Electrochemical Characterization of V_2O_5 Ambigel/Lithium Nanoelectrode Arrays and their Component Nanocells

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Previously our research group has characterized both nanoelectrode arrays (NEA) and individual nanobatteries. These were rocking chair batteries with a V_2O_5 cathode and either a SnO_2 anode or a graphite anode. The electrolyte used for this system was a polymer wax complexed with lithium triflate. The system was created by confining the V_2O_5 sol gel and the electrolyte in the 200 nm diameter pores of Al_2O_3 membranes (Whatman Anodisc). The anode material was applied as a continuous layer on top of the electrolyte. These micro- and nanobatteries have many technological applications including MEMS and NEMS.[1]

Our recent work includes electrochemical characterization of this systems with a metallic lithium anode and two slightly different electrolytes. One electrolyte was the PEO wax used previously. The other electrolyte was a higher molecular weight (4,000,000) spincoated PEO electrolyte. Both electrolytes contained the same concentration of lithium triflate salt. After applying one of these electrolytes to the cathode this film was place on a lithium ribbon which then was placed on top of a nickel plate. The nickel plate served as both a current collector and a seal to prevent contact between the reactive lithium metal and any air or water. In addition, the electrochemical characterizations performed on the cell, was conducted in an inert environment, which was either flowing argon or a glove box filled with argon. Initially an open circuit potential (OCP) was measured for the entire battery with an initial value of 3.0 V. However, the potential dropped rapidly to about 1.5 V.

The resistance of the entire system was characterized by AC impedance analysis while individual nanocells were characterized by performing charge and discharge cycles using a Keithly Sub Femto Amp Remote Source meter. Electrical contact was made by touching the electrode of each individual battery with the cantilever tip of an atomic force microscope (AFM). The battery was charged to about 3.0 V at a rate of 50 pA and discharged at 5 pA. This gave an initial capacity of about 28 $\mu Ah/cm^2 \cdot \mu m$, which is close to what was achieved with the V_2O_5-tin oxide nanocells.

Reference

1. F. Vullum, D. Teeters. *Journal of Power Sources*, accepted for publication