			500 g	675.50 €
		1 kg	954.10 €			1 kg	1105.30 €
<b>Trihexyltetradecylphosphonium dicyanamide, 93%</b>				<b>1-Allyl-3-methylimidazolium chloride, 96%</b>			
IN-0010-LG	[701921-71-3]	C <sub>34</sub> H <sub>68</sub> N <sub>3</sub> P	MW 549.90	IL-0022-TG	[65039-10-3]	C <sub>7</sub> H <sub>11</sub> N <sub>2</sub> Cl	MW 158.63
		25 g	24.50 €			25 g	37.80 €
		50 g	32.20 €			50 g	51.80 €
		100 g	62.30 €			100 g	66.50 €
		250 g	146.30 €			250 g	143.50 €
		500 g	277.20 €			500 g	245.00 €
		1 kg	526.40 €			1 kg	416.50 €

<b>1,3-Dimethylimidazolium methyl sulfate, 96%</b>				<b>1-Butyl-3-methylimidazolium tetrafluoroborate, 97%</b>			
IL-0243- TG	[97345-90-9]	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S	MW 208.24	IL-0012- TG	[174501-65-6]	C <sub>8</sub> H <sub>15</sub> BF <sub>4</sub> N <sub>2</sub>	MW 226.02
		25 g	36.40 €			25 g	18.90 €
		50 g	53.20 €			50 g	25.20 €
		100 g	75.60 €			100 g	38.50 €
		250 g	121.10 €			250 g	85.40 €
		500 g	205.10 €			500 g	153.30 €
		1 kg	272.30 €			1 kg	276.50 €
							
<b>1-Butyl-3-methylimidazolium trifluoromethanesulfonate, 97%</b>				<b>1-Butyl-3-methylimidazolium hexafluorophosphate, 97%</b>			
IL-0013- TG	[174899-66-2]	C <sub>9</sub> H <sub>15</sub> F <sub>3</sub> N <sub>2</sub> O <sub>3</sub> S	MW 288.29	IL-0011- TG	[174501-64-5]	C <sub>8</sub> H <sub>15</sub> F <sub>6</sub> N <sub>2</sub> P	MW 284.18
		25 g	42.70 €			25 g	21.70 €
		50 g	57.40 €			50 g	28.70 €
		100 g	86.10 €			100 g	43.40 €
		250 g	192.50 €			250 g	97.30 €
		500 g	347.90 €			500 g	175.00 €
		1 kg	626.50 €			1 kg	315.00 €
							
<b>1-Ethyl-3-methylimidazolium methyl sulfate, 97%</b>				<b>1-Ethyl-3-methylimidazolium diethyl phosphate, 96%</b>			
IL-0112- TG	[516474-01-4]	C <sub>7</sub> H <sub>14</sub> N <sub>2</sub> O <sub>4</sub> S	MW 222.26	IL-0052- TG	[848641-69-0]	C <sub>10</sub> H <sub>21</sub> N <sub>2</sub> O <sub>4</sub> P	MW 264.26
		25 g	33.60 €			25 g	49.60 €
		50 g	49.00 €			50 g	63.00 €
		100 g	72.10 €			100 g	83.30 €
		250 g	114.10 €			250 g	167.30 €
		500 g	198.10 €			500 g	270.20 €
		1 kg	357.00 €			1 kg	429.10 €
							
<b>1-Ethyl-3-methylimidazolium hydrogen sulfate, 95%</b>				<b>1-Ethyl-3-methylimidazolium trifluoromethanesulfonate, 96%</b>			
IL-0091- TG	[412009-61-1]	C <sub>6</sub> H <sub>12</sub> N <sub>2</sub> O <sub>4</sub> S	MW 208.24	IL-0009- TG	[145022-44-2]	C <sub>7</sub> H <sub>11</sub> F <sub>3</sub> N <sub>2</sub> O <sub>3</sub> S	MW 260.24
		25 g	43.40 €			25 g	51.10 €
		50 g	58.10 €			50 g	68.60 €
		100 g	77.70 €			100 g	98.00 €
		250 g	135.50 €			250 g	217.00 €
		500 g	189.70 €			500 g	385.00 €
		1 kg	265.30 €			1 kg	693.00 €
							
<b>1-Ethyl-3-methylimidazolium tosylate, 96%</b>							
IL-0008- TG	[328090-25-1]	C <sub>13</sub> H <sub>18</sub> N <sub>2</sub> O <sub>3</sub> S	MW 282.36				
		25 g	33.60 €				
		50 g	45.50 €				
		100 g	83.30 €				
		250 g	166.60 €				
		500 g	298.90 €				
		1 kg	511.00 €				
							

Offer is valid until **January 31<sup>st</sup> 2018**, subject to prior sale, please include promotion code **XMASS2017** with your order. It cannot be combined with any other discount. Please mind, that due to their purity profile, these compounds are not suited for electrochemistry and physical data acquisition.

## Christmas sale of selected nanomaterials

A selection of nanomaterials in limited amounts and only for a short period of time is available for sale at **15% discount on list prices**. Please mind, this offer is valid only for the materials listed below in the below described quality. Following nanomaterials are available (price after discount):

<b>Titanium(IV)oxide (anatase), 99.5%</b>				<b>Titanium(IV)oxide (rutile/anatase), 99%</b>			
NO-0038-HP	[1317-70-0]	TiO <sub>2</sub>	MW 79.87	NO-0037-HP	[1317-80-2 / 1317-70-0]	TiO <sub>2</sub>	MW 79.87
APS: 20 nm		25 g	24.65 €	APS: 80 nm		25 g	24.65 €
SSA: >120 m <sup>2</sup> /g		100 g	41.65 €	SSA: ~ 50 m <sup>2</sup> /g		100 g	50.15 €
Appearance: white powder		500 g	165.75 €	Appearance: white powder		500 g	194.65 €
		1 kg	233.75 €			1 kg	301.75 €
 Warning				 Warning			
Packaging: Powder in PE bottle				Packaging: Powder in PE bottle			
<b>Zinc powder, 99.5%</b>				<b>Tungsten (IV)carbide, 99.95%</b>			
NM-0004-HP	[7440-66-6]	Zn	MW 65.39	NC-0014-UP	[12070-12-1]	WC	MW 195.85
APS: 130 nm		5 g	16.15 €	APS: 150-200 nm		10 g	21.25 €
SSA: 6-8 m <sup>2</sup> /g		10 g	24.65 €	SSA: -		25 g	29.75 €
PM: spherical		25 g	50.15 €	PM: -		50 g	38.25 €
Appearance: grey powder		50 g	84.15 €	Appearance: black powder		100 g	55.25 €
		100 g	126.65 €			500 g	211.65 €
  Danger, <b>UN 1436, 4.3, PG II</b>				 Danger, <b>UN3178; 4.1; PG III</b>			
Packaging: Powder in PE bottle under Argon				Packaging: Powder in PE bottle			

Offer is valid until **January 31<sup>st</sup> 2018**, subject to prior sale, please include promotion code **XMASS2017** with your order. It cannot be combined with any other discount.

## **Imprint**

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### **Contact and Order Information:**

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**world@iolitec.de**

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#### **EU**

**European Union (except Austria & Germany):**

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#### **D A C H**

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**DACH@iolitec.de**

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#### **NAFTA**

**USA, Canada & Mexico**

**Peter von Czarnecki**

**czarnecki@iolitec.com**

**Payment by Credit Card, Check or Wire Transfer is possible.**