THIN-FILM RECHARGEABLE LITHIUM BATTERIES

N. J. Dudney, J. B. Bates, and Dan Lubben
Solid State Division
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, TN 37831-6030

ABSTRACT

Thin-film rechargeable lithium batteries using ceramic electrolyte and cathode materials have been fabricated by physical deposition techniques. The lithium phosphorous oxynitride electrolyte has exceptional electrochemical stability and a good lithium conductivity. The lithium insertion reaction of several different intercalation materials, amorphous V_2O_5, amorphous $LiMn_2O_4$, and crystalline $LiMn_2O_4$ films, have been investigated using the completed cathode/electrolyte/lithium thin-film battery.

INTRODUCTION

Rechargeable thin-film lithium batteries have been fabricated and evaluated at ORNL. These batteries have very high specific energies and power densities, due to the low mass and reactivity of lithium, and are being developed for a variety of small electronic devices including computer memory devices, active transdermal electrodes, and personal hazardous gas sensors.

These rechargeable cells are based on the reversible intercalation or insertion of large amounts of lithium into a transition metal oxide based cathode, $xLi + Li_yMO_z \leftrightarrow Li_{x+y}MO_z$. The free energy of this reaction determines the operating voltage of the battery. The cathode material must be a good mixed conductor and be chemically and physically stable over many cycles of the charge-discharge reaction. The lithium electrolyte separating the lithium anode and the Li_yMO_z cathode should have a high lithium ion conductivity with a transference number of unity, and it must also be stable in contact with both the lithium anode and the cathode at