Sandia National Laboratories

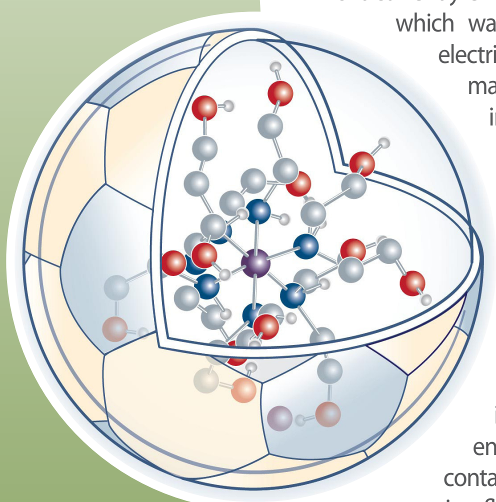
Energy, Climate & Infrastructure Security

Achieving Higher Energy Density in Flow Batteries at Lower Cost with MetILs

Sandia National Laboratories developed a method to produce reduction-oxidation (redox) active ionic liquids for redox flow batteries using inexpensive, non-toxic precursors.

Overcoming Electricity Fluctuation Using Flow Batteries

Despite widespread enthusiasm for greater use of renewable energy, the viability of relying on renewables to satisfy energy demands remains heavily dependent on the infrastructure of the electric grid. As it currently exists, the electric grid's infrastructure, which was originally designed to produce electricity from steady power sources, makes it difficult to accomodate intermittently productive renewable energy sources. Energy storage technologies are needed to help even the flow, storing excess energy and distributing it when needed.

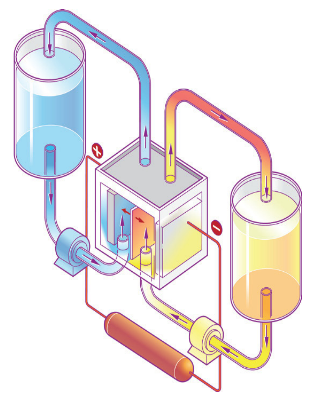


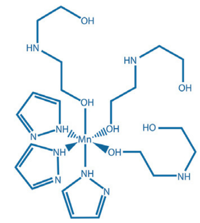
The MetIL's cation complex evenly distributes its net charge across its surface—like a soccer ball has evenly spaced white/black panels. Because of this symmetrical charge distribution, no two complexes can come close enough to each other to initiate ion pairing/solid formation, but they can easily capture, release, and exchange electrons.

Flow batteries work well in large-scale, stationary storage applications. A flow battery is a rechargeable method of energy storage in which electrolytes containing one or more electro-active species flows through a cell that converts chemical energy to electricity. Flow batteries recharge rapidly by replacing the electrolyte liquid while simultaneously recovering spent material for re-energization. In addition to mitigating the variability of wind and solar power generation, flow batteries are instrumental in minimizing electrical loads during peak demand and act as an uninterruptable power supply during power outages.

Reduction-Oxidation Ionic Liquids

Sandia National Laboratories developed a new family of liquid salt electrolytes, known as MetILs, that could lead to cost effective batteries that store three times more energy than today's batteries. Sandia's method produces reduction-oxidation (redox) active ionic liquids for redox flow batteries using inexpensive, non-toxic precursors. MetILs are based on readily available materials such as iron, copper and manganese. By incorporating the redox active species into the ionic liquid's molecular formula, this





method increases metal concentration and energy density well beyond the saturation point of most metals in both aqueous and nonaqueous systems. In addition, the electrochemical efficiency, meaning the ability to reverse charge, is far better than any ionic liquid system reported to date.

Impact on the US Electric Grid

Sandia's success in creating higher density energy storage through the utilization of MetILs, reduces costs and makes the application of flow batteries more competitive with zinc-bromine and other systems. MetILs also have the benefit of higher safety, due to the use of environmentally benign ionic fluids.

The MetILs approach will create an out-of-the box solution to the cathode/electrolyte paradigm, specifically because it is based on inexepensive and practical precursors. It may lead to innovative and cost reducing storage systems that will have a large impact on the United State's electric grid.

Leveraging it's more than ten years of experience, Sandia has built the in-house capabilities for producing and testing ionic liquids for energy storage applications. This has made MetILs suitable for electrochemical work, unlike other commerically available ionic liquids. This experience and capability may eventually lead to a more cost effective, clean and efficient energy source.

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U.S. DEPARTMENT OF ENERGY

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