
Low-Temperature Effect on Lithium Diffusion in 18650 Li-ion Battery

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Investigations of the phenomena at the atomic scale are essential for full understanding of battery operation. The cells are operated in a broad temperature range below and above the ambient temperature. Temperature change could affect the performance and might even raise the safety issue. Apparently, local environment, such as temperature or electric field, could affect the insertion rate, but experimental studies of these effects are still limited. Here, we report on the results of studies made, using cold neutron triple-axis spectrometer – SIKA's elastic mode, on the Li⁺ diffusion rate of an 18650-type Li-ion battery in discharging-charging operations, carried out at and below the ambient temperature. Operation with a C/5 discharging rate performed at -20 °C showed a dramatic 25% reduction in the Li⁺ diffusion rate and even more surprisingly the discharge transfer of only 35% of Lithium out of the graphite anode since the diffusion essentially stops in the early stage (~1/3) of the discharge period. The reduction and stopping of Li⁺ diffusion can be effectively alleviated by employing a lower discharging rate in operation.