Vision

Room-Temperature Molten Salts : A Bright Future for Applications in Clean Technology

Charles L. HUSSEY

It is a great honor to contribute a vision article about room-temperature molten salts to this special issue of *Electrochemistry*, which is dedicated to molten salt chemistry and electrochemistry. A decade ago, only a few prescient scientists were bold enough to predict that room-temperature molten salts (or ionic liquids) could play a significant role in the development of green chemistry and clean technology. However, scientists worldwide are discovering that low-melting chloroaluminate molten salt systems obtained by combining anhydrous aluminum chloride with quaternary ammonium chloride salts such as 1,3-dialkylimidazolium chlorides are excellent solvents *and catalysts* for a wide variety of industrial reactions. These ionic solvents exhibit adjustable Lewis acidity, low melting points, high electrical conductivity, and negligible vapor pressure at room temperature, and they dissolve a wide spectrum of inorganic species. They are miscible with aromatic solvents such as benzene and toluene, dichloromethane and acetonitrile, but are *immiscible* with alkanes and alkenes. This fact proves to be quite important to their success!

The first organic salt-based, room-temperature chloroaluminate melts were invented more than 50 years ago for use as aluminum electroplating baths. Since that time, they have been explored for various applications, including battery and fuel cell electrolytes and media for plating metals and alloys. But in truth, these melts were really only laboratory curiosities with no industrial relevance until scientists at research centers in France and Northern Ireland demonstrated the value of these ionic media as alternative solvents for transition metal catalyzed olefin dimerization reactions, olefin metathesis reactions, and the Diels-Alder dimerization of diolefins. These scientists have also found that Lewis acidic melts are excellent liquid catalysts for alkylation reactions such as the reaction of olefins with isobutane. In fact, they display catalytic efficiencies significantly greater than found with traditional concentrated mineral acids. Because olefins are immiscible with these molten salts, the reaction products form a second phase that can be easily removed, whereas the molten salt and any dissolved transition metal catalyst can be reused many times. By using these molten salts as solvents in these chemical processes, the need for environmentally unfriendly VOCs such as benzene and toluene and as well as concentrated mineral acids is eliminated.

Not surprisingly, room-temperature chloroaluminate melts are unsuitable for aqueous phase chemistry. However, hydrophobic room-temperature melts can be prepared by replacing the aluminate ions with anions that are highly resistant to hydrolysis, e.g., tetrafluoroborate or hexafluorophosphate. Such melts are being actively explored in several laboratories around the world as media for liquid-liquid extraction.

Clearly, the industrial exploitation of room-temperature molten salts has just begun, and the future for them looks extremely favorable. Don't be surprised to learn in the near future that several key industrial chemical processes have been replaced with new more efficient, environmentally friendly processes based on room-temperature molten salts.

Prof. Charles L. HUSSEY
Department of Chemistry
University of Mississippi