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News Release

June 25, 2025
Maxell, Ltd.

Maxell Has Elucidated the Capacity Degradation Mechanism to extend the Life of All-Solid-State Batteries

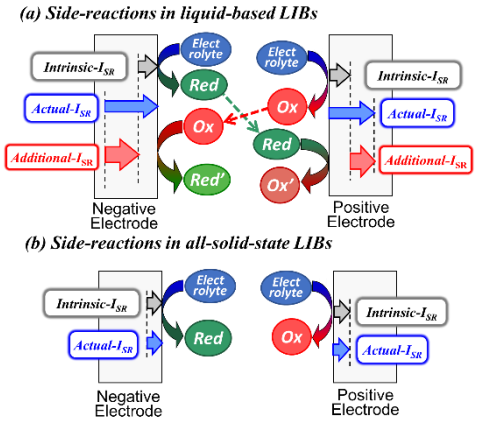
Development of All-Solid-State Batteries with Superior Safety and Reliability for the Realization of a Sustainable Society

Maxell, Ltd. (President and Representative Director: Keiji Nakamura / hereinafter "Maxell") has elucidated the mechanism of capacity degradation of sulfide-based all-solid-state batteries, which are now gaining attention as a key next-generation battery technology.

All-solid-state batteries are theoretically expected to have a long lifetime, and be easily to predict their lifetimes. However, to achieve a long lifetime, it is important to elucidate the capacity degradation mechanism and predict the battery lifetime based on that.

Maxell's detailed analysis of the capacity degradation mechanism of all-solid-state batteries has elucidated that their materials themselves hardly degrade, and that the main cause of the capacity reduction is the SOC (State of Charge) imbalance[*1] between the electrodes. Additionally, the experiments using symmetric cells[*2] have successfully quantified the electrode-specific side-reaction rate, demonstrating that the side-reaction current in all-solid-state batteries is more than one order of magnitude lower than that in liquid-based batteries. In other words, it has become clear that the inherently superior lifetime characteristics of all-solid-state batteries can be attributed to the extremely low side-reaction current in the electrodes.

Furthermore, in all-solid-state batteries, crosstalk reactions[*3] generally observed in liquid electrolytes are not present even at 105°C, and it has been elucidated that only the material-specific side-reaction current needs to be considered when estimating the side-reaction rate. This suggests that lifetime prediction for all-solid-state batteries may be easier than those for conventional liquid-based lithium-ion batteries.



Difference in reaction modes between liquid-based lithium-ion batteries and all-solid-state batteries

In this study, the capacity degradation mechanism of all-solid-state batteries has been elucidated, and we have conducted a velocity logical analysis of the rate of capacity reduction. These results will pave the way for quantitative and theoretical lifetime predictions for all-solid-state batteries. As the byproducts of side-reactions become more evident, it is anticipated that the design of all-solid-state batteries with enhanced safety and reliability, based on lifetime predictions, will become feasible.
The results of this research have been published in the 'Journal of Power Sources.'

Based on this technology, Maxell is continuing the development of all-solid-state batteries with a heat resistance up to 150°C. Furthermore, Maxell is advancing development for fields such as next-generation mobility including electric vehicles, energy storage systems for renewable energy, power supplies for IoT sensors for infrastructure monitoring, maintenance-free power supplies for industrial equipment, and specialized equipment used in extreme environments. Moving forward, Maxell will continue improving the performance of all-solid-state batteries and establishing mass production technologies for these products to contribute to a sustainable society.

*1 SOC (State of Charge) imbalance: A phenomenon in which the current efficiency of the battery reaction changes between the positive and negative electrodes due to decomposition reactions of the electrolyte or electrolyte materials occurring on the electrodes, resulting in a shift in the SOC utilization range of both electrodes.
*2 Symmetric cell: A basic validation cell composed of identical electrodes for the positive and negative sides.
*3 Crosstalk reactions: A phenomenon where byproducts of side-reactions generated on one electrode migrate to the counter electrode, increasing the reaction quantity at the counter electrode.

Published Papers

K. Furukawa, M. Yamada, K. Ariyoshi, Journal of Power Sources, Volume 643, 1 July 2025, “Quantitative analysis of side-reaction rates and capacity fading mechanisms in all-solid-state Li-ion batteries”
https://www.sciencedirect.com/science/article/pii/S0378775325008377

Trademarks

All-solid-state battery webpage

https://biz.maxell.com/en/rechargeable_batteries/allsolidstate.html

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Inquiry form： https://biz.maxell.com/en/rechargeable_batteries/inquiry_form_input1.html

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