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Limiting Factors of Solid-state Battery to Reach Promised Energy Density

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Abstract Solid-state batteries (SSBs) use solid electrolytes (SE) to replace flammable liquid electrolytes resulting in safer batteries with increased energy density. Even though there have been recent breakthroughs at the material level and some at the cell level, there are still more challenges to overcome. In previous work, we have used an equation to understand the stack energy density of Si-based anode battery and for the first time, (1) we use the equation to study the effect of the cathode, anode, and SE thickness on the stack energy density of the SSB. We look into all the changes that need to be made at the material, electrode and cell levels compared to what is currently used in Li-ion cells and critically evaluate their impact on the cell energy density. The study has revealed the thickness of the SE and anode need to be thinner than 50 and 35 ❍m, respectively, to see the improvement of the energy density. Furthermore, the mix of SE in the cathode that results in low cathode active volume (60%) will not improve any energy density unless the SE is thinner than 50 ❍m, which emphasizes to development of a better catholyte or higher energy dense cathode for SSB. Based on the limitation of the SSB components, the challenges will be presented and discussed to meet the promised energy density of the SSB (400 Wh/Kg).

Keyword(s)
Solid-state battery, Li-ion, solid electrolyte, Energy storage, Anode-free

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