Nonosized $LiFePO_4$ manufacturing by ball-milling synthesis for Li-ion batteries

Batukhan Tatykaev, Valeriya Volobuyeva, Zhumabay Bakenov, Almagul Mentbayeva
Nazarbayev University, Nur-Sultan 010000, Kazakhstan

Lithium iron phosphate ($LiFePO_4$) has emerged as a promising cathode material due to its attractive features such as high thermal stability, low toxicity, and extended cycle life. $LiFePO_4$ belongs to the olivine group of compounds and consists of a three-dimensional framework comprising iron-oxygen octahedral linked by phosphate tetrahedral (pnma structure). Despite its lower theoretical capacity of 170 mAh/g compared to other cathode materials, $LiFePO_4$ has high rate capability and stability at elevated temperatures, making it an appealing candidate for rechargeable lithium-ion batteries.

The manufacturing process of $LiFePO_4$ is complex and involves several critical steps as raw material preparation, cathode material synthesis, electrode fabrication, and cell assembly. Control of the raw materials and production processes is crucial to ensure high-quality and consistent performance of the resulting battery cells.

The olivine-structural phosphates have been synthesized by different techniques to improve their electrochemical property, i.e. hydrothermal methods followed by several high-temperature methods [1]. However, the manufacturing cost of such materials/methods is still a hurdle in their utilization for large battery systems. The proposed methodology consists of two stages, namely, mechanical activation (MA) of solid precursors in planetary ball mill and heat treatment in inert atmosphere at a relatively low temperature in the range of 500
optimized by changing MA parameters and including solid diluent to the reaction system.

The ball milling method involved mixing the raw materials in specific stoichiometric ratios, followed by activation of the mixture in a high-energy ball mill (fig.1.)

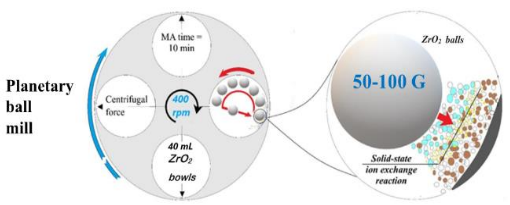

Figure 1. the operation of a planetary ball mill

The mixture of precursors FeC_2O_4 + Li_2CO_3 + $NH_4H_2PO_4$ were used to prepare $LiFePO_4$/C cathode material [2]. The resulting powder has been annealed at high temperatures in an inert atmosphere, such as argon, helps to eliminate any impurities and improve the crystallinity of the material, which can enhance its electrochemical properties.

After mechanical activation and heat treatment in the presence of sucrose as carbon source, nanoparticles were obtained. The electrochemical properties of the half-cell cell, where $LiFePO_4$ nanoparticles are used as a cathode, results show stable performance for 30 cycles with 100% coulombic efficiency.

For the scaling up of LFP manufacturing the ball milling is a promising method due to its ease of implementation, and scalability.

The detailed electrochemical performance and characterization of solidstate synthesized $LFePO_4$ nanoparticles-based cathodes will be presented.

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References

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Batukhan Tatykaev, PhD, Senior Researcher, PI Nazarbayev University. Scientific interests: inorganic chemistry, mechanochemistry, nanotechnology and photocatalysis. Tatykaev B. is a co-author of 5 patents and 12 articles scientific journals in the Scopus database (ID: 56423734400; h = 6) and WoS (h = 6). Tatykayev B.B. defended his PhD thesis in 2017 in the specialty "6D07200-Chemical technology of inorganic substances".

Presenting author: Batukhan Tatykaev, e-mail: batukhan.tatykayev@nu.edu.kz, tel: +77025670089