



The 8<sup>th</sup> International Conference on Nanomaterials and Advanced Energy Storage Systems (INESS-2020)

### Study of the lithium-ion battery at low temperatures

Aiym Mashekova<sup>1\*</sup>, Arailym Nurpeissova<sup>2</sup>, Zhumabay Bakenov<sup>1,2,3</sup>, Aliya Mukanova<sup>1,2\*\*</sup>

<sup>1</sup>*Institute of Batteries, 53 Kabanbay Str., 010000 Nur-Sultan, Kazakhshtan*

<sup>2</sup>*National Laboratory Astana, 53 Kabanbay Str., 010000 Nur-Sultan, Kazakhstan*

<sup>3</sup>*School of Engineering and digital Scineces, Nazarbayev University, 53 Kabanbay Str., 010000 Nur-Sultan, Kazakhstan*

\*E-mail: aiym.mashekova@nu.edu.kz

\*\*E-mail: aliya.mukanova@nu.edu.kz

Nowadays, LIBs are one of the most demanded power sources due to their portability, high power and energy density. The performance of LIBs depends on ambient temperature, especially, at low temperatures. According to [1] kinetic reactions rate slows down at low working temperatures, due to physical and chemical electrolyte properties changes, such as viscosity and conductivity etc. The main function of the electrolyte is to transport lithium ions between the electrodes, which slows down due to a decrease in electrical conductivity at a low operating temperature of LIBs. Furthermore, the solid electrolyte interphase (SEI) morphology, components, and formation mechanism have significant impact on the performance of LIB. Therefore, the wide service temperature range and required properties of the electrolyte can be achieved by changing the combination and ratio of solvents, salts and additives.

In present work, two types of lithium-ion cells (CR2032, MTI Corp.) were assembled in Ar-filled glovebox (LABmaster Pro, MBRAUN, <0.1 ppm H<sub>2</sub>O and O<sub>2</sub>). The first one was a reference and another one was with electrolyte additive. 1 M LiPF<sub>6</sub> (LPF) in ethylene carbonate (EC)/dimethyl carbonate (DMC)/ethyl methyl carbonate (EMC) (1:1:1, by volume) was used as an electrolyte. The modified electrolyte was prepared by adding 3 wt. % acetonitrile (AN) to the above LPF-based electrolyte. Cathode slurry was prepared by mixing LiFePO<sub>4</sub> (LFP), acetylene black (AB), and poly(vinylidene fluoride) (PVDF) at a weight ratio of 80:15:5 in N-methyl-pyrrolidone (NMP) solvent, lithium metal was used as an opposite and reference electrode. The electrochemical performance of the cells with and without AN additive was investigated at room and low (- 30 °C) temperature. All electrochemical cycling test results as well as synthesis routes and characterization details will be presented at the conference.

#### Acknowledgement

This research was supported by the research grants № AP08052231 “Development of solid-state electrolytes with high ionic conductivity for the next generation of lithium-ion batteries”, №AP05133519 “Development of 3-dimensional thin film silicon based anode materials for next generation lithium-ion microbatteries” from the Ministry of Education and Science of the Republic of Kazakhstan for 2018-2020 and №SOE2019001 “Development of 3D solid state thin film materials for durable and safe Li-ion microbatteries” from NU for 2019-2021.

#### References

- [1] J. Hou, M. Yang, D. Wang, J. Zhang. Adv. Eng Mater (2020) 10. Doi: 10.1002/aenm.201904152.
- [2] X. B. Cheng, R. Zhang, C. Z. Zhao, Dr. F. Wei, Dr. Q. Zhang. Adv. Sci. (2016) 3. Doi: 10.1002/advs.201500213.