Double-Sheet Vanadium Oxide Cathode for Rechargeable Calcium-Ion Batteries

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Calcium battery has received attention as one of post lithium-ion battery systems because of potential advantages in cost and capacity. Since the first successful demonstration of a calcium deposition/dissolution with a calcium metal anode, much effort has gone into developing cathode materials as hosts for calcium insertion. However, only a few materials show a capability of calcium intercalation in an aqueous or non-aqueous electrolytes.

In this work, The double-sheet vanadium oxide, $V_2O_5 \cdot 0.63H_2O$ (DS-V_2O_5), demonstrate as a cathode material for calcium-ion batteries, based on electrochemical calcium ion intercalation for the first time. DS-V_2O_5 was synthesized via electrochemical oxidation process on the graphite foil substrate. The reversible electrochemical properties are evaluated by galvanostatic method and cyclic voltammetry (CV), which show high reversible capacity of 203.7 mAh g^{-1} at 0.1 C-rate, and fade to 86% after the 350 cycles due to vanadium dissolution of host materials. The average discharge voltage is estimated to be 2.76 V vs. Ca/Ca^{2+}. A kinetic analysis using CV indicate that the reaction mechanism can be described as the combinations of diffusion-controlled intercalation with surface limited pseudo-capacitance reactions. In addition, elemental analyses, XRD, and BVSM calculation results supported that calcium ion is mainly work for electrochemical reactions.