dataset analysis on Cu₉S₅ material structure and its electrochemical behavior as anode for sodium-ion batteries

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A B S T R A C T

The data presented in this data article are related to the research article entitled "Facile Synthetic Strategy to Uniform Cu₉S₅ Embedded into Carbon: A Novel Anode for Sodium-Ion Batteries" (Jing et al., 2018) [1]. The related experiment details of pure Cu₉S₅ has been stated. The structure data of pure Cu₉S₅ and the electrochemical performance for sodium-ion batteries are described. © 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Specifications Table

| Subject area         | Chemistry                                      |
|----------------------|------------------------------------------------|
| More specific subject area | Sodium-ion batteries                          |
| Type of data         | Figure                                         |
| How data was acquired| X-ray diffraction (XRD, Rigaku D/max 2550 VB⁺); CHI660B electrochemical analyzer (Shanghai Chenhua Instruments Co., Ltd.). |

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Data format: Analyzed

Experimental factors: Samples, assembled coin cells metallic sodium foil as counter and reference electrode

Experimental features: XRD character of sample and CV performance of electrode material

Data source location: Yueyang, China

Data accessibility: The data is with this article.

Related research article: [1] M. Jing, F. Li, M. Chen, J. Zhang, F. Long, L. Jing, X. Lv, T. Wu, X. Ji, Facile synthetic strategy to uniform Cu$_9$S$_5$ embedded into carbon: A novel anode for sodium-ion batteries, J. Alloy. Compd., 762 (2018) 473–479.

Value of the data:
- Detailed experimental data might be used in the development of further experiments in a particular area.
- The summary of material properties can be utilized to compare together and easily accessed from the various applications.
- The CV curves could be used for more scientific analysis of various metal sulfide as anode for Na-ion batteries.

1. Data

In this data article, the detailed experimental method of pure Cu$_9$S$_5$ sample has been presented. The X-ray diffraction (XRD) pattern and Cyclic voltammetry (CV) files of as-prepared sample shown in Fig. 1, which is utilized to analysis the electrochemical performance of as-prepared material as anode for sodium-ion batteries.

2. Experimental design, materials, and methods

An ethylenediamine-assisted hydrothermal method has been utilized to prepare pure Cu$_9$S$_5$ nanomaterial, according to previous report [2]. The detailed experimental design is as follows. Firstly, 6.0 mL of anhydrous ethylenediamine was dissolved in 24.0 mL deionized water. 1.5 mmol of Cu

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**Fig. 1.** (a) XRD pattern of pure Cu$_9$S$_5$. (b) CV files of pure Cu$_9$S$_5$ electrode at 0.2 mV s$^{-1}$. 

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\begin{align*}
\text{Cu}_9\text{S}_5 & \quad \text{XRD pattern of pure Cu}_9\text{S}_5. \\
\text{CV files of pure Cu}_9\text{S}_5 \text{ electrode at } 0.2 \text{ mV s}^{-1}.
\end{align*}
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(NO₃)₂·6H₂O was dissolved in the above solution to form a blue solution with ultrasonic dispersion for 10 minutes. And then, 1.5 mmol of thiourea was introduced to the solution in batches, while the above solution is in the process of magnetic stirring. After 30 min, the color of mixture becomes deep blue. Then, the mixture system was transferred into a 50 mL Teflon-lined stainless steel autoclave and treated at 120 °C for 2 h. Furthermore, black precipitates were deposited on the autoclave bottom after the temperature dropping down to room temperature naturally. The pale upper clear liquid was poured out. Then, the black precipitates were washed several times utilizing absolute ethanol and distilled water with (1:1 of the volume ratio). Finally, the products were further dried at 80 °C for 24 h, and the pure Cu₉S₅ was obtained.

X-ray diffraction (XRD) has been utilized to investigate the crystalline structure of pure Cu₉S₅. The detailed test parameters are based on Ref. [1]. Cyclic voltammetry (CV) tests of pure Cu₉S₅ has been measured on electrochemical working station (CHI 660B) through assembled CR2025 coin cells utilizing sodium foil as counter and reference electrode, according to previous report [1].

Fig. 1a displays the XRD pattern of as-obtained Cu₉S₅. The diffraction peaks of material matched well to the pure hexagonal Cu₉S₅ phase (JCPDS card No. 47–1748). The peaks at 27.7°, 29.2°, 32.3°, 41.5°, 46.3° and 54.9° correspond to the (0 0 15), (1 0 7), (1 0 10), (0 1 17), (1 1 0) and (1 1 15) crystal planes of hexagonal Cu₉S₅.

Furthermore, the CV profiles of Cu₉S₅ were tested with the potential range from 0.01 to 3.0 V (vs Na/Na⁺) at 0.2 mV s⁻¹, which is shown in Fig. 1b. In the first cathodic scan, several oxidation peaks take place from 0.2 to 2.0 V, which is mainly attributed to the oxidation reactions of Cu₉S₅, the insertion process of Na⁺ into electrode material, and the formation of solid electrolyte interphase (SEI) [1,3,4]. During the following anodic scanning, two major peaks at 1.65 and 2.12 V represent the electrochemical reaction from Cu and Na₂S₅ to Na₄Cu₁₂S₁₇ and further changed into Cu₉S₅ [5]. These obvious redox peaks of pure Cu₉S₅ are present, illustrating the pure Cu₉S₅ active material mainly presents conversion reaction in the sodiation/desodiation process. Additionally, the microstructure analysis indicates that Cu₉S₅ electrode material could also exhibit little insertion/extraction mechanism like other metal sulfides [6,7].

Acknowledgments

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Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.08.168.

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