The buckwheat-derived hard carbon as anode material for lithium-ion batteries

U. Kydyrbayeva[1], Ye. Baltash[1], Z. Bakenov[1,2,3] and A. Mukanova[1,2,3]

[1]Institute of Battteries LLC, Kabanbay Batyr Ave. 53, Astana 010000, Kazakhstan

[2]Department of Chemical and Materials Engineering, School of Engineering and Digital Sciences, Nazarbayev University, Kabanbay Batyr Ave. 53, Astana 010000, Kazakhstan

[3]National Laboratory Astana, Nazarbayev University, Kabanbay Batyr Ave. 53, Astana 010000, Kazakhstan

Lithium-ion batteries (LIBs) that utilize hard carbon(HC) as an anode material have gained significant attention in recent years. HC offers advantages such as higher capacity, wider electrochemical potential window, and better cycling stability, making it an attractive choice for improving the performance of LIBs.

Biomass-derived HC has gained interest as a sustainable and renewable alternative to traditional carbon sources [1, 2].

Nevertheless, it is necessary to strive for a cost-effective option for obtaining HC from biomass.

One of the solutions to this problem is to obtain hard carbon from waste biomass. Buckwheat is a nutritious and versatile crop that is grown in many parts of the world, including Asia, Europe, and North America. Despite its many health benefits, such as being high in protein, fiber, and minerals, buckwheat is often underutilized compared to rise and may be subject to waste.

Herein, we obtained the hard carbon from waste buckwheat seeds for further use in LIBs via pyrolysis in the N_2 atmosphere at different temperatures – from 500 to 1000 °C for 2 h. From Fig.1, it can be seen that almost all samples have both open and closed pores with different sizes from 350 nm to 15 μm.

The electrochemical performance of the hard carbon as anode materials in LIBs was tested in CR2032 coin cells using a lithium metal foil as the counter electrode within the operating voltages of 0.01 to 3.0 V at a scanning rate of 0.1 mV s^{-1}.

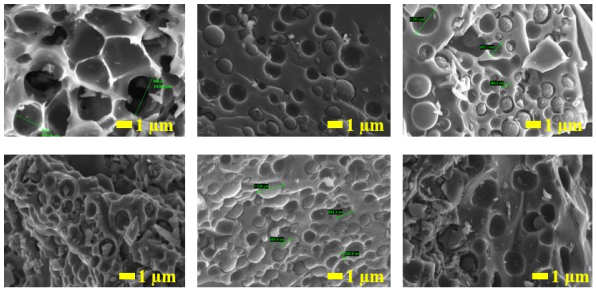


Figure 1. SEM images of obtained HC at different pyrolysis temperatures

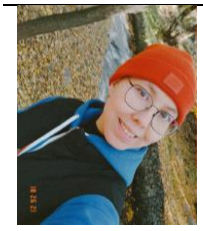
The initial discharge and charge capacity for all LIB cells was on average 1200 mAh/g and around 525 mAh/g, respectively. It was found that HCs obtained at different pyrolysis temperatures demonstrated similar electrochemical performances. Nevertheless capacity stability is observed at higher temperatures. The other results including their dependencies on the morphology and composition details will be discussed at the conference.

This study demonstrates the use of waste buckwheat seeds as a sustainable feedstock for the synthesis of HC offers a promising pathway towards the development of high-performance and environmentally friendly energy storage devices.

References

[1] Issatayev, N., Kalimuldina, G., Nurpeissova, A. & Bakenov, Z., Jan 1 2022, In: Nanomaterials. 12, 1, 22.

[2] Yu, K., Zhang, Z., Liang, J., & Liang, C. 2021, Diamond and Related Materials, 119, 108553.



Currently, I am a junior researcher at the Institute of Batteries LLC. My research aimed to create new methods of obtaining hard carbon from waste biomass exploring various pyrolysis temperatures, activation methods to produce hard carbon with distinct morphologies and electrochemical properties. In my free time, I like to walk, to notice the beauty in the Botanical Garden in Astana city, reading Kazakh literature and about Islam, watching anime, and also films based on real events.

Presenting author: U. Kydyrbayeva, e-mail: kydyrbayevauldana1303@gmail.com tel: 8747732-49-64