Doubling the capacity of iron oxide-type cathodes for cost-effective Li-ion batteries

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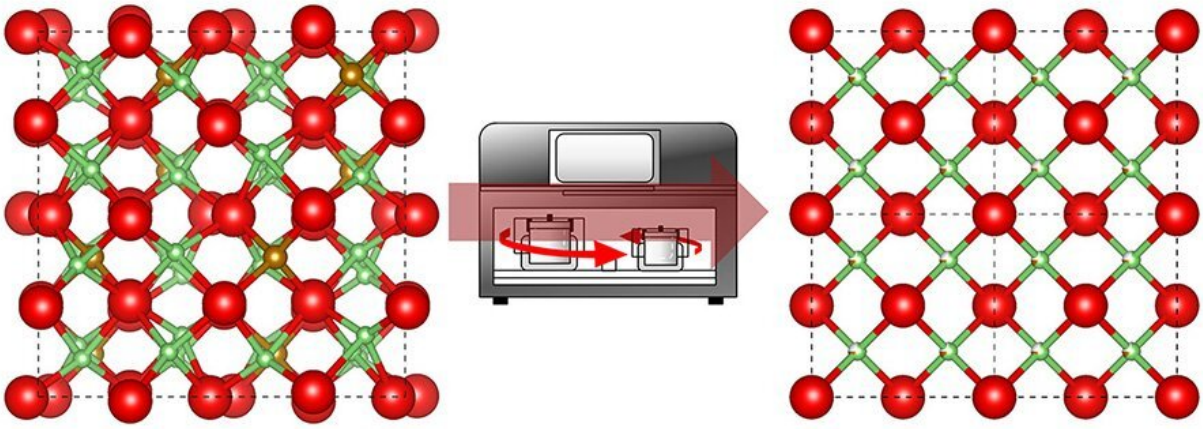

Credit: Tohoku University

A research group has demonstrated a high-energy lithium-ion (Li-ion) cathode, potentially paving the way for cost-effective, safe and high-capacity Li-ion batteries.

Li-ion batteries are ubiquitous in electronics and electric vehicles, and will play a prominent role in charging a sustainable future. But Li-ion batteries rely on transition metals such as cobalt and nickel. And supplies

of these expensive materials are limited to a handful of countries. Developing transition metals from earth-abundant elements is therefore a critical task for scientists.

Olivine-type lithium-iron phosphates ($LiFePO_4$) have shown promise in recent years as a cost-effective alternative. But their storage capacity is limited since the material relies on iron's single electron transfer, i.e., iron redox.

Because of this, the group explored the antifluorite-type lithium-iron oxide (Li_5FeO_4). First reported on in 1999, Li_5FeO_4, has a theoretical capacity twice that of $LiFePO_4$ because it involves an oxygen redox and an iron redox. But utilizing both the iron and oxygen redox is difficult to achieve.

To overcome this, the group employed a mechanochemical alloying approach to bring Li_5FeO_4 to a metastable phase. The fabricated metastable Li_5FeO_4 exhibited iron and oxygen redox, and demonstrated double the capacity of $LiFePO_4$.

"Our approach turned the theoretical into reality, and sets us on a path to developing high-energy cathode materials," says Dr. Hiroaki Kobayashi, lead author of the paper and professor at Tohoku University's Institute of Multidisciplinary Research for Advanced Materials. "This will lead to cost-effective, high-capacity Li-ion batteries based on abundant materials."

The research was conducted as a joint-research project between Tohoku University and the Nagoya Institute of Technology. Details were published in the journal *Advanced Energy Materials* on January 15, 2023.

More information: Hiroaki Kobayashi et al, Metastable Cubic Structure Exceeds Capacity Limit of Antifluorite Li 5 FeO 4 Cathode

Using Small Polarized Oxygen Redox, *Advanced Energy Materials* (2023). DOI: 10.1002/aenm.202203441