Materials

Oxide Fiber Cathode Materials for Rechargeable Lithium Cells

Lyndon B. Johnson Space Center, Houston, Texas

$LiCoO_2$ and $LiNiO_2$ fibers have been investigated as alternatives to $LiCoO_2$ and $LiNiO_2$ powders used as lithium-intercalation compounds in cathodes of rechargeable lithium-ion electrochemical cells. In making such a cathode, $LiCoO_2$ or $LiNiO_2$ powder is mixed with a binder [e.g., poly(vinylidene fluoride)] and an electrically conductive additive (usually carbon) and the mixture is pressed to form a disk. The binder and conductive additive contribute weight and volume, reducing the specific energy and energy density, respectively.

In contrast, $LiCoO_2$ or $LiNiO_2$ fibers can be pressed and sintered to form a cathode, without need for a binder or a conductive additive. The inter-grain contacts of the fibers are stronger and have fewer defects than do those of powder particles. These characteristics translate to increased flexibility and greater resilience on cycling and, consequently, to reduced loss of capacity from cycle to cycle. Moreover, in comparison with a powder-based cathode, a fiber-based cathode is expected to exhibit significantly greater ionic and electronic conduction along the axes of the fibers. Results of preliminary charge / discharge-cycling tests suggest that energy densities of $LiCoO_2$- and $LiNiO_2$-fiber cathodes are approximately double those of the corresponding powder-based cathodes.

This work was done by Catherine E. Rice and Mark F. Welker of TPL, Inc., for Johnson Space Center.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-22892-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Electrocatalytic Reduction of Carbon Dioxide to Methane

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A room-temperature electrocatalytic process that effects the overall chemical reaction $CO_2 + 2H_2O \rightarrow CH_4 + 2O_2$ has been investigated as a means of removing carbon dioxide from air and restoring oxygen to the air. The process was originally intended for use in a spacecraft life-support system, in which the methane would be vented to outer space. The process may also have potential utility in terrestrial applications in which either or both of the methane and oxygen produced might be utilized or vented to the atmosphere.

A typical cell used to implement the process includes a polymer solid-electrolyte membrane, onto which are deposited cathode and anode films. The cathode film is catalytic for electrolytic reduction of CO_2 at low overpotential. The anode film is typically made of platinum. When CO_2 is circulated past the cathode, water is circulated past the anode, and a suitable potential is applied, the anode half-cell reaction is $4H_2O \rightarrow 2O_2 + 8H^+ + 8e^-$. The H^+ ions travel through the membrane to the cathode, where they participate in the half-cell reaction $CO_2 + 8H^+ + 8e^- \rightarrow CH_4 + 2H_2O$.

This work was done by Anthony F. Sammells and Ella F. Spiegel of Eltron Research, Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).MSC-23097-1

Heterogeneous Superconducting Low-Noise Sensing Coils

Electrically superconductive outer layers are supported by highly thermally conductive skeletons.

NASA's Jet Propulsion Laboratory, Pasadena, California

A heterogeneous material construction has been devised for sensing coils of superconducting quantum interference device (SQUID) magnetometers that are subject to a combination of requirements peculiar to some advanced applications, notably including low-field magnetic resonance imaging for medical diagnosis. The requirements in question are the following:

- The sensing coils must be large enough (in some cases having dimensions of as much as tens of centimeters) to afford adequate sensitivity;
- The sensing coils must be made electrically superconductive to eliminate Johnson noise (thermally induced noise proportional to electrical resistance); and
- Although the sensing coils must be cooled to below their superconducting-transition temperatures with sufficient cooling power to overcome moderate ambient radiative heat leakage, they must not be immersed in cryogenic liquid baths.

For a given superconducting sensing coil, this combination of requirements can be satisfied by providing a sufficiently thermally conductive link between the coil and a cold source. How-