proceedings

Abstract

Effect of MgO Templating on the Synthesis and Properties of Dissolved Lignin-Based Hard Carbon for Na-Ion Battery Applications †

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† Presented at the International Conference EcoBalt 2023 "Chemicals & Environment", Tallinn, Estonia, 9–11 October 2023.

Keywords: lignin; hard carbon; Na-ion battery; porous material; template synthesis

Citation: Robiños, A.; Zhang, H.; Mousavi, Z.; Smått, J.-H.; Laurén, T.; Hupa, L.; Xu, C.; Bobacka, J. Effect of MgO Templating on the Synthesis and Properties of Dissolved Lignin-Based Hard Carbon for Na-Ion Battery Applications. *Proceedings* **2023**, *92*, 16. https://doi.org/10.3390/proceedings2023092016

Academic Editors: Monika Morti-mer, Anne Kahru, Ivo Leito, Riin Rebane and Villem Aruoja

Published: 21 November 2023

The increasing use of wind and solar energy creates an enormous need for intermittent storage of electrical energy in batteries. Today, Li-ion batteries are the state of the art in mobile applications, such as electric vehicles. However, due to the limited sources of lithium, there is a growing need to replace Li-ion batteries with more sustainable alternatives, such as Na-ion batteries. This development involves the replacement of graphite with alternative anode materials, such as hard carbon. Lignin, a naturally abundant biopolymer, has shown promising potential as a carbon precursor for electrical energy storage applications, particularly in the synthesis of hard carbon anodes for Na-ion batteries [1]. In this study, we investigate the synthesis of lignin-based hard carbon using a MgO template technique, where lignin is dissolved using NaOH. The effect of the synthesis process on the morphology, porous structure, and electrochemical properties of the resulting hard carbon material is investigated. The synthesis process involves the carbonization of freeze-dried solutions containing dissolved lignin and magnesium gluconate [2]. By subjecting the mixture to preheat treatment at 600 °C, nano-sized domains of Mg and Na crystals form within the carbon matrix. Acid leaching of the resulting particles is subsequently carried out, followed by high-temperature post-heat treatment at 1100–1500 °C. These lead to the formation of a hierarchical porous hard carbon structure for Na-ion battery applications. The findings from this research have the potential to contribute to the development of sustainable and high-performance energy storage systems.

Author Contributions: Conceptualization, A.R., H.Z., C.X. and J.B.; methodology, A.R., H.Z. and Z.M.; formal analysis, J.-H.S.; investigation, A.R., H.Z. and Z.M.; supervision, J.B., C.X. and L.H.; project administration, J.B., C.X. and T.L.; funding acquisition, J.B. and C.X. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Jane and Aatos Erkko Foundation, Finland (Grant number 220015).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available upon request from the corresponding author.

Acknowledgments: The authors gratefully acknowledge CH-bioforce, Finland, for generously providing the birch lignin used in this study.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

1. Matei Ghimbeu, C.; Zhang, B.; Martinez de Yuso, A.; Réty, B.; Tarascon, J.-M. Valorizing Low Cost and Renewable Lignin as Hard Carbon for Na-Ion Batteries: Impact of Lignin Grade. *Carbon* **2019**, *153*, 634–647. [CrossRef]
2. Kamiyama, A.; Kubota, K.; Igarashi, D.; Youn, Y.; Tateyama, Y.; Ando, H.; Gotoh, K.; Komaba, S. MgO-Template Synthesis of Extremely High Capacity Hard Carbon for Na-Ion Battery. *Angew. Chem. Int. Ed.* **2021**, *60*, 5114–5120. [CrossRef]