



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 8, August 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Uniquely Synthesized Lithium Sulfide Composite via Chemical Route for Battery Application

Anant.M. Kute, Satish B. Khobragade

Ghulam Nabi Azad Art's Commerce and Science College Barshitakli. Dist- Akola, India

ABSTRACT:As a result of solid-solid contact between electrolyte and electrode particles, interfacial resistance determines how well solid state batteries work. In order to provide remote solid-solid contact, it is imperative to improve the pathways for lithium ion and electron transport. One crucial stage in determining the interfacial resistance between electrolyte and electrode particles is the electrode fabrication process. Selecting a straightforward way to prepare electrode composite is crucial to avoid degrading performance. The key to creating an effective Li_2S cathode is finding a low-cost synthesis technique for nanosized Li_2S with a tiny diameter and low charging overpotential. The creation process for Li_2S nanoparticles is outlined below, along with a laboratory production method.

In present work, lithium sulfide composite is uniquely synthesized by chemical route method as a result it is possible to boost performance of lithium sulfide as counter electrode.

KEYWORDS: Synthesis of lithium sulfide, chemical route method

I. INTRODUCTION

People's interest in new energy has increased as a result of the energy crisis in the latter half of the 20th century. After the turn of the century, a number of environmental organizations and nations passed stricter environmental protection legislation, which aided in the growth of alternative energy sources. It should be emphasized that electric energy must be stored and released by certain equipment, such as batteries, capacitors, and other similar devices, just like hydrogen energy [1]. lithium-ion batteries have been widely used in portable electronic devices[2]. Batteries are made up of different electrochemical cells that are connected either in series or parallel to produce the necessary voltage and capacity[3]. Each electrochemical cell has an anode and a cathode, and because an electrolyte solution containing salts separates the two electrodes, charge can move between the electrodes in an electrochemical cell[4]. Lithium sulfur batteries has been under intensive development as one of the most promising next-generation rechargeable batteries used for electrified transportation and stationary energy storage, among others[5][6][7].

II. RELATED WORK

With the unique features, lithium sulfide (Li_2S) has been investigated as the cathode material for next-generation rechargeable batteries[8]. Because of its high theoretical capacity, high melting point, affordable volume expansion, and lithium composition, lithium sulfide (Li_2S) is regarded as the most promising cathode material[9]. The size distribution of the commercially available Li_2S particles ranges from a few micrometers to tens of micrometers. In the first charge cycle, a significant potential barrier greater than 1.0 V will arise when this microscale Li_2S powder is applied directly to prepare the cathode. But employing Li_2S as the initial cathode material comes with its own set of problems. If the cathode structure is not appropriately built, the Li_2S activation during the first charging phase proves to be a significant difficulty since it necessitates an extreme over potential[10]. The employed Li_2S 's particle size, morphology, and crystallinity all have a direct bearing on this overpotential. Commercially available Li_2S is not a good candidate since it has very poor electrochemical properties and tens of micrometer-sized particle size. Therefore, creating new preparation methods for high-performance Li_2S is crucial. The charging barrier should be effectively reduced by a Li_2S cathode material with tiny particle diameter[11], and at the same time, the cost should be low to gain a competitive edge over currently used cathode materials.

Researchers in the past have put a lot of effort into figuring out how to alter the properties of synthetic Li_2S to lower the potential barrier during first charging, which has resulted in a wide range of cutting-edge techniques for the in-lab synthesis of Li_2S . In addition to solid phase carbothermal reduction or lithium combustion with hotter reaction

temperatures, these techniques also incorporate liquid-phase synthesis techniques with kinder reaction conditions[12]. The activation of the initial charging process benefits from the liquid phase synthesis methods' good ability to control the particle size of the Li_2S product[13]. However, the reactants used in these procedures are frequently extremely active organolithium complexes. Lithium sulfate (Li_2SO_4) and cheap carbon can be used as the feedstock for carbothermal reduction processes, however manufactured Li_2S particles often have greater diameters. This kind of technique must be used in conjunction with other techniques, such as ball milling, electrospinning, or in-situ polymerization, to evenly distribute Li_2SO_4 and the carbon source prior to heat reduction and to prevent the formation of Li_2S particles during reduction.

Hong Liu, et al. employed n-butyllithium to convert sulfur to Li_2S using mesoporous carbon CMK-3/S composite, which has previously been described for its performance in lithium-sulfur batteries[14]. The pore size of the mesoporous carbon limits the Li_2S in the CMK-3/ Li_2S composite similarly to the CMK-3/S composite, although the voltage–capacity curve during first charging demonstrates that the phase transition barrier is not entirely abolished. Lithium triethylborohydride (LiEt_3BH), in addition to n-butyllithium, was utilized as a reducing agent in the creation of Li_2S . The so-called "Lithium Superionic Sulfide (LSS)" was created by Lin et al. by heating a tetrahydrofuran (THF) solution of lithium ethoxide to reduce sulfur to Li_2S with an average diameter of about 30 to 50 nm.

By thermally decomposing the resorcinol-formaldehyde (RF) gel into partially graphitized carbon at 900 °C while converting the Li_2SO_4 to Li_2S , immobilized the Li_2SO_4 in solution. The resulting Li_2S particles have sizes ranging from 500 nm to 2 μm .

In the current work, Li_2S was chemically produced in the manner stated below.

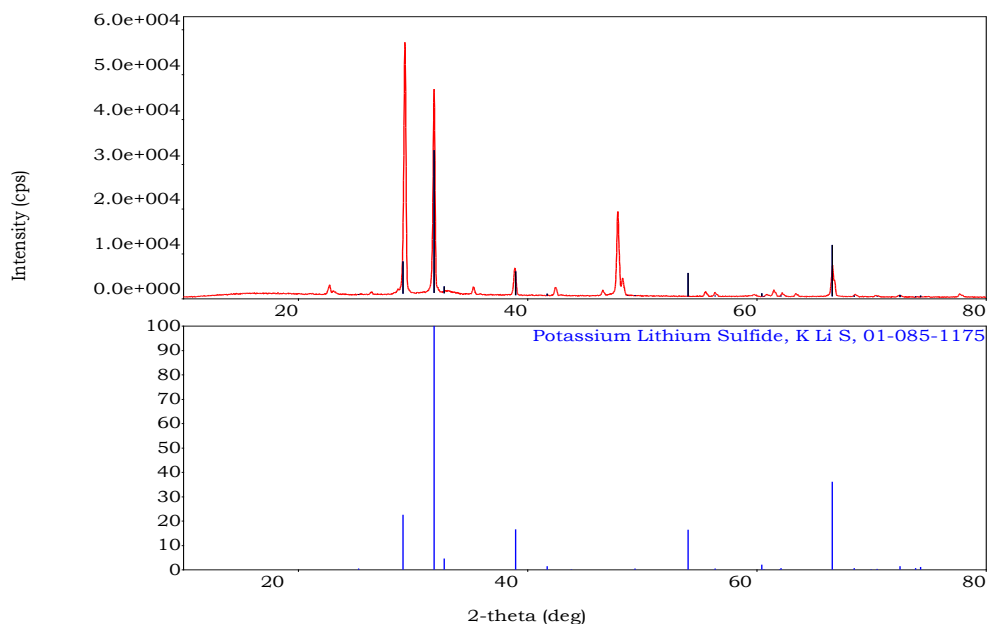
III. METHODOLOGY

For the synthesis of Li_2S composites, AR grade (SD fine, India) chemicals were used without any further purification. In the present work, chemical route approach was used for the synthesis of Li_2S nanoparticles. The Lithium Nitrite (LiNO_3) and sodium sulfide (Na_2S) were used as starting chemicals for the synthesis of Li_2S nanoparticles. 10 ml Methanol added to 1 mole of LiNO_3 and homogenized by magnetic stirring. As-obtained homogenous mixture added drop wise to the mixture of 1 mole of Na_2S and 10 ml methanol. The mixture was again homogenized by rigorous magnetic stirring results the formation of lithium sulfide.

The physic-chemical analysis of prepared sample was done. The structural study of samples was completed using X-ray diffraction (XRD) analysis on XRD (Philips PW 1830).

IV. EXPERIMENTAL RESULTS

Figure 1. shows XRD pattern of Li_2S composite. XRD pattern clearly shows the presence of characteristics peaks of Li_2S with correct diffraction peak position and marginal intensity. The signature peaks are exactly match with JCPDS card. The broad hump with some shoulder peaks appears between 27° to 32° shows presence of Lithium sulfide composite.

Figure 1 xrd pattern of Li_2S

For the practical use of Li_2S cathodes, a low-cost synthesis method that can generate nanosized Li_2S with tiny size and low activation barrier is required. Numerous strategies have been reported, some of which are practically feasible. The production of nanosized Li_2S still has a lot of potential for improvement, despite the enormous achievements. Here are a few of the topics that, in our opinion, require more study.

V. CONCLUSION

In this study, we successfully demonstrate the synthesis of lithium sulfide by chemical route method. The oxidation of Li_2S is achieved through the direct charge transfer between the solid Li_2S and conducting materials. The potential barrier is found to be strongly dependent on the size of cathode particle and ultimately method of synthesis. An appropriate architecture for the construction of free-standing cathodes is provided by the as-synthesized Li_2S . Importantly, this synthetic technique is scalable and highly reproducible. The cathode in an all-solid-state battery may perform exceptionally well in terms of capacity retention and efficiency when using this nanostructured Li_2S .

REFERENCES

- 1) Dong Sui, Manman, Kaiyuan Shi, Changle Li, Junwei Lang, Recent progress of cathode materials for aqueous zinc-ion capacitors: Carbon-based materials and beyond, *Carbon* 185(2021)
- 2) Yoshinori Morita, Yuko Saito, Toshiaki Yoshioka, Toshikazu Shiratori, Estimation of recoverable resources used in lithium-ion batteries from portable electronic devices in Japan, *Resources, Conservation and Recycling*, 175(2021)
- 3) Changbeom Hong, Hyeonwoo Cho, Daeki Hong, Se-Kyu Oh, Yeonsoo Kim, An improved thermal single particle model and parameter estimation for high-capacity battery cell, *Electrochimica Acta*, 439(2022)
- 4) Miao Zhou, Yue Chen, Guozhao Fang, Shuquan Liang, Electrolyte/electrode interfacial electrochemical behaviors and optimization strategies in aqueous zinc-ion batteries, *Energy Storage Materials*, 45(2022)
- 5) A. Mauger, C.M. Julien, A. Paolella, M. Armand, K. Zaghib, A comprehensive review of lithium salts and beyond for rechargeable batteries: Progress and perspectives, *Materials Science and Engineering: R: Reports*, 134(2018)
- 6) Shiqi Li, Dan Leng, Wenyue Li, Long Qie, Zhihua Dong, Zhiqun Cheng, Zhaoyang Fan, Recent progress in developing Li_2S cathodes for Li-S batteries, *Energy Storage Materials*, 27(2020)
- 7) Furkan Ahmad, Mohd Khalid, Bijaya Ketan Panigrahi, Development in energy storage system for electric transportation: A comprehensive review, *Journal of Energy Storage*, 43(2021)



- 8) Shiqi Li, Dan Leng, Wenyue Li, Long Qie, Zhihua Dong, Zhiqun Cheng, Zhaoyang Fan, Recent progress in developing Li₂S cathodes for Li-S batteries, *Energy Storage Materials*,27(2020)
- 9) Wenjing Deng, Jason Phung , Ge Li , Xiaolei Wang, Realizing high-performance lithium-sulfur batteries via rational design and engineering strategies, *Nano Energy*,82(2021)
- 10) Xiangtao Bai, Tianwei Yu, Zhimin Ren, Shengmin Gong, Rong Yang, Chunrong Zhao, Key issues and emerging trends in sulfide all solid state lithium battery, *Energy Storage Materials*,51(2022)
- 11) Hong Liu , Peng Zeng a, Yongfang Li a, Hao Yu, The preparation and performances of lithium sulfide (Li₂S)-oriented cathode composite via carbothermic reduction, *Journal of Alloys and Compounds*, 835(2020)
- 12) Liqiang Zhang, Chenxi Zhu, Sicheng Yu, Daohan Ge, Haoshen Zhou, Status and challenges facing representative anode materials for rechargeable lithium batteries, *Journal of Energy Chemistry*, 66(2022)
- 13) M. Liu, Y.X. Ren, H.R. Jiang, C. Luo, F.Y. Kang, T.S. Zhao, An efficient Li₂S-based lithium-ion sulfur battery realized by a bifunctional electrolyte additive, *Nano Energy* 40(2017)
- 14) Hong Liu, Peng Zeng, Yongfang Li, Hao Yu, The preparation and performances of lithium sulfide (Li₂S)-oriented cathode composite via carbothermic reduction, *Journal of Alloys and Compounds*,835(2020)



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 **6381 907 438** **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details