Ionic Liquid's Makeup Measurably Non-Uniform at the Nanoscale

November 10 2009

(PhysOrg.com) -- Researchers at Texas Tech University, Queen's University in Belfast, Ireland, the University of Rome and the National Research Council in Italy recently made a discovery about the non-uniform chemical compositions of ionic liquids that could lead to greater understanding and manipulation of these multi-purpose, designer solvents.

Their findings were published online in the *Journal of Physics: Condensed Matter*. The article was selected for inclusion in the Institute of Physics' IOP Select, which is a special collection of articles chosen by IOP editors based on research showing significant breakthroughs or advancements, high degree of novelty and significant impact on future research.

Ionic liquids are a new frontier of research for chemists. Originally invented to replace volatile and toxic solvents such as benzene, they're now used in high-efficiency solar cells, as cheaper, more environmentally friendly rocket fuel additives and to more effectively dissolve plant materials into biofuels. Since 1990, research on ionic liquids has grown exponentially.

"Their properties are strikingly different than those of most conventional liquids," said Edward Quitevis, a professor of chemistry in the Texas Tech Department of Chemistry and Biochemistry. "A conventional liquid for the most part is composed of neutral molecules whereas an ionic liquid is composed entirely of ions."

Because of their ability to be tailored and manipulated for specific applications, ionic liquids can be compared to a new form of Erector Set for chemists. By modifying the ions, scientists can create specific properties in the liquids to fit particular applications or discover new materials.

Each new discovery that adds to the understanding of ionic liquids leads to new possibilities for applications and materials, Quitevis said.

“An ionic liquid is basically a salt that happens to have a melting point at or about room temperature,” he said. “The reason why it’s a liquid and not a solid is because the ions are bulky and don’t crystallize readily. The more we learn about them, the more we can find new applications for them that we never could have imagined for conventional liquids.”

By using X-rays and lasers, researchers found that parts of the liquid at the nanoscopic level were not uniform. Some domains of the liquid may have had more or less density or viscosity compared to other domains. Also, these non-uniform domains could be measured.

“At the nanoscopic scale, these liquids are not uniform, compared to other liquids, such as water, where properties are all uniform throughout,” Quitevis said. “This non-uniformity is not random. These domains of non-uniformity are well defined and can be measured. And this nanoscopic non-uniformity was predicted in computer simulations, but never confirmed experimentally until recently.”

Understanding these types of attributes of ionic liquids can lead to more breakthroughs in the future, Quitevis said.

Provided by Texas Tech University