Preface: An International Look at Ionic Liquids

Welcome to the *Science China Chemistry* special issue “Ionic Liquids and Green Chemistry”. We have assembled 28 papers (13 from China and 15 from outside China) in the field to highlight the continued growth of this exciting area. We gratefully acknowledge the support from Science China Press and thank Prof. Xingmei Lu, Dr. Qian Wang, Dr. Guanqun Song, the authors, and the referees for their great contributions to this special issue.

We might have actually entitled this special issue, “Ionic Liquids in Support of International Sustainability” given the role ionic liquids have begun to play in many major technological advances worldwide. Perhaps, though the emphasis should be on the ‘international’ part given that this special issue is a combined effort of not only China, but of 11 other countries as well.

Indeed Green Chemistry, or more generally Sustainability, is a great concern to the entire World. China will have a large role to play in global sustainability and it is clear from the great work arising from China and the international interactions Chinese scientists enjoy today, that China will have a large role to play in the science as well. This is quite clear from the growing number of scientific papers arising from China when compared to the rest of the world. Let’s take ionic liquids as an example. Since 2000, the rate of publications appearing in the field of ionic liquids has grown at an enormous rate with 6519 publications appearing in 2011 alone (Figure 1). Figure 2 provides information on how many of these papers arise from Chinese authors and the trend is quite clear.

Given the growth in Chinese science over the past few decades, China should adopt a leadership role in the science of sustainability since this area is critical for future growth and prosperity. Leadership in science, however, requires proof and conviction; it requires data to back up claims. The field of ionic liquids and green chemistry offers some valuable lessons in this regard.

Sustainability is a beautiful dream. Using ionic liquids to lead to sustainable technology is a wonderful goal. However, defining one’s work or one’s field as sustainable is a far cry from having proven or demonstrated it. Scientists need

Figure 1 Total number of publications on ionic liquids around the world (publication numbers were obtained from SciFinder (www.scifinder.cas.org) with keywords “ionic liquids” and refining the references by year).

Figure 2 Number of publications from 2000 to 2011 by country (publication numbers were obtained from SciFinder (www.scifinder.cas.org) with keywords “ionic liquids” and refining the references by country).

proof not hype. Motivation to be sustainable is good, but one must also expect failures along the way and not be afraid to admit them.

International understanding is also absolutely vital to attack broad social issues of global importance, but this understanding is often hampered by competing economic issues or even cultural backgrounds. Science should be able

to transcend this by developing fundamental scientific knowledge. Such fundamental science is key to technological advances. From knowledge comes problem solving power, new answers to key questions, new thinking, and a new awareness of what questions to ask in the first place.

In our field of ionic liquids, the chemistry and the engineering are complex. This complexity arises from the multicomponent nature of the systems with which we work and we should learn from this. A more systems oriented thinking within the narrow field of ionic liquids, will allow a more systems level thinking in the utilization of ionic liquids in important new technologies.

Progress will arise from an openness and a willingness to think in new ways and in new directions. There is really no need to “protect one’s turf” by forcing strict definitions of what it means to work in a given field or to engage in exclusionary actions trying to force others out of the field. Instead, we need to reach out, to learn from others and other fields, and happily teach them what we know of our field. If this is done in a manner true to the science, and we don’t fall victim to the hype, advances can and will be made in both our fundamental understanding and in our ability to use that understanding to solve Society’s problems of tomorrow.

We hope that this special issue, where international authors from 12 different countries have come together to provide a brief glimpse at some of their science, will continue to open doors to international collaboration. The papers in this special issue and indeed the authors, represent only a small fraction of the activities in this field. There is still much to learn and much to do. For example, we should establish comprehensive structure-property relationships of ionic liquids, which will point us in the direction of designing more efficient ionic liquids for special applications. We need to understand reaction-transport coupling and how contrasting types of interactions at the mesoscale in ionic liquid systems affect reaction outcomes in order to scale up

and optimize innovative processes with ionic liquids. Additionally, we must continue to pursue and understand the amazing new phenomena observed in nano materials synthesis and/or assembling biochemical systems, solar cells, *etc.* using ionic liquids. If we continue to do so, we believe that ionic liquids will play an important role for creating a green and sustainable world.

In September of this year (2012) and April of next year (2013), the international ionic liquids community will meet to continue these and other discussions. The 3rd Asian-Pacific Conference on Ionic Liquids and Green Chemistry (APCIL) will be held in Beijing, China September 17–19, 2012 (<http://apcil12.org/dct/page/1>). The 5th Congress on Ionic Liquids (COIL) will be held April 21–25, 2013 in Vilamoura, Portugal (<http://coil-5.itqb.unl.pt/>). We invite you to these two interesting ionic liquids meetings to explore beyond the hype and into the true science of this fascinating field.

We would ask that Green Chemistry and Sustainability remain an entrenched goal of this and every scientific endeavor, and that these terms and goals not be used to define the work, but to guide the work. There is much work to be done toward a sustainable society, we need not waste effort on hype. Indeed, there is no time to waste at all; the problems are too big, the time too short. Join us on this journey.

ROGERS Robin D., ZHANG SuoJiang, WANG JianJi
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Dr. ROGERS Robin D. obtained both his B.S. in Chemistry (1978, Summa Cum Laude) and his Ph.D. in Chemistry (1982) at The University of Alabama and currently serves as Distinguished Research Professor, Robert Ramsay Chair of Chemistry, and Director of the Center for Green Manufacturing at UA. In 2007 he was also Chair of Green Chemistry and Co-Director of QUILL at The Queen's University of Belfast in Northern Ireland (UK) before returning full time to The University of Alabama in 2009. In 2009, he was named Honorary Professor at the Institute of Process Engineering, Chinese Academy of Sciences in Beijing.

His research interests cover the use of ionic liquids and Green Chemistry for sustainable technology through innovation and include Materials (advanced polymeric and composite materials from biorenewables), Separations (novel strategies for separation and purification of value added products from biomass), Energy (new lubricant technologies and selective separations), and Medicine (elimination of waste while delivering improved pharmaceutical performance).

Rogers is the Founding Editor-in-Chief of the American Chemical Society journal *Cryst. Growth Des.* He is also an editorial board member of *Sep. Sci. Technol.*, *Solvent Extr. Ion Exch.*, and *Chem. Lett.*, as well as a member of the international advisory boards for *Green Chem.*, *Chem. Commun.*, and *ChemSusChem*.

Dr. ZHANG SuoJiang graduated and received his Ph.D. degree from the department of Chemistry of Zhejiang University in 1994, and won the scholarship of Japanese Ministry of Education and went to Japan to do research with Professor Kazuo. In 1997, he was employed by Mitsubishi Chemical Corporation. From 1998, he worked as a Senior Engineer and a Senior Consultant. From 2001, he started working in Institute for Process Engineering, Chinese Academy of Sciences as the "Hundred Talents" till now. He is "National Science Fund for Distinguished Young Scientists" Winner, 973 Chief Scientist, and won the Second Class Prize of National Natural Science Award in 2010. Prof. ZHANG SuoJiang is the Editor-in-Chief of *Chin. J. Pro. Eng.*, and is also serving as advisory board member of *Greenhouse Gases: Sci. & Technol.* and editorial board member of *CIESC J.* Prof. Zhang mainly engages in ionic liquids and green process researches, including molecular design, large-scale preparation and clean processes of ionic liquids.

Dr. WANG Jianji graduated from Henan Normal University in 1978, and received his Msc. at Wuhan University in 1983, and Ph.D. at Yokohama National University of Japan in 2001. He worked as research fellow at University College London from 1987 to 1989 and at University of Surry from 1992 to 1993. He has been a professor at Henan Normal University since 1992, and director of the key laboratory for green chemistry and technology at the same university since 2001. His research interests are centered in electrolyte solution chemistry and green media with special emphasis in structures of ionic solutions and ionic liquids and their applications in green processes. Currently, he serves as the vice chairman of Thermodynamics and Thermal Analysis Committee of Chinese Chemical Society, and editorial board members of *J. Chem. Thermodyn.* and *Chin. J. Chem. Phys.*