



## Ionic Liquids in Separations and Mass Spectrometry, a New Frontier

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### Abstract:

Room-temperature ionic liquids (RTILs), also known as liquid organic, molten, or fused salts, are a class of nonmolecular ionic solvents with low melting points. The accepted definition of an RTIL is any salt that has a melting point lower than ambient temperature. However, "ionic liquid" (IL) is often applied to any compound that has a melting point  $<100\text{ }^{\circ}\text{C}$ . Most common RTILs are composed of unsymmetrically substituted nitrogen-containing cations (e.g., imidazole, pyrrolidine, pyridine) with inorganic anions (e.g.,  $\text{Cl}^-$ ,  $\text{PF}_6^-$ ,  $\text{BF}_4^-$ ). ILs are also interesting because of their other useful and intriguing physicochemical properties. Wilkes et al. first reported ambient-temperature ILs based on the 1-alkyl-3-methylimidazolium cation in 1982 (1). Since then, many ILs containing a variety of cations and anions of different sizes have been synthesized to provide specific characteristics. Over the past few years, research and applications of ILs have expanded tremendously. The initial impetuses for this expansion were organic synthesis and the growth of green chemistry. In this presentation an overview of the structure and properties of ILs and a description of their expanding use in various applications in separations, chromatography and mass spectrometry will be given (2). A number of studies have appeared indicating that ILs have exceptional promise as stationary phases. They have a dual nature selectivity in that they separate nonpolar molecules as would a nonpolar stationary phase and they separate polar molecules as would a polar stationary phase (2-5). Many ILs have exceptional thermal stability. They are being used increasingly in a variety of applications including 2-D GC and enantiomeric separations (6). ILs have proven to be the best liquid MALDI MS matrix since we introduced them as such a few years ago (7). The properties of ILs that make them effective will be discussed. Further, the dications developed for high stability ILs have found another novel use in electrospray MS as a reagent for ultra sensitive anion analysis.

- (1) J.S. Wilkes, et al., *Inorg. Chem.* 21 (1982) 1263, (2) J.L. Anderson, D.W. Armstrong, G.-T. Wei, *Anal. Chem.* 78 (2006) 2893  
(3) D.W. Armstrong, L. He, Y.-S. Liu, *Anal. Chem.* 71 (1999) 3873, (4) J.L. Anderson, et al., *J. Am. Chem. Soc.* 124 (2002) 14, 247  
(5) J.L. Anderson, et al., *J. Am. Chem. Soc.* 127 (2005) 593, (6) G.R. Lambertus, et al., *J. Am. Chem. Soc.* 1135 (2006) 230  
(7) D.W. Armstrong, et al., *Anal. Chem.* 73 (2001) 3679

### About the Speaker:

Daniel W. Armstrong is the Robert A. Welch Professor of Chemistry at the University of Texas at Arlington. He received his B.S. (1972) from Washington and Lee University and his M.S. (1974) and Ph.D. degrees (1977) from Texas A&M University. He has over 470 publications including 22 book chapters, one book ("Use of Ordered Media in Chemical Separations") and twelve patents and given over 430 invited seminars and colloquia worldwide. He is considered the "Father" of pseudophase (micelle and cyclodextrin-based) separations and elucidated the first chiral recognition mechanism for cyclodextrins. He also first developed macrocyclic antibiotics as chiral selectors. He is one of the world's leading authorities on the theory, mechanism and use of enantioselective molecular interactions. His work and columns were in part responsible for the chromatography and electrophoresis - lead revolution in chiral separations over the last two decades. This work provided the impetus for the FDA's regulatory changes regarding chiral drug development in 1992. More recently, he has developed rapid, high efficiency, microfluidic methods for analyzing microorganisms and colloidal particles. He also developed the most comprehensive solvation and characterization models for room temperature ionic liquids (RTILs) and pioneered their use in analytical chemistry.

Dr. Armstrong has received the Eastern Analytical Award for Chromatography (1990), Great Britain's Martin Medal (1991), and the Isco Award for contributions to instrumentation for biochemical separations (1991), the Presidential Award for Research and Creativity (1993), the ACS Midwest Award in Chemistry (1993), the Perkin Elmer Award for Capillary Electrophoresis (1994), The R&D 100 Award for Inventions leading to a better world (1995), and was named a Fellow of the American Association of Pharmaceutical Scientists (1995). In 1996 he was given the Benedetti-Pichler Award in microchemistry; in 1997, the Karen Morehouse Award, in 1998 the ACS Helen M. Free Award, and in 1999 the ACS Award in Chromatography, in 1999 the Distinguish Scholar Award from Hope College/Park Davis, and in 2001 the Chicago Area Chromatography Discussion Group (CCDG) Merit Award. He was awarded the Weber Medal, and was made an honorary member of the Slovaca Pharmaceutical Society, for his contributions to the Pharmaceutical Sciences (2001). He received the Spencer Award for Agriculture and Food Chemistry in 2002, the Chirality Medal, 2003 and the Zuffa medal for Pharmaceutical Chemistry, 2004. He was the 2005 Dal Nogare Award winner presented at the Pittsburgh Conference and was awarded the 2007 Medal of the Slovak Medical Society. He is the Separations Associate Editor for Analytical Chemistry and was the Editor of the international journal *Chirality*, a Section Editor for *Amino Acids*, and a member of the Editorial Board of over 20 other journals. He is a member of the American Chemical Society, American Association for the Advancement of Science, Smithsonian Associate and Sigma Xi. His current research involves chiral recognition, specific separation and detection of enantiomers, cyclodextrin chemistry, investigation of biologically active molecules, macrocyclic antibiotics, and high efficiency microbial analysis, and use of room temperature ionic liquids in chemical analysis and separations. He also has interests in a variety of other areas from oceanography to gemstone analysis. He originated and broadcast the NPR (National Public Radio) show, "We're Science" that was broadcast on ~140 stations and the Armed Forces Network.

**Location:**  
D'Ignazio's Towne House  
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**Times:**  
Executive Mtg - 5:00 pm  
Social "Hour" - 5:45 pm  
Dinner - 6:30 pm  
Presentation - 7:30 pm

**Directions:**  
See below

**Cost of Dinner:**  
\$30 or MC/Visa /AmEx

**NOTE TO STUDENTS:** Full-time students with valid ID may attend dinner meetings at half price. **Faculty members at colleges and universities are urged to bring one or more students to the meeting. If they do, they also can attend at half-price.**

**Dinner Choices:** Sirloin Steak, Eggplant Parmesan, or Salmon. Please specify choice of entree when making dinner reservations.

**For Reservations:**

Please register/call before 4 p.m., **Friday, February 12<sup>th</sup>, 2010**. Please note that "no-shows" will be billed for the dinner.

**Late reservations:** We still want you to attend, so call now. However, we cannot guarantee your entrée selection for dinner.

**Contact:** We strongly recommend online registration <http://www.cfdv.org/> but you can also e-mail [sheree@cfdv.org](mailto:sheree@cfdv.org), or FAX 610-485-9467. For FAX/e-mail, please include your name, employer, work telephone & meal choice. Alternatively, call Ms. Sheree Gold at 610-485-3479 and provide same information.

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- **Introductory HPLC – May 10-12, 2010**
- **Gas Chromatography – May 17-19, 2010**
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**For Inclement Weather:** cancellations will be accepted up to **12:00pm** on the day of the meeting. Call Ms. Sheree Gold at 610-485-3479. If the meeting is cancelled, you will be notified by **email** by 3pm.