Electrochemical properties of CoV_2O_4: A novel anode material for sodium-ion batteries

Jeng-Shin Lu, Irish Valerie B. Maggay, and Wei-Ren Liu*
Department of Chemical Engineering, Chung Yuan Christian University, Chung Li, Taiwan, R.O.C.
E-mail: WRLiu1203@gmail.com

Transition metal oxides have been greatly studied on LIBs due to their high theoretical capacities (>600 $mAh \cdot g^{-1}$) which is provided through conversion reaction with Li^+[1, 2]. In LIB systems, numerous vanadium containing compounds have been studied such as, ZnV_2O_4[3], CoV_2O_6[4], CuV_2O_6[5], $FeVO_4$[6], and so forth. There are vanadium containing compounds that have already been applied to SIBs and showed promising results. This study reports the spinel based transition metal oxide – CoV_2O_4 (CVO) was synthesized by solvothermal method and annealed at 500 ℃. Its electrochemical performance as anode material for sodium ion battery was investigated for the first time. Ex-situ analyses were performed in order to understand the reaction mechanism that transpire during the charge-discharge cycle. The results showed that the initial reversible capacity of CVO was 115 $mAh \cdot g^{-1}$ at the current density of 100 $mA \cdot g^{-1}$ in the potential window of 0.01-3.0 V. The results indicate that CVO is a potential anode material for sodium ion battery.

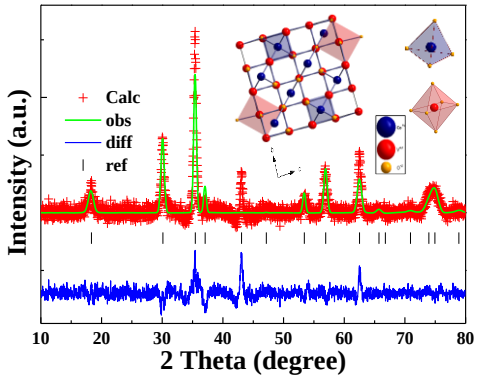

Fig. 1 Neutron powder diffraction data of CVO; observed, calculated (Rietveld) and difference intensity profiles and crystal structure.

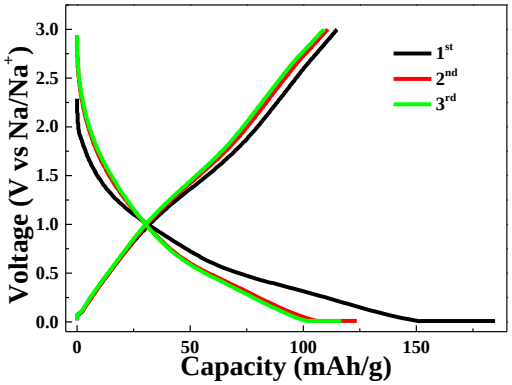

Fig. 2 Charge/discharge curves of CVO at 100 $mA \cdot g^{-1}$ for the first three cycles.

References:

[1] R. Jin, G. Liu, C. Liu, L. Sun, High electrochemical performances of hierarchical hydrangea macrophylla like $NiCo_2O_4$ and $NiCo_2S_4$ as anode materials for Li-ion batteries, Materials Research Bulletin, 80 (2016) 309-315.

[2] M. Reddy, Y. Xu, V. Rajarajan, T. Ouyang, B. Chowdari, Template free facile molten synthesis and energy storage studies on MCo_2O_4 (M= Mg, Mn) as anode for Li-ion batteries, ACS Sustainable Chemistry & Engineering, 3 (2015) 3035-3042.

[3] X. Zhu, X. Jiang, L. Xiao, X. Ai, H. Yang, Y. Cao, Nanophase ZnV_2O_4 as stable and high capacity Li insertion electrode for Li-ion battery, Current Applied Physics, 15 (2015) 435-440.

[4] M. Sivakumar, P. Prahasini, R. Subadevi, W.-R. Liu, F.-M. Wang, An efficacy of 'nano'in brannerite-type CoV_2O_6 conversion electrode for lithium batteries, RSC Advances, 6 (2016) 112813-112818.

[5] J. Ma, S. Ni, J. Zhang, X. Yang, L. Zhang, The charge/discharge mechanism and electrochemical performance of CuV_2O_6 as a new anode material for Li-ion batteries, Physical Chemistry Chemical Physics, 17 (2015) 21442-21447.

[6] D.H. Sim, X. Rui, J. Chen, H. Tan, T.M. Lim, R. Yazami, H.H. Hng, Q. Yan, Direct growth of $FeVO_4$ nanosheet arrays on stainless steel foil as high-performance binder-free Li ion battery anode, RSC Advances, 2 (2012) 3630-3633.