Microwave-Assisted Hydrothermal Synthesis and Electrochemical Characterization of CuS Electrode for Lithium Batteries

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CuS is supposed to be next generation of electrode material for secondary lithium batteries becuase of its high theoretical capacity (～560 mAh g^{-1}), flat voltage plateau and good electronic conductivity (～10^{-3} S cm^{-1}). However, it has usually suffered from poor cycling performance due to the incomplete re-oxidation of electrochemically inactive discharge product (Li_2S) in delithiation processes, which leads to polysulfide dissolution [1]. Thus far, several approches to solve this probrem have been reported, such as reducing particle size or mixing with conducting materials[2,3]. In this study, we have prepared CuS fine particles by microwave-assisted hydorothermal synthesis and investigated their pysical and electrochemical properties.

The precursor solutions were prepared by dissolving accurate amount of copper (II) nitrate trihydrate ($Cu(NO_3)_2{\cdot}3H_2O$) and thiourea ($CS(NH_2)_2$) or copper sulfite pentahydrate ($CuSO_4{\cdot}5H_2O$) and sodium thiosulfate monohydrate ($Na_2S_2O_3{\cdot}H_2O$) in distilled water. Microwave-assisted hydorothermal synthesis was conducted for different synthesis temperatures and concentrations of precursor solutions. The resulting samples were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), and inductively coupled plasma-optical emission spectroscopy (ICP-OES) to study their physical properties, such as crystal structure, surface and interior morphologies, chemical composition, respectivelly. Furthermore, their electrochemical properties have been investigated using CR2032 coint-type cells.

Fig. 1 shows the XRD pattern of the sample prepared at 200℃ from the precursor solution of $Cu(NO_3)_2$ and $CS(NH_2)_2$. The diffraction peaks are well indexed to the standard card of hexagonal phase CuS (ICDD No. 00-006-0464). The chemical composition of the sample was confirmed as Cu/S=1.02 by ICP-OES analysis. The cycle performance of the CuS electrode is shown in **Fig. 2**.

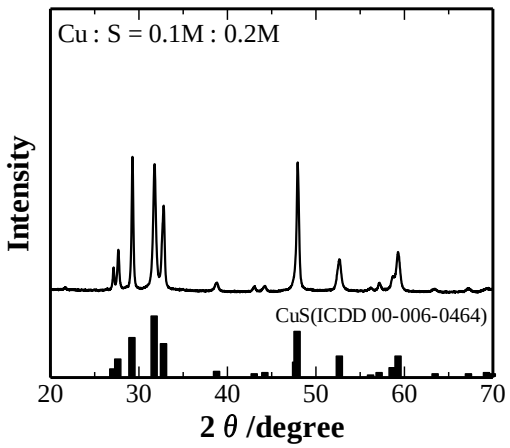

Fig. 1 XRD patterns of the sample prepared at 200℃ for 1 h.

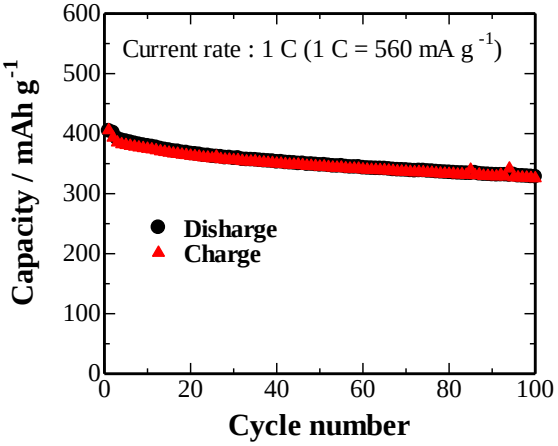

Fig. 2 Cycle performance of the sample prepared at 200℃ for 1 h.

References

[1] X. Wang, Y. Wang, X. Li, B. Liu, J. Zhao, J. Power Sources 281(2015) 185–191.
[2] H. Li, Y. Wang, J. Huang, Y. Zhang, J. Zhao, Electrochim. Acta 225(2017) 443–451.
[3] M. Zhou, N. Peng, Z. Liu,Y. Xi, H. He, Y. Xia, Z. Liu, S. Okada, J. Power Sources 306(2016) 408–412.