A New Probe for Characterizing Thin Film Defects

The electrical and structural characteristics of thin film defects are important in the performance of microelectronic circuits. Electrical characterization is typically accomplished by electron beam-induced current, deep level transient spectroscopy, scanning probe microscopy, or scanning tunneling microscopy techniques. However, these methods do not always provide the lateral resolution required for detailed understanding of certain grain boundary, void, and dislocation defects. Researchers at Stanford University have developed a new test structure, the transparent probe, which allows electrical isolation and testing of a small region of a thin film which may then be directly analyzed by transmission electron microscopy (TEM). The probe is a four-point structure, precisely fabricated from 1 mm-thick polycrystalline silicon by photolithography and dry etching processes, which sensitively measures the resistance of a 1.2 mm x 0.2 mm region of the thin film. Further, the procedure used to prepare cross-sectional TEM samples for the transparent probe is far simpler than the traditional procedure of repeated grinding and polishing. The authors describe the technical limitations of the transparent probe, but conclude that this new test structure allows physical structure to be associated with electrical properties with a resolution not previously available by other techniques.

From: J. Electrochem. Soc., ***147****, 4633 (2000)*

A Photorechargeable Metal Hydride/Air Battery

Researchers at the NTT Telecommunications Energy Laboratories in Japan have proposed and investigated a new type of secondary battery. Photorechargeable metal hydride/air batteries discharge via reduction of oxygen (from air) and can be charged by light irradiation. The positive electrode of the cell is a conventional oxygen electrode with platinum or carbon-supported platinum as catalysts. The negative electrode consists of a metal hydride and an n-type semiconductor. The electrolyte is aqueous KOH solution. The authors overcame several technical obstacles in the development of this battery. First, the self-discharge resulting from metal hydride dissociation was prevented using $LaNi_{3.76}Al_{1.24}$ instead of $LaNi_5$ as the hydrogen storage alloy because the aluminum replacement of nickel can decrease the equilibrium pressure of hydrogen significantly. In addition, the aluminum replacement was found to positively shift the metal hydride potential. As a result, semiconductor band bending was achieved, and the photoreduction of metal to metal hydride was facilitated during the photocharging step. Finally, a photostable semiconductor, $SrTiO_3$, was chosen to avoid photoanodic dissolution problems. Among the attractive features of the battery are its good energy efficiency and high energy density.

From: J. Electrochem. Soc., ***148****, A121 (2001)*

In Situ Infrared Spectroscopy and Kelvin Probe Measurements during Atmospheric Corrosion

The development of the Kelvin probe for measurement of corrosion potential has aided in quantification of corrosion rates of metals in humid air. The potential changes measured in the Kelvin probe technique depend on the nature of the films that form during the atmospheric corrosion process. To quantify the composition and thickness of the films, researchers at the Swedish Corrosion Institute in Stockholm and at SINTEF Materials Technology in Trondheim, Norway developed a technique to simultaneously perform *In Situ* Reflection Absorption Spectroscopy (IRAS) while conducting Kelvin probe potential experiments. They tested this device during atmospheric corrosion of chloride-contaminated zinc in humid air. In the initial stages of the humid air exposure, the Volta potential measured using the Kelvin probe dropped due to activation of the zinc surface. Using IRAS, the formation and growth of a corrosion film containing zinc oxide, zinc hydroxy carbonate, and zinc hydroxy chloride was observed. Further growth of the surface film resulted in a large increase in the Volta potential. The authors conclude that this combination of electrochemical and spectroscopic techniques is quite powerful for obtaining information about the changes in Volta potential associated with the formation and growth of different types of corrosion products on metal surfaces.

From: Electrochem. and Solid-State Lett., ***4****, B7 (2001)*

Electrodes for Electrochemical Supercapacitors

Conducting polymers such as polyaniline (PANI), polythiophene, and polypyrrole (PPy) have a wide range of potential applications due to their unusual electrical and electrochemical properties. Principally because of their high charge capacity and low cost, conducting polymers offer good alternatives to traditional active electrode materials such as activated carbon and noble metal oxides. Fusalba *et al.* at the Université du Québec à Montréal in Canada have reported new information on the behavior of PANI deposited on carbon paper electrodes and used in electrochemical supercapacitors. Cyclic voltammetry and electrochemical impedance spectroscopy showed that PANI prepared in nonaqueous media with CF_3COOH as a proton source has high charge capacity and electroactivity that spans a large potential window. Galvanostatic charge-discharge cycling in a two-electrode configuration cell using separators of symmetrical PANI-PANI or asymmetrical PPy-PANI was performed to simulate a prototype version of an electrochemical supercapacitor. The authors found that the combination of PPy-PANI in an asymmetric capacitor led to a performance improvement compared to a symmetric capacitor using the same p-dopable polymers on both electrodes.

From: J. Electrochem. Soc., ***148****, A1 (2001)*

Batteries for Implantable Defibrillators

Implantable cardioverter defibrillators (ICDs) are used to treat potentially lethal cardiac arrhythmias. They continuously monitor the heart's electrical signals, sense when the heart is beating dangerously fast, and when required, rapidly deliver one or more electric shocks to return the heart to a normal rhythm. ICDs place stringent demands on the lithium/silver vanadium oxide batteries that power them. They run constantly at low power for 5-10 years and then occasionally deliver electric shocks as small as a few microjoules or as large as 40 joules. Researchers at Medtronic, Inc., in Minnesota have reported an extensive experimental and modeling study of these batteries that thoroughly covered high power, high energy density, and long-term stability performance issues. They mapped the power capability of the batteries as a function of current density, pulse duration, and extent of lithiation of the cathode. At high current densities and long durations, concentration polarization rapidly increases cell resistance, which appears mostly on the cathode. The authors developed a model that very accurately predicts time- and temperature-dependent resistance increases over time periods typical of those required in the ICD application.

From: J. Electrochem. Soc., ***148****, A30 (2001)*

Tech Highlights was prepared by Zenghe Liu, Yanrong Zhu, Terry Guilinger, and Mike Kelly.

Be sure to visit ***Tech Highlights*** *on the web, where you can link through to the full text version of these articles. Go to* ***www3.electrochem.org/interface.html*** *and link through to the current issue.*