$CoMoO_4$@N-doped carbon nanocomposite as a high-performance anode material for lithium-ion batteries

R. M. Bhattarai, S. M. S. P, Md. M. Hossain, S. Saud, and Y. S. Mok*

Department of Chemical and Biological Engineering, Jeju National University, Jeju, South Korea

*Corresponding author: smokie@jejunu.ac.kr

1. Introduction

Lithium-Ion Batteries (LIBs) have been a major energy source for uncountable electronic accessories for a few decades now [1]. LIBs use for portable electronics such as cell phones, laptops, cameras, electronic cigarettes, flashlights, and many more is almost irreplaceable. LIBs are also growing popularity in electric vehicles, military and aerospace applications due to their high energy density, low self-discharge, lightweight and various other features.[1]

Over the past few decades, a worldwide effort has been made to search for alternative anode materials for improving the capacity and cyclability of LIBs [2,3]. The $CoMoO_4$ delivered a high theoretical capacity of 980 mAh/g, but it showed poor cycling stability [4,5]. However, its low electronic conductivity, rapid capacity loss, and poor capacity retention are the major concerns for its practical applications [5]. In quest of minimizing the shortcomings of $CoMoO_4$ as an excellent LIBs anode material, we adopt a simple one-pot hydrothermal method and chemical carbon deposition techniques to fabricate $CoMoO_4$@N-doped carbon nanocomposites acted as a buffering and conducting matrix that restricted the volume change and enhanced the electronic conductivity of the electrode material.

2. Abstract

Nanosized $CoMoO_4$ was prepared via a one-pot hydrothermal method [6]. Obtained $CoMoO_4$ nanoparticles were calcined at 500°C. Dopamine HCl was used as an N-Doped carbon source and treated with $CoMoO_4$ in pH-maintained tris-buffer solution. Obtained nanocomposites have been characterized using different approaches like XRD analysis, FE-SEM, EDS elemental mapping, Raman Spectroscopy, and Fourier Transform Infrared Spectrophotometry. CR2032 cell has been fabricated and put for the electrochemical characterization process. These nanocomposites as an anode material for lithium- ion batteries (LIBs) should exhibit excellent rate capability and high stable cycling performances compared to its pristine electrode $CoMoO_4$. Cyclic Voltammetry (CV) analysis demonstrate the good electrochemical reversibility of the $CoMoO_4$@N-Doped carbon nanocomposites. The superior electrochemical performance of the synthesized $CoMoO_4$@NC is attributed to the synergetic chemical coupling effects between the conductive carbon matrix and the high lithium-ion storage capability of $CoMoO_4$ nanoparticles.

3. Results

Formation of pristine $CoMoO_4$ is verified by the peaks obtained from XRD analysis, as shown in Fig. 1. Several numbers of CR-2032 coin cells were assembled inside the glove box. All those cells were checked for a satisfying value of open-circuit voltage (OCV). The capacity of the composites in the current study is based on the mass of active material. Fig. 2A shows the charge/discharge voltage profiles of the $CoMoO_4$ at 100 mA/g between the potential range of 0.01–3 V for the 1st, 2nd, 10th, 20^{th}, 30th and 40th cycles. In the first charge process, an inclined platform between 0.75 V and 0.01V is observed. The $CoMoO_4$ electrode delivers a discharge capacity of 610 mAh/g and a charge capacity of 886 mAh/g in the first cycle. And after 40 cycles at 100 mA/g, the $CoMoO_4$ electrode maintained capacity around 715 mAh/g. Fig. 2B shows the coulombic efficiency of $CoMoO_4$ electrode is maintained 90% up to 43 cycle.

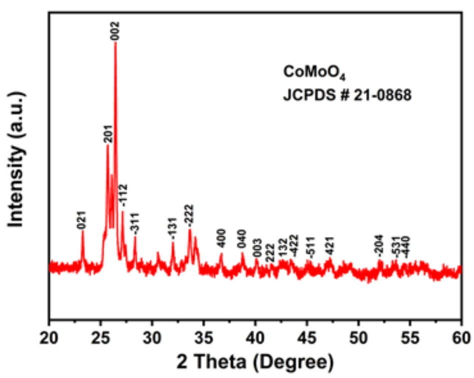

Fig.1 XRD pattern of $CoMoO_4$ obtained after calcination at 500 ^{0}C.

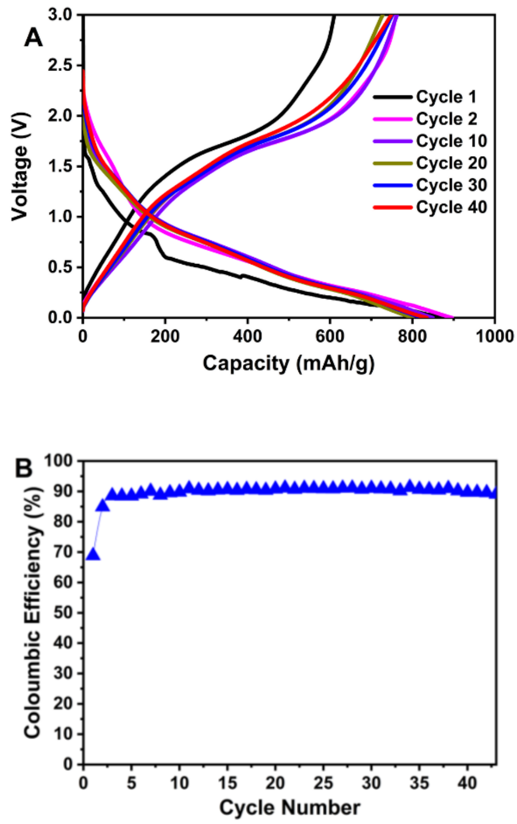

Fig. 2 Galvanostatic charge-discharge cycles of pristine $CoMoO_4$ (A), Coulombic efficiency curve of pristine $CoMoO_4$ (B).

4. Conclusions

In summary, we have developed a method to prepare Nano size $CoMoO_4$ and successfully synthesize $CoMoO_4$@NC nanocomposites. Physicochemical characterizations of $CoMoO_4$ and $CoMoO_4$@NC were confirmed the crystallinity, structural morphology, and chemical composition by several techniques. Electrochemical measurements possess the significant performance of synthesized electrode material.

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