Reactive electrolyte additives improve lithium metal battery performance

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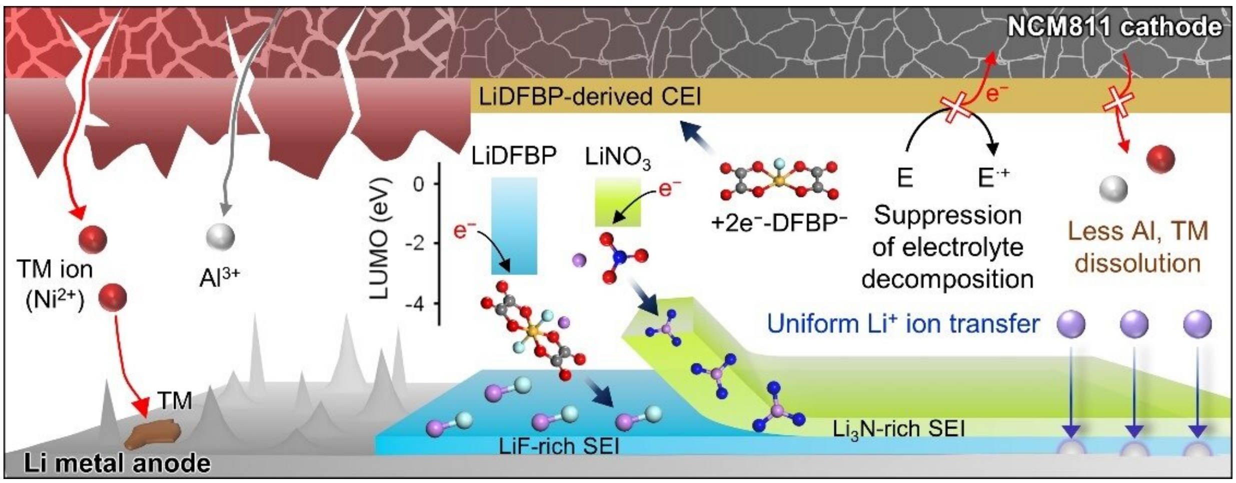

A combination of lithium difluoro (bisoxalato) phosphate as an F donor and lithium nitrate as an N donor with different electron accepting abilities and adsorption tendencies improves the cycle performance of Li|NCM811 full cells through the creation of a dual-layer SEI on a Li metal anode and a protective CEI on a Ni-rich cathode. Credit: The Korea Advanced Institute of Science and Technology (KAIST)

A research team showed that electrolyte additives increase the lifetime of lithium metal batteries and remarkably improve the performance of fast charging and discharging. Professor Nam-Soon Choi's team from the Department of Chemical and Biomolecular Engineering at KAIST hierarchized the solid electrolyte interphase to make a dual-layer structure and showed groundbreaking run times for lithium metal batteries.

The team applied two electrolyte additives that have different reduction and adsorption properties to improve the functionality of the dual-layer solid electrolyte interphase. In addition, the team has confirmed that the structural stability of the nickel-rich cathode was achieved through the formation of a thin protective layer on the cathode. This study was reported in *Energy Storage Materials.*

Securing high-energy-density lithium metal batteries with a long lifespan and fast charging performance is vital for realizing their ubiquitous use as superior power sources for electric vehicles. Lithium metal batteries comprise a lithium metal anode that delivers 10 times higher capacity than the graphite anodes in lithium-ion batteries. Therefore, lithium metal is an indispensable anode material for realizing high-energy rechargeable batteries. However, undesirable reactions among the electrolytes with lithium metal anodes can reduce the power and this remains an impediment to achieving a longer battery lifespan. Previous studies only focused on the formation of the solid electrolyte interphase on the surface of the lithium metal anode.

The team designed a way to create a dual-layer solid electrolyte interphase to resolve the instability of the lithium metal anode by using electrolyte additives, depending on their electron accepting ability and adsorption tendencies. This hierarchical structure of the solid electrolyte interphase on the lithium metal anode has the potential to be further applied to lithium-alloy anodes, lithium storage structures, and anode-free technology to meet market expectations for electrolyte technology.

The batteries with lithium metal anodes and nickel-rich cathodes represented 80.9% of the initial capacity after 600 cycles and achieved a high Coulombic efficiency of 99.94%. These remarkable results contributed to the development of protective dual-layer solid electrolyte interphase technology for lithium metal anodes.

Professor Choi said that the research suggests a new direction for the development of electrolyte additives to regulate the unstable lithium metal anode-electrolyte interface, the biggest hurdle in research on lithium metal batteries.

She added that anode-free secondary battery technology is expected to be a game changer in the secondary battery market and electrolyte additive technology will contribute to the enhancement of anode-free secondary batteries through the stabilization of lithium metal anodes.

More information: Saehun Kim et al, Stable electrode–electrolyte interfaces constructed by fluorine- and nitrogen-donating ionic additives for high-performance lithium metal batteries, *Energy Storage Materials* (2021). DOI: 10.1016/j.ensm.2021.10.031

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