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Synthesis and Processing by Design of High-Nickel Cathode Materials

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Invited for this month's cover picture is the group of Feng Wang and Jianming Bai at Brookhaven National Laboratory. The cover picture shows "watching" the formation of $Li(NiMnCo)O_2$ (NMC) particles and their evolving structure and morphology in real time, providing guidance to rational design of synthesis/processing in making high-performance NMC cathodes for batteries powering electric vehicles. Read the full text of the Minireview at 10.1002/batt.202100174.

What is the most significant result of this study?

We present here a synthesis/processing-by-design approach as an alternative to the traditional *trials and errors* in synthesis/processing of high-Ni cathode materials. Despite the large number of battery materials being discovered over the past decades, very few of them have been commercially deployed, mostly bottlenecked by synthesis and processing — namely, making certain phases with the desired structure and properties to meet the multifaceted performance requirements. With examples from recent research, this work illustrates how we may use the synthesis/processing-by-design approach to develop protocols for making high-performance cathode materials.

What future opportunities do you see (in the light of the results presented in this paper)?

We expect to see the wide application of the "*synthesis/processing-by-design*" approach to developing high-performance cathode materials for next-generation batteries. Currently, the layered oxide with low Co and high Ni content (80% and above) are intensely pursued for boosting the energy density while reducing the cost of Li-ion cells. The high-Ni loading, on the other hand, worsens the surface-instability-related issues, such as capacity-fade during operation and property-degradation during materials production/storage, which is becoming a major obstacle to realizing commercial deployment. For overcoming these challenges, we see the opportunities of employing the "*synthesis/processing-by-design*" approach for alleviating surface-related issues in making high-Ni cathode materials as it provides a rational way of controlling the structure, morphology and surface properties.

The "*synthesis/processing-by-design*" approach may also be applied to developing different types of battery materials, such as anodes and solid electrolytes, and more broadly various other functional materials.

What other topics are you working on at the moment?

We are working with our industrial partners on battery manufacturing, to scale up the processing technologies for manufacturing of manganese-nickel-cobalt (MNC)-based cathodes for lithium-ion batteries (LIBs). Through the collaboration, we expect to develop a commercially viable process to stabilize high-Ni/low Co NMC cathodes for safe operation in next-generation LIBs that are powerful, low-cost, and easy to manufacture but require less cobalt, a metal that is in low supply and is difficult and environmentally harsh to mine.

Who pays the bill for the research highlighted in the cover?

Department of Energy's Vehicle Technologies Office, Office of the Energy Efficiency and Renewable Energy.