Properties of Lithium Vanadium Phosphate As a Cathode Material for Lithium-ion Batteries

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Transition metal oxides and chalcogenides, with layered and three-dimensional frameworks, have been the focus of a wide development effort as cathodes for lithium rechargeable batteries [1-3]. Recently, considerable study has also been given to lithium conducting phosphates materials for use in rechargeable lithium batteries [4,5]. Their structural types allow for various isomorphous replacements, which are of importance in increasing the concentration of lithium or selecting the optimal dimensions of the conductivity channels for. A general study of a vanadium phosphate compound with the general formula $Li_3V_2(PO_4)_3$ will be presented. Such framework structures containing an interconnected interstitial space are potentially fast ionic conductors, especially if the energetically equivalent sites are connected. The substitution of the larger poly-anion in a open three dimensional framework helps to stabilize the structure and the 3D tunnel network allows for fast ion migration. Furthermore, anion substitution can alter the voltage through two effects; the first is an inductive one due to changes in the metal ion energy levels because of the changed anion group. The second effect is possibly achieved by providing fewer or more electrons, thereby shifting the lithium concentration at which a given redox reaction takes place.

Previously, nasicon-related vanadium compounds ($Li_xV_2(PO_4)_3$) have been found to cycle two lithiums reversibly over the range 3-4.3V [6]. Since the $V^{3+/4+}$ redox couple takes place at 3.5 and 4V, it suggests that the $V^{4+/5+}$ is quite high. In this work, attempts to extract the remaining lithium in this compound electrochemically will be presented.

References:

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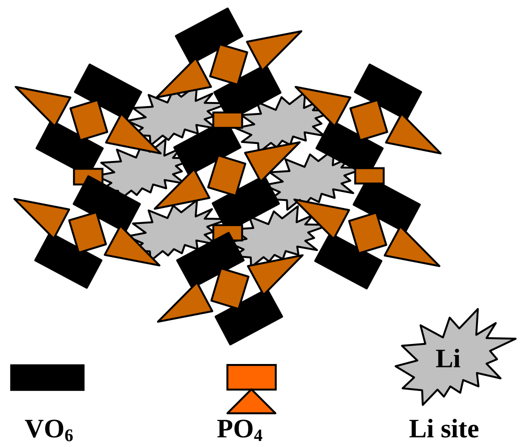

Figure 1: Structural representation of $Li_3V_2(PO_4)_3$

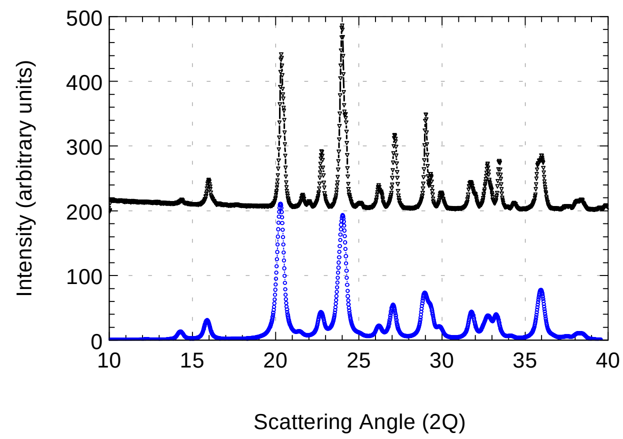

Figure 2: XRD pattern for $Li_3V_2(PO_4)_3$

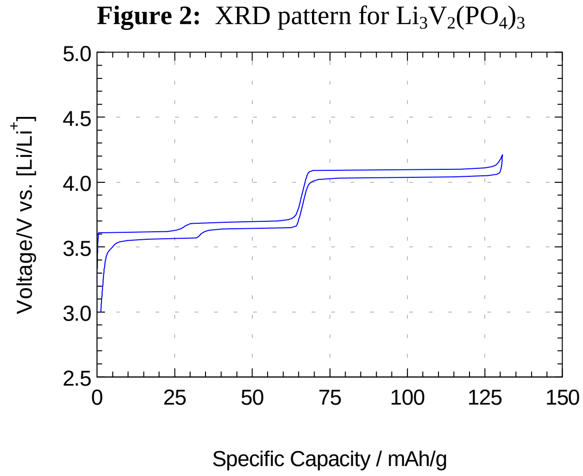

Figure 3: EVS Voltage Profile for Li// $Li_3V_2(PO_4)_3$ cell cycled between 3.00–4.20V

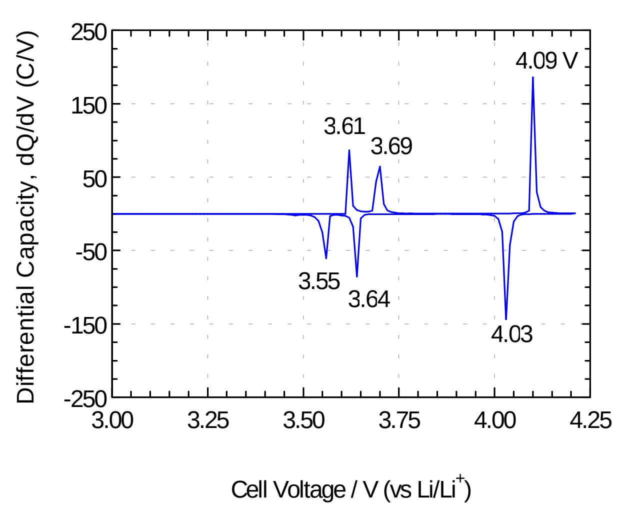

Figure 4: Differenital Capacity Profile for Li// $Li_3V_2(PO_4)_3$ cell.