Confirmed Existence of Omega – Vanadium Oxide

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V_2O_5 is an increasingly interesting candidate for cathodes especially in thin film rechargeable lithium batteries.. It is well known that V_2O_5 undergoes a variety of structural transformations as a function of Li content upon electrochemical cycling. Most of the studies of $Li_xV_2O_5$ have been done in the range of $0 \leq x \leq 1$(x=1 is equivalent to discharging down to 2.15 V). It has been reported that if crystalline V_2O_5 is cycled between 2.15 and 1.9 V, it loses the crystallinity after a few cycles. However, if the crystalline V_2O_5 is cycled down below 1.9 V, a reordering of the structure occurs as observed by X-ray diffraction. It has been discussed that a new cubic phase, ω-phase $Li_xV_2O_5$,[1-3] is produced. However, others have reported that this could be explained by a combination of known phases.[4-5]

We have confirmed the existence of the ω-phase. We prepared thin film and powder V_2O_5 electrodes and cycled them between 4 and 1.5 V. All new XRD peaks that appeared after cycling can be indexed to the calculated pattern for the ω-phase $Li_xV_2O_5$ as shown in Figure 1. After annealing in Argon at 200 °C for 3 hours, the peak intensities increased dramatically. However, after annealing at 300 °C, the data showed signs of decomposition for the ω-phase $Li_xV_2O_5$ as shown in Figure 2.

Figure 1.XRD patterns of carbon black, V_2O_5- powder electrode as deposited, after first discharge and after 9 cycles.

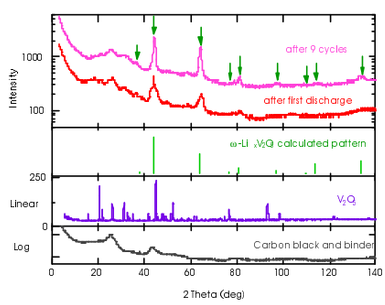
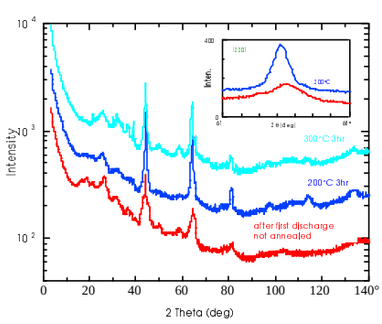


Figure 2. XRD patterns of ω-phase $Li_xV_2O_5$ after annealing at 200 and 300 C.

We have also employed Transmission Electron Microscopy (TEM) to further investigate this unique phase. TEM results ,as shown in Figure 3, also confirmed the existence of ω-phase $Li_xV_2O_5$. The rings in the diffraction pattern were indexed to the ω-phase $Li_xV_2O_5$ (002), (220) and (222).



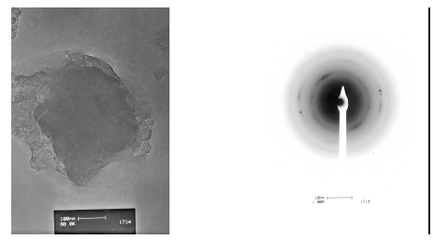


Figure 3. TEM results showing bright field image and diffraction rings of ω-phase $Li_xV_2O_5$.

We will report on additional cycling experiments on the ω-phase $Li_xV_2O_5$ as well as additional TEM and annealing results.

This work is supported by the Office of Science in the Department of Energy under the contract no. DE-AC36-99-GO10337.

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