[Note: This is a reprint of an abstract. Contents of this document should not be quoted or referred to without permission of the author(s).]

Invited talk to be presented during the Material Research Society's Spring 2002 Meeting, San Francisco, California, April 1-5, 2002.

THIN FILM MATERIALS AND DESIGNS FOR RECHARGEABLE BATTERIES

Nancy J. Dudney and Young-Il Jang

Solid State Division
Oak Ridge National Laboratory
Bldg. 3025M, MS-6030
Oak Ridge, Tennessee 37831-6030

"The submitted manuscript has been authored by a contractor of the U.S. Government under contract No. DE-AC05-00OR22725. Accordingly, the U.S. Government retains a nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or allow others to do so, for U.S. Government purposes."

Prepared by the

SOLID STATE DIVISION
OAK RIDGE NATIONAL LABORATORY
Managed by
UT-BATTELLE, LLC, for the
U.S. DEPARTMENT OF ENERGY
Under Contract DE-AC05-00OR22725

October 2001

2002 MRS Spring Meeting
Symposium V: Materials for Energy Storage, Generation, and Transport
I was invited by Dr. Ricardo Schwarz

THIN FILM MATERIALS AND DESIGNS FOR RECHARGEABLE BATTERIES

Nancy J. Dudney, Solid State Division, Oak Ridge National Laboratory, Oak Ridge, TN
Young-Il Jang, Solid State Division, Oak Ridge National Laboratory, Oak Ridge, TN

Rechargeable batteries fabricated of thin film materials offer some exceptional performance characteristics. These will be discussed and illustrated by examples from work done at ORNL on thin film rechargeable lithium batteries. Assembled by successive deposition of 0.1 to 4 µm-thick films, the battery structure creates a large active interface area enhancing both the power density and the efficient use of the battery materials. The need for inactive materials such as binders and separators as well as second phases to augment the electron transport are eliminated because each layer is thin and dense. These savings may be more than offset, however, by the mass and volume of a substrate that serves no dual purpose. Power densities of the thin film battery approach 8 kW/kg, if the substrate can be excluded. Synthesis of the active battery materials by vapor deposition techniques also produces materials with compositions and microstructures not readily achieved by bulk processing methods. An amorphous inorganic electrolyte offers wide electrochemical stability and very small leakage current to provide for robust performance over a long lifetime and wide temperature range. Electrode materials with submicron and nanocrystalline grains are exceptionally tolerant of deep cycling and the associated volume changes and phase transitions. A high cost of fabrication is the principal disadvantage of these batteries and materials. Thin film batteries are expected to find uses is niche markets for small devices requiring either ultra-thin power sources or very long unattended battery life. The application of thin film materials either as an individual component or as a thin film cell in larger scale power sources may await development of more rapid and economical deposition processes, lower processing temperatures, and the use of low cost and light weight substrates. Ultimately, the full potential of the thin film batteries lies in their direct integration with devices or complementary power sources.