Investigation of a new lithium-free cathode material exhibiting outstanding energy density

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Among metallic elements, lithium has low atomic mass (6.94 g mol^{-1}), high specific capacity (3860 mAh g^{-1}), and the most electropositivity (−3.04 V vs. SHE), which facilitate designing of batteries with high energy density. Thus, lithium ion batteries (LIBs) have been the leading energy storage technology.

The initial study of electrochemical Li intercalation into V_4O_9 was reported by A. Hammouche in 1987,[1] and was considered as a cathode material for LIBs by F. Mattelaer et al. in 2016.[2] The charge-discharge properties were evaluated with thin film electrodes comprised of various vanadium oxides, and V_4O_9 has the highest energy density among the Wadsley series (V_nO_{2n+1}− VO_2, V_2O_5, V_6O_{13}, V_3O_7, V_4O_9). Herein, we present V_4O_9 as high performance cathode material for LIBs, and reveal the mechanism of lithiation/delithiation behavior. In order to improve diffusivity and rate capability, the particle size of V_4O_9 was controlled. In addition, the electrochemical stability that adversely affects by the vanadium dissolution problem was improved by adopting an appropriate electrolyte which was compared with the 1M $LiPF_6$ in EC/DMC, a conventional electrolyte. Based on this approach, we have found that V_4O_9 demonstrated high energy density (270 mAh g^{-1}, 2.6 V) comparable to conventional $LiCoO_2$ and also showed excellent power density in Li-ion cells.

References:

[1] A. Hammouche, A. Hammou, Electrochimica acta, 32 (1987) 1451-1452.
[2] F. Mattelaer, K. Geryl, G. Rampelberg, T. Dobbelaere, J. Dendooven, C. Detavernier, RSC adv., 6 (2016) 114658-114665