Electrochemical behaviour of layered vanadium oxychloride in rechargeable lithium ion batteries

Ping Gao, a Ruiyong Chen, a,b Xiu-Mei Lin, a M. Anji Reddy, a Le Zhang, a Thomas Diemant, c R. Jürgen Behm, a,c and Maximilian Fichtner a,b,*

a Helmholtz Institute Ulm Electrochemical Energy Storage (HIU), Helmholtzstr.11, D-89081 Ulm, Germany
b Institute of Nanotechnology, Karlsruhe Institute of Technology (KIT), P.O. Box 3640, D-76021 Karlsruhe, Germany
c Institute of Surface Chemistry and Catalysis, Ulm University, Albert-Einstein-Allee 47, D-89081 Ulm, Germany

Abstract
Here, we report on the electrochemical behavior of layered VOCl material as potential electrode material in rechargeable lithium-ion batteries. Orthorhombic VOCl with a space group of Pmmn was synthesized via a solid-gas reaction. During electrochemical charge and discharge a combination of intercalation and conversion reactions are proposed to take place based on the data collected from a variety of analytical methods such as X-ray diffraction (XRD), scanning electron microscopy (SEM), high-resolution transmission electron microscopy (HRTEM), X-ray photoelectron spectroscopy (XPS), X-ray absorption near edge spectroscopy (XANES), infrared spectroscopy (IR), Raman spectroscopy and electrochemical methods. The pseudocapacitive contribution to the Li+ storage was identified using a cyclic voltammetry (CV) technique. Charge and discharge tests showed that the VOCl electrode can deliver first discharge and recharge capacities of 1228 mAh g⁻¹ and 759 mAh g⁻¹ at a current density of 100 mA g⁻¹, respectively. Even after 120 cycles at 260 mA g⁻¹ a reversible capacity of 351 mAh g⁻¹ can be obtained with a high coulombic efficiency (> 98 %).

Keywords: Vanadium oxychloride, VOCl, lithium ion battery, anode, conversion reaction.

Submitted: 02.03.2016