

# Challenges and strategies for practical all-solid-state lithium batteries based on sulfide solid electrolytes

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## Abstract

Since lithium ion battery (LIB) made its debut into the market in 1991, it has shown remarkable progress in capacity, energy, power and cost reduction. However, inherent limitations in energy density and safety make it difficult for the LIB chemistry to meet the growing demands for portable electronics, electric vehicles and grid-scale energy storage, which has driven researchers to next-generation Li batteries such as Li-air, Li-S, and Li metal batteries with intercalation-type cathodes. All-solid-state lithium batteries (ASSLBs) with sulfide solid electrolytes (SEs) also have received great attention not only due to the wide electrochemical stability window (kinetically > 5 V), high ionic conductivity ( $\sigma \geq 1$  mS/cm), high Li ion selectivity (transference number  $\sim 1$ ), high deformability with low Young's modulus ( $\sim 20$  GPa) and intrinsic thermal safety of sulfide SEs, but also due to the high energy density achievable by the adoption of a Li metal anode ( $> 1,000$  Wh/L). Despite these beneficial features of sulfide solid electrolytes, the practical development of ASSLBs has been hindered by fundamental challenges arising from the electrode-electrolyte interfaces, including intimate solid-solid contact, effective electronic and ionic conduction pathways, and chemical, electrochemical and mechano-chemical stabilities of the interfaces. In this presentation, we introduce the efforts in KERI to overcome those interfacial issues and the strategies for the practical development of ASSLBs

## References

- [ 1 ] S.J. Choi, S.H. Lee, Y.C. Ha\*, J.H. Yu, C.H. Doh, Y. Lee, J.W. Park, S.M. Lee and H.C. Shin, J. Electrochem. Soc. 165, A957 (2018)
- [ 2 ] S.J. Choi, S.H. Choi, A.D. Bui, Y. Lee, S.M. Lee, H.C. Shin and Y.C. Ha\*, ACS Appl. Mater. Interf. 10, 31404 (2018)
- [ 3 ] S.W. Park, G. Oh, J.W. Park, Y.C. Ha, S.M. Lee, S.Y. Yoon and B.G. Kim, Small 15, 1900235 (2019)

## Biography

Yoon-Cheol Ha is a principal researcher in Next-Generation Batteries Research Center at Korea Electrotechnology Research Institute (KERI) and also a professor in the Department of Electro-Functionality Materials Engineering at University of Science and Technology (UST), Korea. His research focuses on materials for next-generation batteries, battery performance & safety assessment, and multiscale simulation. He received his Ph.D. in Materials Science & Engineering from Seoul National University.