

Symp D03

Charge-Discharge Properties of Amorphous Vanadium Polyanionic Borate as Anode Material for Lithium Secondary Battery

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Polyanionic compounds have engendered much interest not only as rare-metal-free cathode materials, but also as anode materials such as Fe_3BO_6 , FeBO_3 , and VBO_3 for next-generation lithium secondary batteries. VBO_3 is attractive as anode material than FeBO_3 , due to its low redox potential. However, VBO_3 showed a large irreversible capacity at 1st cycle. In this study, we tried to reduce the irreversible capacity of VBO_3 at 1st cycle, and to improve the synthetic process into a cheap and simple process by synthesizing amorphous VBO_3 containing Li. To synthesis amorphous VBO_3 containing Li, the mixtures of V_2O_3 , B_2O_3 , and Li_2CO_3 with the molar ratio of $\text{V}_2\text{O}_3:\text{B}_2\text{O}_3:\text{Li}_2\text{CO}_3:\text{AB} = 1:1:x:y$ ($x = 1,2$ with $y = 0$ and $y = 0,1,2,5$ with $x = 1$) were melt at 1300 °C for about 10 min under atmospheric condition. The molten mixtures were then quenched at a cooling rate of about 1000 °C/s. Two The electrochemical anode performances were evaluated in coin-type cells with 1 M $\text{LiPF}_6/\text{EC}:\text{DMC} = 1 : 1$ in volume and a polypropylene separator against a Li metal counter electrode. As Li content in synthetic process of water-quenched amorphous VBO_3 increase, the irreversible capacity of VBO_3 decrease. This seems to come from structural modification of VBO_3 into open structure by a glass modifier of Li_2O . Both the reversible and irreversible capacities of air-quenched VBO_3 increase with the content of AB added in synthetic process. This suggest that a number of electrochemically active site in air-quenched VBO_3 increased by the addition of AB in synthetic process.

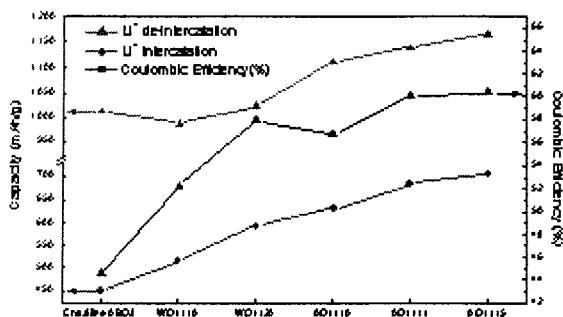


Fig. 1 Effects of Li and Acethylene Black contents in synthetic process on capacity and coulombic efficiency of VBO_3 at 1st cycle. (In Fig. 1, WQ and AQ indicate synthesized products by water quenching and by air quenching, respectively. Four numbers after WQ or AQ stand for molar ratio of V_2O_3 , B_2O_3 , Li_2CO_3 , and Acethylene Black in sequence.)