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ABSTRACT:

Challenges of Inorganic Filler-Integrated Composite Polymer Electrolytes in Solid-State Lithium Metal Batteries

Jae Hyun Kim

Divison of Energy & Environmental Technology,
Daegu Gyeongbuk Institute of Science & Technology, Daegu, 42988,
Republic of Korea

Composite solid-state electrolytes (CSEs) have been developed by integrating inorganic fillers such as SiO_2, Al_2O_3, NASICON-type, and garnet-type ceramics to mitigate the drawbacks of poly(ethylene oxide) (PEO)-based electrolytes, These materials aid in reducing polymer crystallization and enhancing Li-ion dissociation via Lewis acid-base interactions, leading to superior ionic transport properties. Zeolites, owing to their highly tunable porous framework and abundant Lewis acid sites, have emerged as effective fillers for CPEs[1]. Innovations in PEO-based composite polymer electrolytes (CPEs), including YNa-CPE and SSZ13-CPE, have demonstrated significant performance improvements. YNa-CPE has achieved a Li-ion transference number of 0.84 and an ionic conductivity of 1.66×10^{-2} S cm^{-1} at 60°C, while SSZ13-CPE with 5 wt% SSZ-13 has exhibited a conductivity of 5.34×10^{-2} S cm^{-1} at 70°C, maintaining excellent compatibility with lithium metal anodes.
MOFs such as ZR8-MOF and novel fillers like modified silica mesoballs (MSMB) were also studied for their role in improving the stability and ion transport of CSEs. These developments collectively pave the way for the next generation of high-performance solid-state lithium metal batteries.

[1] M. Li, X. Chi and J. Yu, PRX ENERGY, 1, 031001 (2022).