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Foreword

5th Australasian Symposium on Ionic Liquids

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The diversity and intensity of ionic liquid (IL) research in the Australasian region has mirrored that worldwide, as these unique materials move from simply being conceptually interesting, to valuable commodities for many different areas of application. The presentations in the 5th Australasian Symposium on Ionic Liquids (ASIL-5) reflected the variety of research in the field and highlighted the exciting promise of ILs in applications ranging from electrochemistry to green chemistry, corrosion resistance to pharmaceutical salts. The fifth in the series of the very successful Australasian Symposium on Ionic Liquids was held on the 3rd–4th May 2012 in Clayton, Australia. The symposium was co-hosted by the ARC Centre of Excellence for Electromaterials Science at Monash University, CSIRO and the Monash Ionic Liquids group. The symposium was initiated in 2003 and has remained a magnet for world-leaders in the field as well as a friendly forum for young students and researchers to present their work.

International speakers at ASIL5 included Professor Hiroyuki Ohno, Tokyo University of Agriculture and Technology, Professor Frank Endres, Clausthal University of Technology, Professor Suojiang Zhang, Chinese Academy of Sciences, Professor Edward Maggin, University of Notre Dame, Professor Toshiyuki Itoh, Totteri University, and Professor Sergey Verevkin, University of Rostock. The symposium also featured speakers from CSIRO and a range of Australian universities including Curtin University, Deakin University, Monash University, the University of Newcastle, the University of New South Wales, and the University of Sydney. Contributions from an invited selection of speakers are presented here, in this special IL issue of the *Australian Journal of Chemistry – an International Journal for Chemical Science*.

The electrochemical applications of ILs have always been one of the leading interests in the field, particularly their use for electrodeposition and battery applications. Endres and coworkers,[1] have shown that polycarbonate templates can be used within a chloroaluminate-based IL for the electrodeposition of aluminium nanowire electrodes. These electrodes show promising properties for use as anodes in lithium ion batteries, with good mechanical stability after 50 cycles in an IL-based electrolyte. Additives within chloroaluminate-based ILs can also influence the nucleation process, morphology, and crystallinity of aluminium electrodeposits, as reported by Zhang et al.[2] Endres and coworkers also show that lithium can be deposited onto copper electrodes modified with polystyrene sphere opals, using an air and water stable IL-based medium, producing lithium either as hollow spheres or with a macroporous structure.[3] This work highlights the complex nature of electrodeposition from ILs, and also points the way towards high surface area lithium electrodes that could be useful for rechargeable lithium metal micro-batteries.

The use of ILs in lithium metal batteries is attracting increasing interest, particularly from a safety perspective as many ILs are non-flammable. One important aspect of this research involves understanding any chemical reaction between the lithium metal and the IL, normally assessed during or after cycling the battery. A novel approach is discussed here by Bhatt and coworkers,[4] who report a significant influence of storage time on the morphology and performance of lithium electrodes in an IL/lithium salt medium. This indicates that for use of ILs in practical battery applications, the periods when the battery is not in use may also impact the performance.

Dr Jenny Pringle received her degree and Ph.D., on ionic liquids, at The University of Edinburgh in Scotland before moving to Monash University in Melbourne, Australia in 2002. In 2008 she started an ARC QEII Fellowship, in association with the ARC Centre of Excellence for Electromaterials Science, which focuses her research on ionic liquids and plastic crystals into the areas of dye-sensitised solar cells and lithium batteries.

Dr Angel A. J. Torriero is a Research Academic at Deakin University in Melbourne, Australia and has published more than 40 refereed papers, four book chapters, and one edited book, Electrochemical Properties and Applications of Ionic Liquids. *His research in electrochemical science focuses on developing an understanding about the properties of ionic liquids as solvents for electrochemical processes at metal/ionic liquid interfaces and within the ionic liquids. He has made significant contributions in a number of fields, including analytical electrochemistry, biosensor, bioelectrochemistry, organic and organometallic electrochemistry, and most recently internal reference systems for ionic liquids.*

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ILs can also be used in metal-air batteries, and in particular magnesium-air batteries represent a promising alternative to lithium-based devices as magnesium is more abundant, cheaper, and safer. In order for ILs to function as electrolytes in these devices they must be sufficiently ionically conducting. Furthermore, as investigated by Forsyth and coworkers,[5] it is important to understand the transport properties of the electrolytes containing different concentrations of both salts and water, as will be present in the metal-air battery. NMR diffusion measurements provide an important insight into the transport in these IL-based electrolytes.[5]

Another interesting aspect of IL-based electrochemistry is their use as a unique medium for the synthesis and electrochemical cycling of conducting polymers. Best and coworkers[6] discuss the surprising observation of *proton*-mediated chemical polymerisation of pyrrole and 3,4-ethylenedioxythiophene when the chemical oxidant $FeCl_3.6H_2O$ is used. The possibility of an acid-driven chemical polymerisation route has significant implications for simplifying the chemical synthesis of conducting polymers by eliminating the need for metal removal from the resultant conducting polymer.[6]

The potential use of ILs for energy-based applications has also attracted considerable attention in the field of biomass-derived energy, as reviewed by Hossain and Aldous.[7] In particular, the ability to tailor the physical properties of ILs through adjusting the cation and anion structure, and the possibility of thus being able to control different aspects of the processing of lignin, is particularly attractive.[7] In this special issue, Amano and coworkers[8] report preparation of regenerated celluloses prepared from microcrystalline cellulose by treatment with four different ILs, and the effect of the IL on the crystallinity of the regenerated cellulose. Kondo and coworkers[9] demonstrate the preparation of bacterial cellulose membranes containing an IL, and the properties of the resulting membranes for the separation of organic nitrogen compounds.

The biological applications of ILs were highlighted in the ASIL5 symposium, and in this special issue Byrne and coworkers[10] discuss the use of protic ILs with the Alzheimer's peptide Aβ 16–22. They show that the nature of the cation of the IL can have a significant effect on conversion of Aβ monomers to Aβ amyloid fibrils, possibly as a result of the different hydrogen bonding networks in the ILs. Another fascinating biological application of ILs was revealed by the Ohno group,[11] where mixtures of ILs and water can be used for the temperature-dependant selective extraction of proteins via reversible phase changes between homogeneous mixtures and phase-separated states.

In addition to these different aspects of IL applications, presentations at the symposium also reflected the importance of fundamental studies of these unique materials, such as a more sophisticated understanding of the surface composition of IL/water mixtures,[12] and use of a combination of experimental and theoretical techniques to assess thermochemical properties.[13] The continued development of new IL families is also essential to future growth of the field, and Oshiki and coworkers demonstrate the use of a hybrid ion, $[FeCl_3{\cdot}EtSO_4]$, to make new magnetic ILs.[14] Finally, Weis and MacFarlane point us in a possible future direction for the development of new ILs, with a review of the progress in computer-aided molecular design.[15]

The selection of invited papers in this special issue is just a snapshot of the research progress being made across the IL field. The variety of possible applications of these unique materials, and improvements in the fundamental understanding through both in-depth analytical techniques and computational studies, are continually expanding. We wait in anticipation for the exciting advances that will have been made in time for the next Australasian Symposium on Ionic Liquids.

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