A advance in solid-state electrolytes for all-solid-state batteries: Twice the quality with streamlined processes

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Solid electrolyte powder (left) produced by KERI's wet-synthesis process and a prototype of an all-solid-state battery using it. Credit: Korea Electrotechnology Research Institute

Korea Electrotechnology Research Institute (KERI) has reached a significant milestone with a study published in *Energy Storage Materials*, marking a crucial stride toward the commercialization of all-solid-state batteries, free from the inherent risks of explosion and fire.

Dr. Park Jun-woo of the KERI Next-Generation Battery Research Center and Sung Junghwan (student researcher at the UST KERI Campus) have successfully engineered a revolutionary technology. This technology, focused on the "size-controlled wet-chemical synthesis of solid-state electrolytes (sulfide superionic conductors)," not only slashes the processing time and cost by over fifty percent but also doubles the resultant quality.

All-solid-state batteries leverage solid-state electrolytes in lieu of liquid counterparts for ion transfer between the cathode (+) and anode (-), significantly reducing the risk of fire or explosion. However, for integration into all-solid-state batteries, particularly in the cathode, solid-state electrolytes must be minute, measuring a mere few micrometers—roughly one-hundredth the thickness of a human hair.

KERI has pioneered a technology capable of mass-producing these diminutive solid-state electrolytes with heightened ionic conductivity through a simplified process. Contrary to existing practices, where solid-state electrolytes are often large in particle size, necessitating additional processes such as mechanical grinding, KERI's approach mitigates both the time and cost burdens associated with such processes. Additionally, it eliminates the performance degradation of solid-state electrolytes induced by grinding, a significant impediment to their commercialization.

Dr. Park's team employed microscopic raw materials, such as lithium sulfide, and meticulously controlled the nucleation rate of each material during chemical reactions, resulting in substantially downsized products. This innovative approach enables the production of fine solid-state electrolytes using a straightforward wet synthesis technique devoid of intricate processes.

The successful control of the chemical composition has yielded a remarkable ionic conductivity, more than doubling that achieved through existing solid-state electrolyte production methods ('dry synthesis' and grinding through high-energy ball milling) (from 2 mS/cm to 4.98 mS/cm).

A breakthrough was found by the KERI research team, who found the ideal combination after years of experiments with countless materials and multiple rounds of analyses.

Dr. Park of KERI said, "By selecting the right materials and reliably controlling the chemical reactions, we were able to bypass the complex and expensive processes typically used for refining solid-state electrolytes, opting for a 'simple process.' Despite its simplicity, the resulting solid-state electrolytes exhibit significantly improved quality, meeting the requirements of efficiency and business accessibility for mass production and commercialization."

KERI has submitted numerous patent applications for this groundbreaking achievement, anticipating considerable interest from the all-solid-state battery industry. The institute plans to engage in technology transfer agreements with companies expressing demand.

Furthermore, KERI aims to synergize this accomplishment with a previous development—a special wet synthesis technique designed to mass-produce solid-state electrolytes at one-tenth the raw materials cost, using a patented special additive. This strategy will position KERI as a frontrunner in the low-cost mass production of high-quality solid-state electrolytes.

More information: Junghwan Sung et al, Size-controlled wet-chemical synthesis of sulfide superionic conductors for high-performance all-solid-state batteries, *Energy Storage Materials* (2024). DOI: 10.1016/j.ensm.2024.103253

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