Phase Transition, Electrochemistry, and Structural Studies of High Rate LixV3O8 Cathode with Nanoplate Morphology

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Abstract: Structural and kinetic behavior of lithium-vanadium-oxide ($Li_xV_3O_8$) cathode is studied as lithium-ion battery electrode. The morphology of $Li_xV_3O_8$ is found to be nanoplates with nanorods as minor constituents. Theoretical prediction shows such a nanoplate morphology will have almost thirty four times faster lithium diffusion than spherical particle of same volume. In the present study, experimental and theoretical observation of Fourier transform infrared spectroscopy (FT-IR) is compared to investigate the vibrational mode of V-O bond. $Li_xV_3O_8$ cathode, delivers a high discharge capacity of 270 mAh g^{-1} at 200 mA g^{-1} and as high as 200 mAh g^{-1}, 135 mAh g^{-1}, and 100 mAh g^{-1} at 1000 mA g^{-1}, 2000 mA g^{-1}, and 3000 mA g^{-1} current rates respectively. A detailed electrode kinetic study using galvanostatic intermittent titration technique (GITT) and electrochemical impedance spectroscopy (EIS) are performed to establish the relationship between high rate capability with kinetic parameters. The diffusion co-efficient ($D_{Lithium}$) value of $Li_xV_3O_8$ is estimated to be $\sim 10^{-15}$–10^{-13} cm^2 s^{-1} and 10^{-13}–10^{-11} cm^2 s^{-1} in the single phase region ($0 \le x \le 1.7$) during discharge and charge processes respectively. Further, ex situ XRD is performed on $Li_xV_3O_8$ cathode material to study the phase transformation during charge/discharge process.