SnS_2 and C-SnS_2/Si Anode Materials for LIBs

Akzhan Bekzhanov [1, 2], Irshad Mohammad[1], Freddy Kleitz [2], Damian Cupid [1,]

[1] *AIT Austrian Institute of Technology GmbH*

[2] *University of Vienna, Faculty of Chemistry, Department of Functional Materials and Catalysis*

Introduction

In this project, a portion of silicon (Si) will be replaced with a high-capacity alternative, such as tin disulfide (SnS_2), which is both cost-effective and free of critical raw materials. To achieve this, a new class of carbon-coated Si/SnS_2 (C-SnS_2/Si) nanocomposite materials will be developed. This innovative anode material is expected to offer higher specific and volumetric energy densities while reducing resource consumption by incorporating silicon recovered from photovoltaic waste.

SnS_2-based anode materials for lithium-ion batteries are synthesized using a hydrothermal method, with varying degrees of crystallinity. Their electrochemical performance is evaluated, revealing that the highest specific reversible capacities achieved during cycling and rate performance testing are 598 mAh g^{-1} after 100 cycles and 605 mAh g^{-1} after the rate capability test. Additionally, the C-SnS_2/Si nanocomposite anode is synthesized via solid-state synthesis. Electrochemical testing demonstrates a specific capacity of 510 mAh g^{-1} after 200 cycles in a half-cell setup.

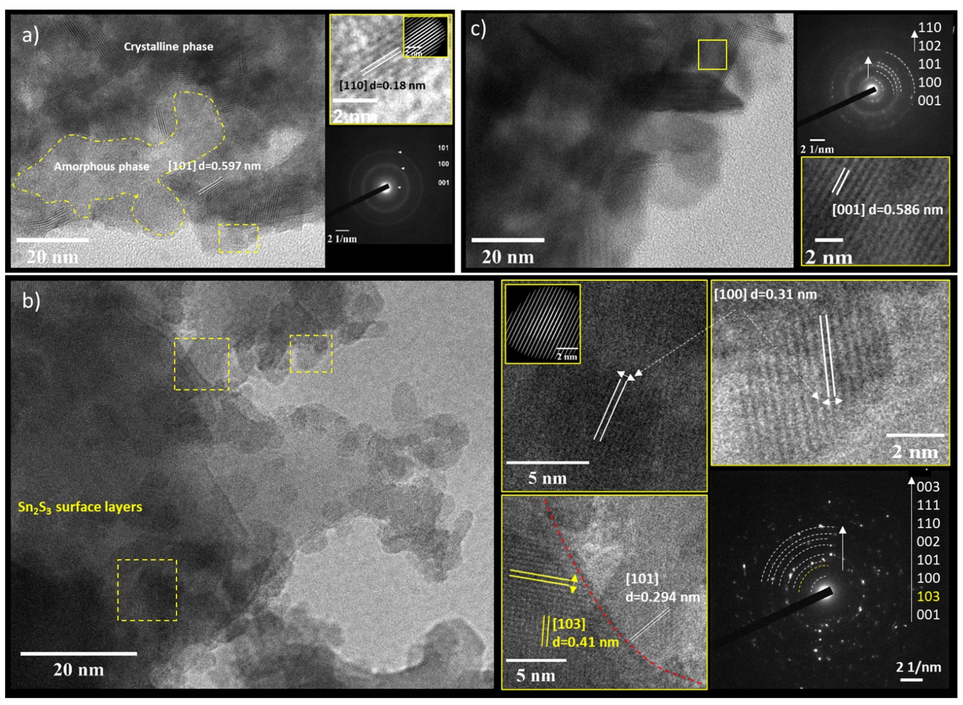
Objectives

* Carbon-based coating of Si/SnS_2 nanocomposites
* Green processing of electrode materials
* Fabricate and test full pouch cell with coated Si/SnS_2 nanocomposite anodes and NMC cathodes
* Phase diagram investigations, modelling and electrochemistry

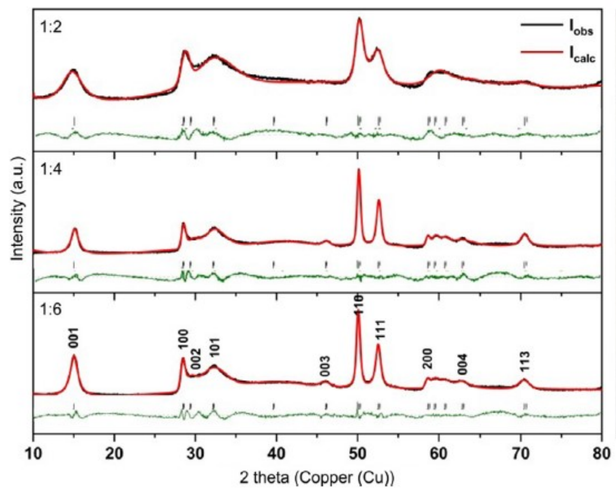
Motivation

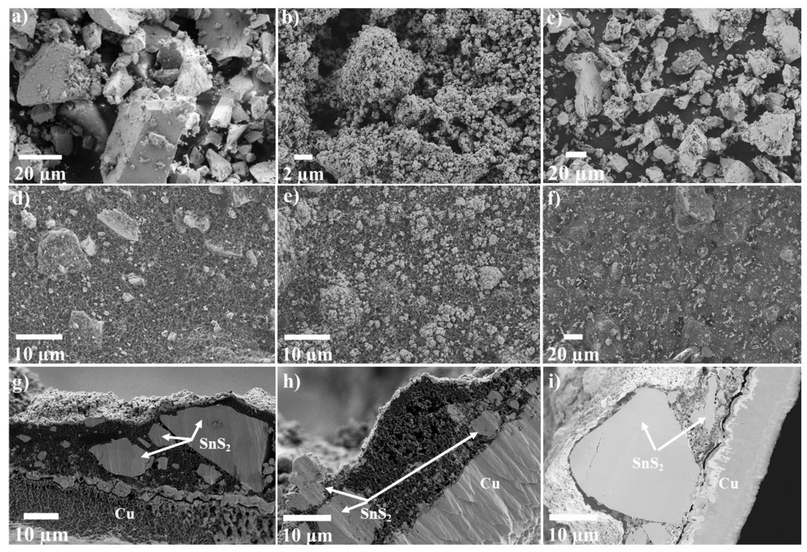
* Design a new, low-CRM carbon coated Si/SnS_2 (CRM = critical raw materials) nanocomposite anode material.
* Synthesis of SnS_2 and carbon coating of SnS_2 and physico-chemical and electrochemical characterizations.
* Apply protective carbon-based coatings onto the Si/SnS_2 nanocomposites.

Electron Microscopy Analysis

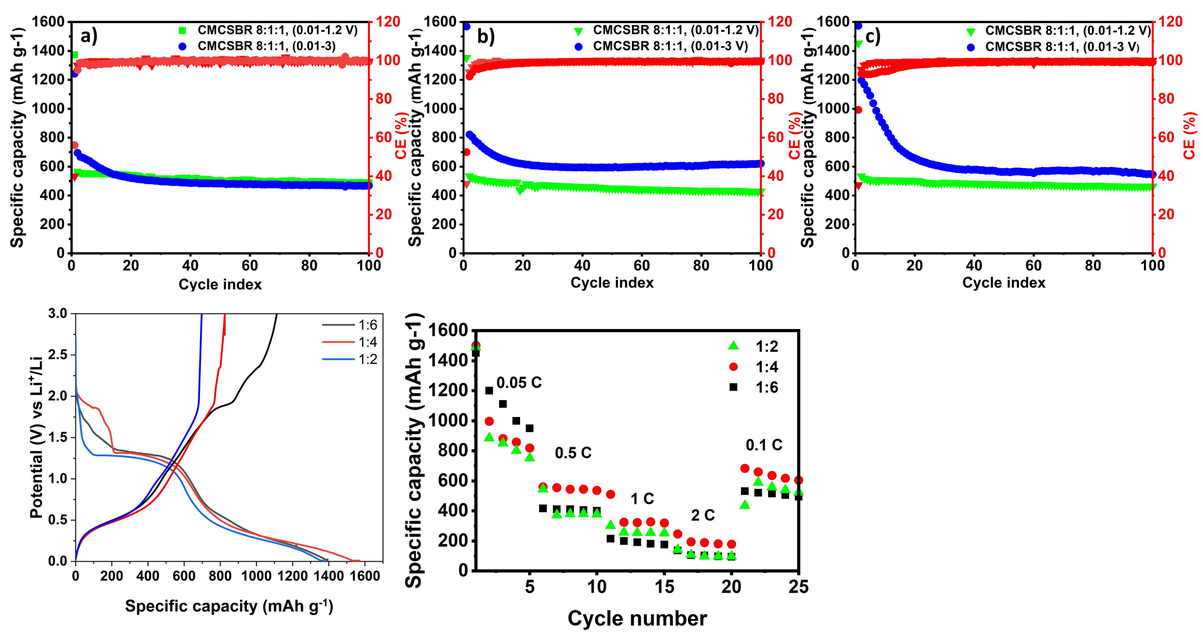


XRD, SEM

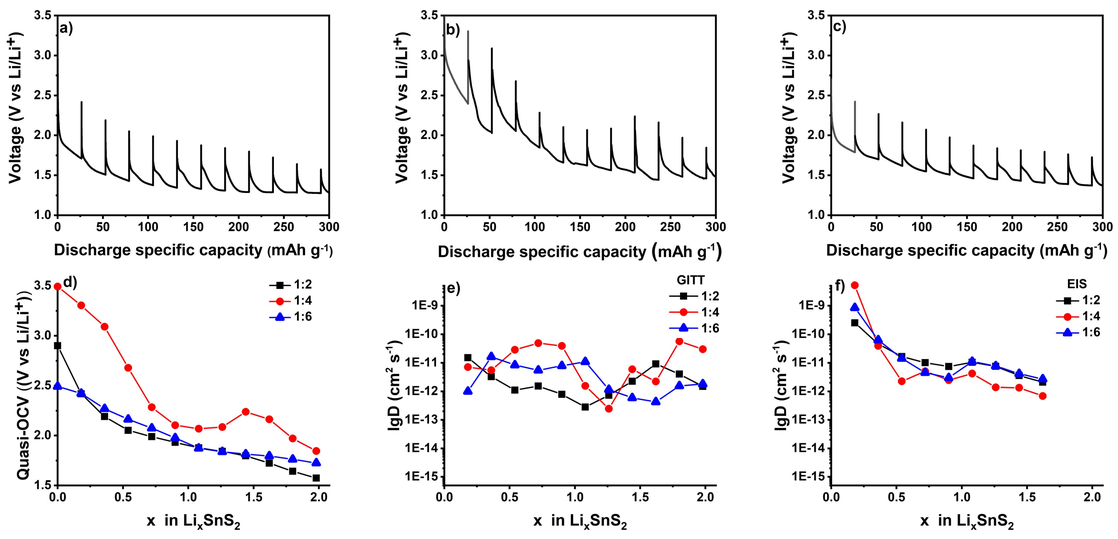




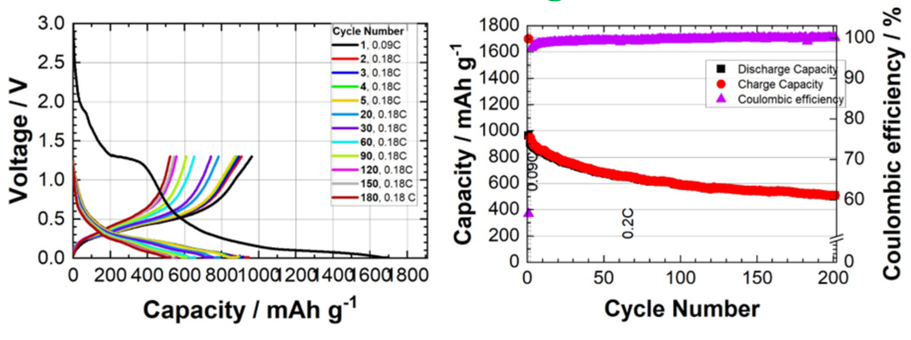
Galvanostatic electrochemical testing SnS_2



Li^+ Diffusion coefficient determination



Electrochemical testing C-SnS_2/Si



Conclusion

* **Green Processing**: Environmentally friendly methods were employed, utilizing water-based binders.
* **Hydrothermal Synthesis of SnS_2**: SnS_2 was synthesized using a hydrothermal approach to achieve varying degrees of crystallinity.
* **Synthesis of C-SnS_2/Si Composite Anode**: A carbon-coated SnS_2/Si (C-SnS_2/Si) nanocomposite anode material was developed.
* **Electrochemical Testing**: Electrochemical performance was evaluated for both C-SnS_2/Si and SnS_2 anode materials.
* **Performance Results**: The C-SnS_2/Si anode retained a discharge capacity of 510 mAh g^{-1} after 200 cycles.

Acknowledgments

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