NiO nanowire as a high performance anode materials for lithium ion batteries

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Transition metal oxides (such as NiO, CoO_x, MnO_2 and FeO_x) have been extensively investigated as alternative negative materials for lithium ion batteries (LIB) owing to high theoretical capacity (700 ~ 1,000 $mAhg^{-1}$) based on a novel conversion mechanism. Among them, with a theoretical capacity of 718 $mAhg^{-1}$, NiO is one of the most promising negative materials for LIB. However, its practical application, it is constrained by poor electrochemical performance. Because of the conversion reaction problem caused by the large volume change and the low electronic conductivity. In order to solve this problem, an effective way to enhance the electronic conductivity is different morphologies and structures. Recent reports, NiO has been a variety reports on the synthesis of different NiO nanostructures including porous nanospheres, nano-flowers, nanofibers and nanowires.

The NiO nanowire was synthesized by hydrothermal method. In a typical procedure, $NiCl_2 \cdot 6H_2O$, $Na_2C_2O_4$, H_2O were dissolved in ethylene glycol and then stirred for 10 min to form clear solution. The autoclave was sealed and heated at 220 ^oC for 12 h. The products were washed three times with de-ionized water and absolute ethanol, respectively. Finally, the as-prepared products were heat-treated at various temperatures below 700 ^oC for 2 h in air to obtain the final products. The electrode was formed by mixing 70 wt% active material, 10 wt% carbon black (electronic conductive additive) and polyacrylic acid (PAA, binder) in N-methylpyrrolidinone (20 wt%). A solution of 1 M $LiPF_6$ dissolved in a mixture of ethylene carbonate (EC) and dimethyl carbonate (DMC) (3 : 7 weight ratio) was used as the electrolyte in the cell. Electrochemical test was carried out in coin type cell. Galvanostatic electrochemical charge and discharge test were made between 0V and 3.0V at 100 mAg^{-1} current at room temperature.

XRD analysis confirmed that the $NiC_2O_4 \cdot 2H_2O$ were only component of initial sample. During the heat treatment, the $NiC_2O_4 \cdot 2H_2O$ were transformed gradually into NiO phase as the heating temperature increased, finally fully transforming at more than 600 ^oC. The as-prepared $NiC_2O_4 \cdot 2H_2O$ nanowire have had the length of 3 ~ 5μm and the width of ~ 100 nm. As the heating temperature increased, has not change its shape.

The as-prepared $NiC_2O_4 \cdot 2H_2O$ nanowire demonstrated a high performance as anode material for LIB. It shows a high initial discharge capacity of 1321 $mAhg^{-1}$. The first charge capacity of the as-prepared electrode at a current density of 100 mAg^{-1} arrived at 786 $mAhg^{-1}$, with good capacity retention. Also, NiO nanowire, the discharge and charge capacities are 1392 and 880 $mAhg^{-1}$ at the first cycle and good cycling performance.