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Liquefied Gas Electrolytes for All-Temperature Lithium Metal Batteries

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Abstract

Among the several challenges to enable next-generation batteries is the development of an electrolyte which compatible with both lithium (Li) metal anode and high-voltage cathode at wide temperature range. Liquefied gas electrolytes with a new cosolvent and higher salt concentration show improved ionic conductivity of $> 4 \text{ mS/cm}$ at wide temperature range from -80 to $+70 \text{ }^\circ\text{C}$. With a new solvation structure, the liquefied gas electrolytes demonstrated high-temperature operation of Li-metal batteries at 55°C , which is the operation above the electrolytes' critical point for the first time. The electrolytes enable improved Li metal stability and coulombic efficiency at aggressive current and capacity of $3 \text{ mA}\cdot\text{cm}^{-2}$ and $3 \text{ mAh}\cdot\text{cm}^{-2}$ with average coulombic efficiency of 99%. The use of liquefied gas electrolytes presents stable cycling of Li/NMC (4.4 V) cell at all-temperature range between -60 and 55°C . This study opens up a promising avenue toward the applications of all-temperature high energy density Li-metal batteries.