**High energy density Ni-rich layered cathode materials with the stabilized microstructure**

**S. Nasser (Master’s Student), A.A. Savina, A.M. Abakumov**

*Skolkovo Institute of Science and Technology, Moscow, Russia*

*e-mail:* sara.nasser@skoltech.ru

Lithium-ion batteries (LIBs) are a type of rechargeable battery widely used in electric vehicles and other energy storage systems. The global LIBs market size was valued at USD 41.97 billion in 2021 and is expected to expand at a compound annual growth rate of 18.1% from 2022 to 2030. Since the cathode material has a crucial role in any battery performance and cost, layered oxides of transition metals and lithium LiNixMnyCozO2 (NMC, x+y+z=1) are widely embraced as cathodes for next generation LIBs as they provide high specific capacity up to 220 mAhg-1 and high energy density up to 900 Whkg-1. The physical and chemical properties of these compositions may vary depending on the percentage of each element present[1-3].

However, They still have some drawbacks, mainly the micro-crack evolution during electrochemical cycling which leads to poor capacity retention. There are many approaches to enhance their performance. Among them, approach based on obtaining NMC with **concentration gradient structures** comes in place as an interesting research topic to dig deeper in.

The main goal this work is optimizing the synthesis of Ni-rich NMCs following concentration gradient approach using co-precipitation method. This research establishes a better understanding of the synthesis set-up and how synthesis parameters reflect on the microstructure and the performance of the cathode materials. For this, a series of Ni-rich NMC with different type of gradient concentration structures was prepared via co-precipitation technique followed by high temperature annealing with Li source. The obtained materials are single-phase and adopt the layered α-NaFeO2 structure (space group *R*-3*m*). According to SEM analysis, the secondary particles in the materials have a roundish shape with 8-10 μm in diameter and consist of sheet-like primary particles. The gradient structured Ni-rich NMCs demonstrate greatly improved cycling stability compared to pristine Ni-rich NMCs with the similar composition, as well as good rate capability. The boost in capacity retention is attributed to the synergetic effect of the compositional gradient and resulting microstructure organization.

**Literature**

1. **<https://www.grandviewresearch.com/industry-analysis/lithium-ion-battery-market.>**
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3. **Deng, Da. "Li‐ion batteries: basics, progress, and challenges." Energy Science & Engineering 3.5 (2015): 385-418.**

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