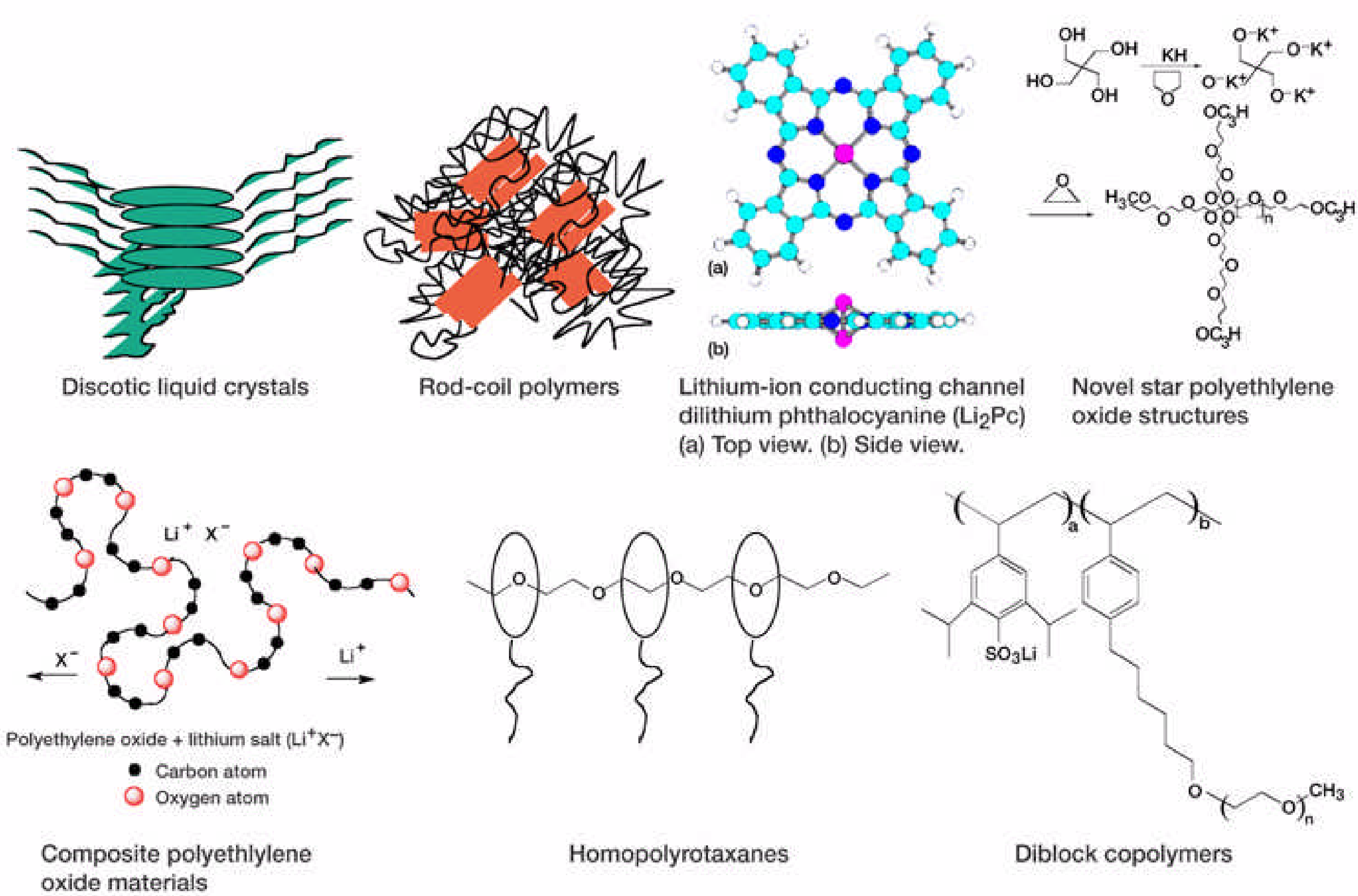
Polymer Energy Rechargeable System Battery Being Developed



Representative solid polymer electrolyte concepts under investigation for PERS batteries.
Long description. Illustrations of discotic liquid crystals, rod-coil polymers, lithium-ion conducting channel dilithium phthalocyanine (Li_2Pc) from top and side, novel star polyethylene oxide structures, composite polyethylene oxide materials (showing polyethylene oxide + lithium salt, carbon atoms and oxygen atoms), homopolyrotaxanes, and diblock copolymers

In fiscal year 2000, NASA established a program to develop the next generation, lithium-based, polymer electrolyte batteries for aerospace applications. The goal of this program, known as Polymer Energy Rechargeable Systems (PERS), is to develop a space-qualified, advanced battery system embodying polymer electrolyte and lithium-based electrode technologies and to establish world-class domestic manufacturing capabilities for advanced batteries with improved performance characteristics that address NASA's future aerospace battery requirements.

This advanced lithium-based battery chemistry is of interest for the following reasons:

1. It has a high cell voltage: 3.6 V compared with 1.3 V for conventional alkaline

chemistries. Consequently, the battery can achieve a desired system voltage with fewer cells and, hence, reduced system complexity and lower manufacturing and assembly costs.

2. It has a high specific energy and energy density: 25 percent of the mass and/or volume of conventional alkaline cells. The improvements in specific energy (watt-hours per kilogram) and energy density (watt-hours per liter) realized by this battery system can enhance any mission that uses rechargeable batteries for energy storage and can enable missions that have critical weight and/or volume margins. Lighter weight systems also contribute to lower launch costs.

3. It incorporates environmentally safe materials and has safe battery operation. Because there are no free liquids in the battery, polymer electrolyte systems are inherently safe systems. The polymer electrolyte enables a flexible, conformable battery that does not generate internal pressure during operation.

4. It offers improved coulombic and energy efficiencies comparable to those of conventional systems and exhibits low self-discharge rates that contribute to more efficient operations.

5. It operates over a wide range of temperatures centered on the ambient temperature. This flexibility simplifies thermal system design and expands the envelope of operational parameters under which the battery can be used.

A NASA Research Announcement was released in fiscal year 2000 to solicit efforts to address the development of the polymer electrolytes, cathodes, and anodes for PERS batteries. Development of a polymer with room-temperature conductivity in the range of 10^{-3} S/cm has been identified as the enabling technology breakthrough required for this battery system. There are currently seven contracts and seven grants in place that address various aspects of component-level development required for the PERS batteries. The current contractors are the Lawrence Berkley National Laboratory, Max Power, Inc., Naval Air Warfare Center Weapons Division, Physical Sciences Inc., Yardney Technical Products, Inc., Eagle Picher Technologies, LLC (Joplin, MO), and Lithium Power Technologies, Inc. Grantees include Northwestern University, the University of Utah, Indiana University, the University of Minnesota, Texas Engineering Experiment Station, and the University of Akron. In addition to these contracts and grants, research and development activities have been supported at the Jet Propulsion Laboratory, the Air Force Research Laboratory, and the NASA Glenn Research Center.

A component-screening facility has been established at NASA Glenn, and procedures have been developed to evaluate the materials developed via the supported research and development efforts. This includes the construction of a state-of-the-art dry room facility that will be used to conduct research relating to lithium batteries, and the installation of analytical equipment that will be used for component characterization and analysis. Recently, researchers reported room-temperature conductivities in the range of 10^{-4} S/cm for the polymer electrolytes under development. This represents an increase of nearly 2 orders of magnitude over conductivities exhibited by the state-of-the-art polymer electrolyte at room temperature. The progress to date has been encouraging, and several concepts offer the promise of meeting the program goals.

Find out more about the research of Glenn's Electrochemistry Branch http://www.grc.nasa.gov/WWW/Electrochemistry/doc/pers.html.

Glenn contact: Michelle A. Manzo, 216-433-5261, Michelle.A.Manzo@nasa.gov
Author: Michelle A. Manzo
Headquarters program office: OAT
Programs/Projects: Space Science, ESE, HEDS, aeronautics, commercial satellites