# All-solid-state battery - Developments of the electrolytes

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All-solid-state is an ideal form of batteries. The solidification of the electrolyte provides an additional advantage for use in battery applications. However, despite the expected advantages of all-solid-state batteries, their power characteristics and energy densities must be improved to allow application in technologies such as long-range electric vehicles. All-solid-state batteries are based on the combination of cathodic, anodic, and electrolyte materials, with properties that depend mostly on the electrolyte characteristics. The low rate capabilities and low energy densities of the all-solid-state batteries are partly due to a lack of suitable electrolyte materials exhibiting high ionic conductivity comparable to liquid electrolytes. We developed the ionic conducting materials LGPS ($Li_{10}GeP_2S_{12}$) with a bcc anion sub-lattice structure exhibiting higher ionic conductivity than liquid electrolytes. Material variations of the electrolytes are of particular importance in finding suitable combinations of the electrodes and the electrolyte. The new LGPS materials, such as $Li_{9.54}Si_{1.74}P_{1.44}S_{11.7}Cl_{0.3}$ and $Li_{9.6}P_3S_{12}$, provided high power and high energy density to the all-solid-state cells. These results clearly derive from the intrinsic nature of the solid electrolytes, indicating the advantages of the all-solid-state devices over conventional electrochemical devices. Furthermore, the lithium tin-silicon system with $Li_{10.35}[Sn_{0.27}Si_{1.08}]P_{1.65}S_{12}$ with high ionic conductivity and the oxygen doped Li-P-S-O system with high electrochemical stability were also developed based on the materials search on the ternary and quaternary systems. The present study revealed the materials variety solid electrolytes, which provide high battery characteristics for all-solid-state system.

Reference

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