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Design of pilot-scale pouch-type lithium-metal batteries

조석규 박사 | 한국에너지기술연구원

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○ **초록**

Lithium-metal batteries (LMBs) have received significant attention as next-generation energy storage systems owing to their exceptionally high theoretical energy density. However, due to formidable challenges such as physicochemical instabilities, spontaneous side reactions, porous dead lithium formation, and overpriced processing costs, lithium-metal anodes have struggled to gain traction in high-performance applications. To overcome these intrinsic bottlenecks and achieve unimpaired performance beyond the reach of conventional lithium-ion batteries, this study presents a comprehensive integration of materials and process innovations toward designing a 30 Ah-class pouch-type LMB cell. A multi-scale interface engineering approach is demonstrated across all cell components: incorporating anion-rectifying protection layers at the anodes, implementing facile single-Li^+ relaxation in the electrolytes, optimizing ion/electron-percolating high-mass-loading cathodes, and establishing a 100 MWh/yr LMB manufacturing line. Finally, this presentation highlights the consilience between molecular engineering and practical manufacturing, offering actionable insights for scaling up reliable LMBs for commercial deployment.

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문의 화학과 정관영 교수 | 032-835-8235, gyjung@inu.ac.kr