次世代固体電池へ向けたイオン伝導固体の設計と応用そして展望

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Materials design of solid ionic conductors toward the next-generation solid-state batteries
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Solid-state batteries are attracting attention as the next-generation energy storage devices that realize safety and high energy density. The first part of this talk will present the design strategies of ion-conducting inorganic solids. [1] As mobile ions travel through their lattice sites via a hopping conduction mechanism, any modification of the crystal structure of the material of interest greatly impacts the resulting ion transport.[2] In addition to this “static-lattice” effect, recent studies revealed that “lattice dynamics” contribute further changes in the ionic conductivity of inorganic superionic conductors. For instance, whereas the conventional oxides have high electrochemical stability, more polarizable sulfides tend to possess faster ion transport. Followed by a brief overview of materials design, challenges and perspectives of their applications toward the next-generation solid-state batteries will be discussed with a particular emphasis on the current issues in composite cathodes with a substantially high interfacial area density.[3,4]

Keywords : Solid-state batteries, Solid electrolytes, Structure-composition-transport relationship, Li-ion conducting sulfides, sulfur cathodes

高いエネルギー密度と安全性を持つ次世代蓄電デバイスとして注目される全固体電池だが、その実現と更なる向上へ取り組むべき課題は数多く存在する。本講演の前半では、その要となる固体電解質の性能向上への取り組みを、最新の研究成果を基に紹介する [1]。ホッピング伝導機構に依拠する固体中のイオン伝導は、ごく僅かな結晶構造や組成の変化によりその値を大きく変える [2]。また、例えば“硬い”酸化物材料と比較して“柔らかな”硫化物固体電解質が高いイオン伝導度を保持するように、結晶構造の静的な変化のみならず、その“動的な”変化も構造中のイオン輸送に大きく影響を与えることも明らかになってきている。後半では、次々世代型大容量複合正極の全固体化へ向けた取り組みに焦点を当てる。複合化に伴う界面濃度の上昇により、電解質の界面での劣化が電池性能へ及ぼす影響が顕在化する [3]。今後固体電解質に求められる特性や乗り越えるべき障壁、そしてその展望を議論する [4]。

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