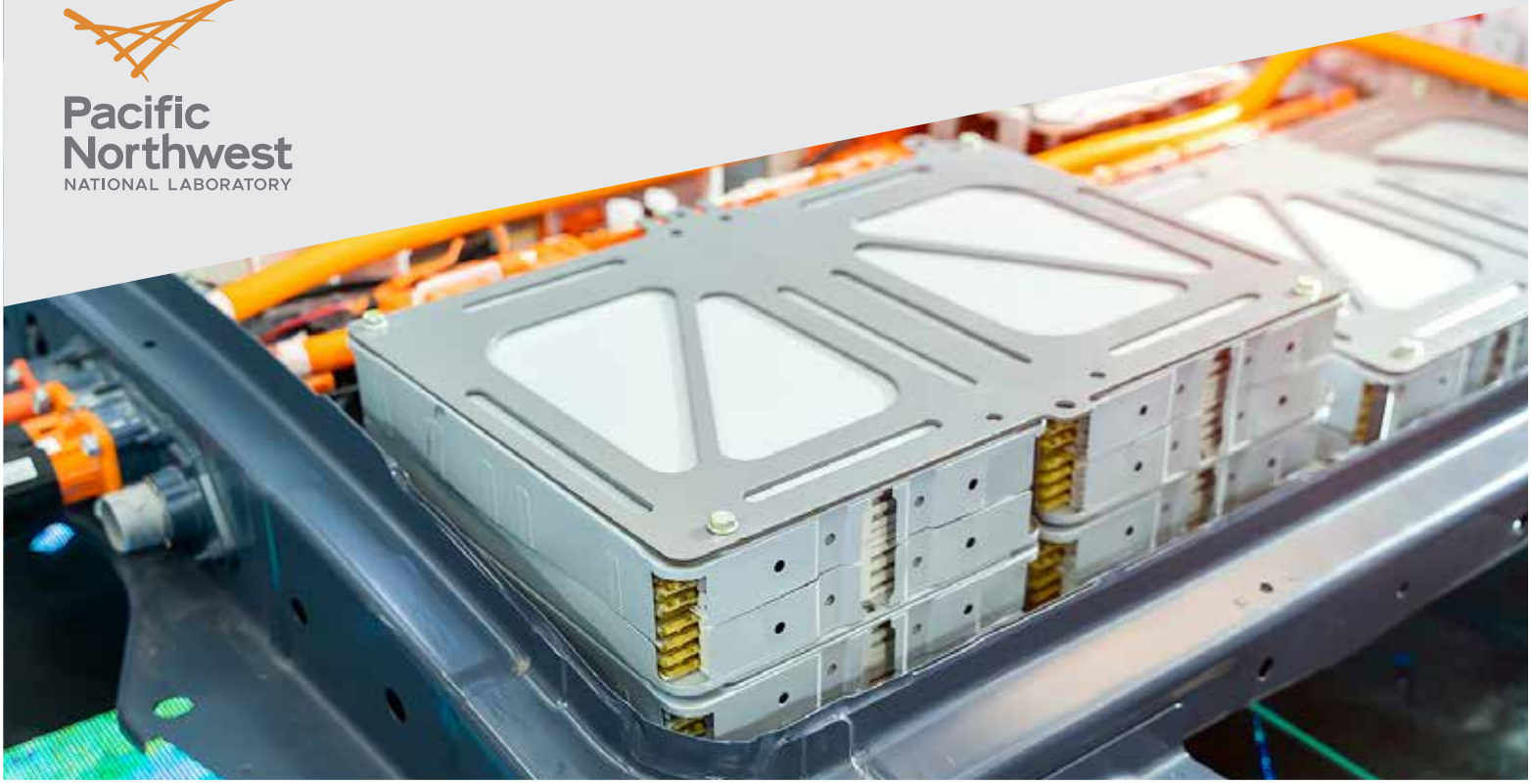
Pacific Northwest
NATIONAL LABORATORY



A new synthesis method developed at Pacific Northwest National Laboratory (PNNL) yields uniform nanometer-sized sulfide solid electrolytes for higher energy density batteries and longer-range electric vehicles for the same battery weight.

LITHIUM PHOSPHATE SULFIDE SOLID ELECTROLYTE

New wet synthesis method promises simpler manufacturing of high-performing solid-state battery electrolytes

HIGHER-PERFORMING AND SAFER BATTERIES

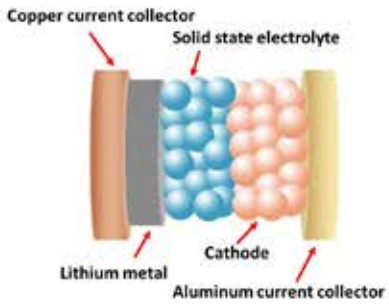
Safety remains a lingering issue with rechargeable lithium batteries due to flammability hazards associated with traditional liquid organic electrolytes. Sulfide solid electrolytes (SSE) have been shown to reduce this hazard while meeting the high bar for electrochemical performance.

PNNL researchers have developed a low-cost, scalable wet synthesis method for lithium phosphate SSE materials that can uniformly control particle size down to tens of nanometers.

The resultant electrolyte creates intimate contact with electrode materials to deliver high conductivity and energy density in solid state batteries, which are inherently safer than current lithium-ion batteries.

TECHNOLOGY FEATURES

- Scalable manufacturing process
- Electrolyte particle size can be manipulated down to tens of nanometers
- High lithium conductivity
- Electrochemical and chemical stability
- Commercially available and inexpensive starting materials



U.S. DEPARTMENT OF ENERGY

Researchers at PNNL create solutions to our nation's toughest challenges in energy resiliency and national security. Often, federally funded research results in intellectual property that is available for licensing. Visit our available technologies website to view this portfoilo.

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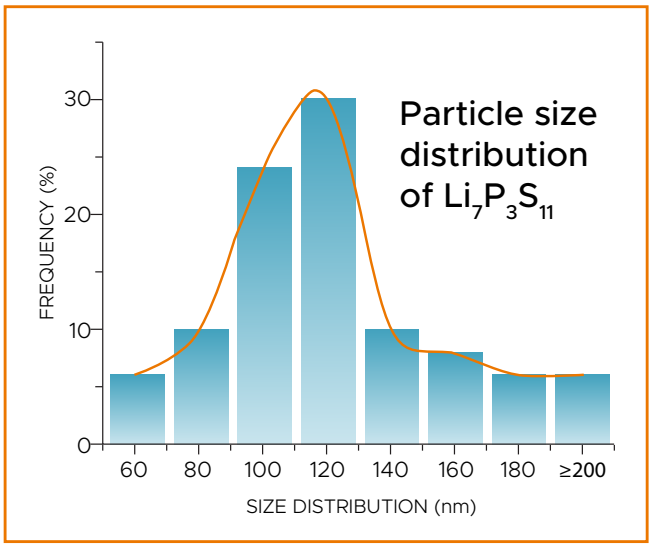

With PNNL's synthesis method, particle sizes for sulfide solid electrolytes can be easily manipulated down to tens of nanometers.

OVERCOMING INTERFACIAL RESISTANCE

Current production processes for SSE involve costly heating and mixing steps that do not fully dissolve the precursors, yielding undesirable large-particle powders. The large-sized particles reduce contact area at the interface between the SSE and the battery cathode, which impedes conductivity.

SCALABLE SYNTHESIS METHOD

PNNL's wet-chemical method involves making a simple solution of lithium and phosphate precursors in a commercially available solvent, which is subsequently evaporated. The concentration and drying temperature are easy-to-control parameters for manipulating the electrolyte particle size, even down to tens of nanometers—about 1,000 times smaller than the width of a human hair.

The small-sized SSE particles create large contact areas with active materials in the cathode, prompting the formation of thin SSE layers to achieve high energy density in the battery. High energy density translates into longer-range vehicles for the same battery weight.

DIFFERENTIATORS/COMPETITIVE COMPARISON

For large-scale production of electrolytes, wet-chemical methods are generally less expensive, more flexible, and more controllable than existing ball-milling, quench, hot-press, and microwave heating methods.

PNNL's method also uses an inexpensive, commercially available solvent, which can quickly and fully dissolve lithium and phosphate precursors. By tuning the experimental conditions, PNNL's method allows for production of electrolyte particles having high lithium conductivity and an average size of about one hundred nanometers in a uniform size distribution.

INDUSTRY APPLICATIONS

High conductivity, electrochemical and chemical stability, and scalable processing of solid-state electrolytes are crucial requirements for the commercialization of all-solid-state lithium batteries—primarily for electric vehicles but also laptops and cell phones.

PNNL's sulfide solid electrolyte material and wet synthesis method enables large-scale production of the necessary nanometer-sized lithium and phosphate-based sulfide SSE with the high conductivity needed for solid-state lithium batteries.

AVAILABLE FOR LICENSING

PNNL's new wet synthesis method is a general recipe that can be used for large-scale synthesis of important lithium and phosphate-based SSE for all solid-state lithium sulfur batteries. The technology is available for licensing in all fields. View all of PNNL's technologies available for licensing at pnnl.gov/available-technologies.

LET'S CONNECT

If you have questions, regarding this technology, please send inquiries to commercialization@pnnl.gov. You can view all PNNL technologies available for licensing at www.pnnl.gov/available-technologies.