Anionic effects on lithium ion solvation behavior in lithium-sulfur batteries under low electrolyte to sulfur ratios

추현원, 노형준, 김희탁†
KAIST
(heetak.kim@kaist.ac.kr†)

Minimizing the electrolyte amount is essential to realize the high practical energy density of lithium-sulfur (Li-S) batteries. However, the concentration of lithium polysulfides surges when decreasing the electrolyte to sulfur (E/S) ratio, resulting in low sulfur utilization and fast passivation of the sulfur cathode. In addition, continuous electrolyte decomposition on the lithium (Li) metal anode provokes capacity degradation and short cycle life as well. In this work, we examine the role of the nitrate (NO_3^-) anion on lithium ion (Li^+) solvation behavior. It is shown that NO_3^- anions elevate the solubility of lithium polysulfides and lithium sulfide based on their high electron donating ability. It is further demonstrated that NO_3^- anions suppress solvent decomposition on Li metal interfaces as manipulating the Li^+ solvation structure. As a result, the discharge capacity and cycle life of lean-electrolyte Li-S cells are notably improved with increasing the amount of NO_3^- anions. As understanding the anionic effects in the electrolyte, this work will provide a guidance to develop new electrolytes, which are effective for both the cathode and anode of Li-S batteries.