Knowledge Transfer Office
香港城市大學
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Nickel-rich Layered Oxide Cathode Materials for Li-ION Batteries

Energy & Environment

Manufacturing

Consumer Electronics

Electricity and Power Electronics

Energy Conservation/Generation/Management/Storage (Battery)

Opportunity

Electric vehicles predominantly use lithium-ion batteries (LIBs). However, the energy density of LIBs needs to be increased if they are to substantially replace internal combustion engines. To increase their energy density, cathode engineering is necessary. Layered Ni-rich transition metal oxides with the formula $LiNi_xCo_yMn_{1-x-y}O_2$ (NCMs) are leading candidates for LIB cathode materials. However, they are structurally unstable during battery cycling (charge–discharge), leading to performance degradation, i.e., poor cycling stability and rapid failure. Additionally, the rate capability of NCM cathodes is low owing to slow charge-transfer kinetics. Thus, their power and charging speed are limited. The application of coatings to stabilise NCM cathodes has the drawbacks of process complexity and poor material homogeneity. Therefore, the design of NCM cathode materials must be improved at a more fundamental level, i.e., the primary-grain level, to prevent unwanted structural transitions and enable the high energy density of these materials to be fully exploited.

IP Status
Patent filed

Technology Readiness Level (TRL) ?

5

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Technology

The novel technology comprises a nickel-rich cathode material (NCM) for high-performance lithium-ion batteries (LIBs) and a facile approach for preparing such a material. The material has the formula $LiNi_xM_{1-x}O_2$, where M is one or more transition metals. Specifically, salt precursors of nickel and M are mixed with oxidising agents; the solution is then alkalised to precipitate the NCM precursors after mixing with a lithium precursor, and this is calcined to generate the NCM. Microstructurally, the material consists of primary particles with secondary particles formed on their surfaces. Through careful parameter design, a three-dimensional functional network is spread over the secondary particles. This both protects the hexagonal structure of the primary particles – which is important for high LIB performance – against the distortion that affects conventional NCMs, and offers an interconnected “highway” for ion and electron transport through the material, increasing the rate capability.

Advantages

- Better structural stability than conventional NCMs for Li-ion battery cathodes
- Better cycling stability than conventional NCMs due to improved structural stability (point 1 above)
- Higher rate capability than conventional NCMs
- More cost-effective than conventional NCMs due to maximised Ni content
- Minimum alteration of structure, composition and morphology of NCMs

Applications

- Stable, high-performing cathode materials for lithium-ion batteries and a method for their preparation
- Electric vehicles will benefit from these battery cathode materials
- Fundamental research into primary-grain engineering of transition metal oxide materials will benefit