Performance Characteristics of Lithium Ion Cells based on γ-LiV_2O_5

J. Barker, J. Swoyer and M. Y. Saïdi
Valence Technology Inc.
301 Conestoga Way
Henderson, NV 89015
(702) 558-1000

The cell chemistry of conventional lithium ion batteries is limited by the choice of lithium liberating cathode materials i.e. $LiMn_2O_4$, $LiCoO_2$ or $LiNiO_2$. Novel compounds based on the phosphate polyanion materials have also recently been proposed [1,2]. In this presentation, prototype lithium ions cells based on a lithiated vanadium oxide (γ-LiV_2O_5) compound as the cathode active material will be demonstrated.

The γ-LiV_2O_5 was prepared by a proprietary solid-state method [3]. High-resolution evaluation experiments were carried out using the Electrochemical Voltage Spectroscopy (EVS) method [4].

The typical EVS voltage response for the γ-LiV_2O_5 in a lithium metal half-cell configuration is shown in Figure 1. Good reversibility, together with a specific discharge capacity of over 130 mAh/g for this material is shown. Performance of the γ-LiV_2O_5 material compares favorably with the theoretical capacity of 142 mAh/g and clearly demonstrates the high quality of this active material. The low level of voltage hysteresis in the figure is indicative of the small overvoltage associated with the lithium insertion/extraction processes. Complementary EVS differential capacity data, shown in Figure 2, further confirms the reversibility of the insertion reactions. Long term cycling capability of lithium cells, at both 23 and 60°C have shown only minimal capacity fade after greater than 250 cycles.

The γ-LiV_2O_5 cathode, when coupled with a crystalline graphite anode, forms a lithium ion cell configuration which further demonstrates the encouraging performance of this cathode material. The first charge and discharge EVS cycle of a typical cell, cycled between voltage limits of 2.50 – 3.60 V, is shown in Figure 3. The first cycle coulombic inefficiency is less than 9 %. The initial charge capacity corresponds to a specific material utilization of 133 mAh/g while the discharge capacity equates to 121 mAh/g, values in line with expectations from the lithium half-cell results. From the voltage profile, the system clearly shows low overvoltage. Life cycling characteristics of this system is shown in Figure 4, indicating promising reversibility for commercial applications.

Detailed performance characteristics of prototype graphite//γ-LiV_2O_5 lithium ion cells will be presented and discussed.

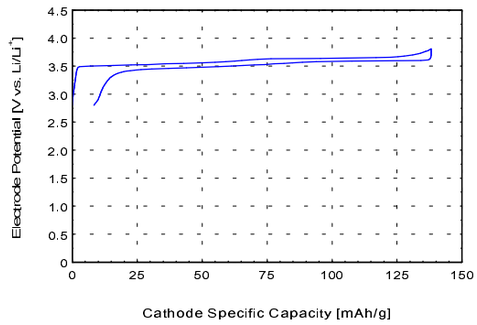

Figure 1: EVS Voltage Profile for a typical Li//γ-LiV_2O_5 cell cycled between 2.80 – 3.80 V.

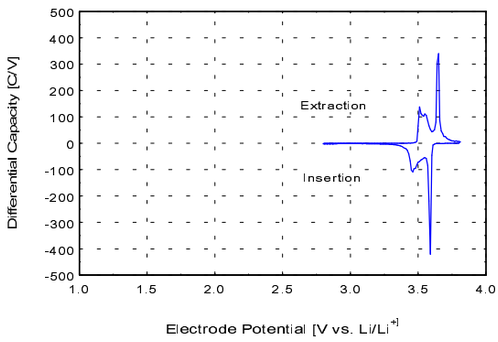

Figure 2: EVS Differential Capacity Profile for Li//γ-LiV_2O_5 cell cycled between 2.80–3.80V.

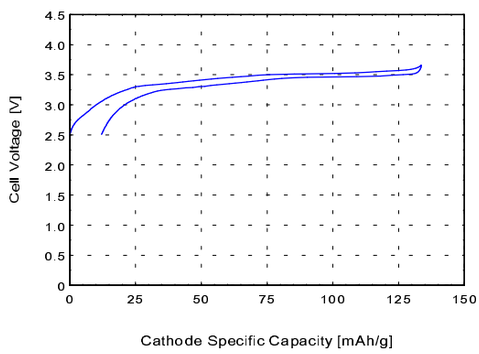

Figure 3: EVS Voltage Profile for Graphite//γ-LiV_2O_5 lithium ion cell cycled between 2.50–3.60 V.

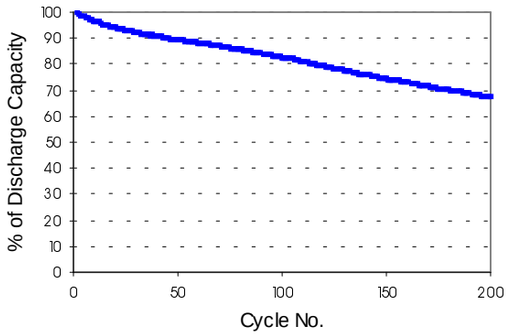

Figure 4: Life cycling behavior for Graphite//γ-LiV_2O_5 lithium ion cell cycled at C/5 rate, 2.5–3.6V.

References:

[1] J. Barker and M.Y. Saidi, US Patent 5,871,866 (1999).
[2] A. K. Padhi, N.S. Nanjundaswamy, C. Masquelier and J.B. Goodenough, *J. Electrochem. Soc.* 144, 2581 (1997).
[3] J. Barker, M.Y. Saidi and J. Swoyer, US Patent Application.
[4] J. Barker, *Electrochim. Acta* **40**, 1603 (1995).