Carbides Provide a Path to Safer Solid-State Sodium Batteries

Scientific Achievement

Researchers present a new NASICON-type solid electrolyte using carbide precursors instead of traditional oxides to produce a material that's denser, cleaner, and more resistant to metal dendrite formation.

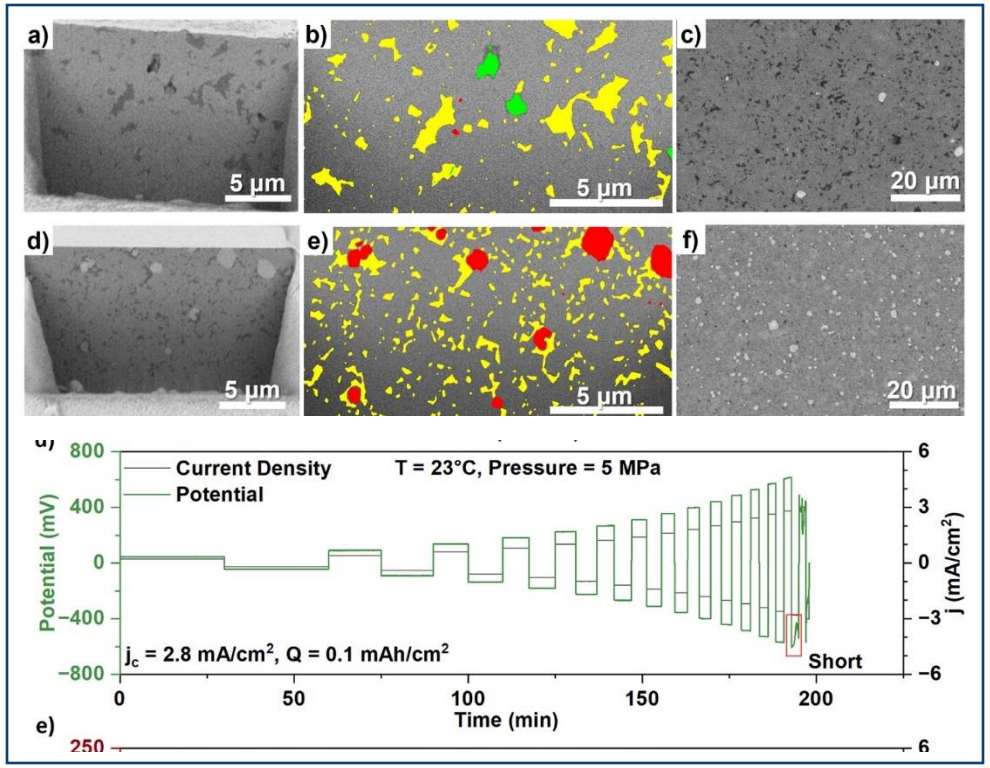

Figure: Cross sections of the carbide and oxide-based electrolyte, respectively. Compared to the traditional oxide-based method, the carbide route yields a more homogeneous microstructure with drastically reduced secondary zirconia and glassy phosphate phases, leading to a threefold increase in critical current density.

Significance and Impact

This carbide-based synthesis enables precise control of microstructural phase distribution, leading to enhanced densification, phase purity, and dendrite suppression for improved electrochemical stability in solid-state sodium batteries.

Research Details

- Reactive carbides (ZrC and SiC) decompose exothermically in air to form NASICON-type NZSP electrolytes with highly uniform microstructures.
- Simulations and experiments show that tough zirconia particles block dendrite growth, while controlling brittle glassy phases prevents them from accelerating failure.

Campbell, C. J.; Monismith, S.; Raj, V.; Wang, Y.; Yan, Q.; Fincher, C. D.; Raj, R.; Chiang, Y.; Watt, J.; McBrayer, J. D.; Mitlin, D. Reactive Carbide-based Synthesis and Microstructure of NASICON Sodium Metal All Solid-state Electrolyte. *Advanced Materials*. 2025.

Work was performed, in part, at the Center for Integrated Nanotechnologies.