**Motivation**

The DOE Office of Electricity views sodium batteries as a priority in pursuing a safe, resilient, and reliable grid. Improvements in solid-state electrolytes are key to realizing the potential of these large-scale batteries.

- NaSICON structure consists of SiO$_4$ or PO$_4$ tetrahedra sharing common corners with ZrO$_6$ octahedra
- Structure forms “tunnels” in three dimensions that can transport interstitial sodium ions
- 3D structure provides higher ionic conductivity than other conductors (β'-alumina), particularly at low temperature
- Lower temperature (cheaper) processing compared to β'-alumina

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**Objectives**

- Identify mechanisms of dendrite initiation and propagation from molten Na electrodes using high-current (100 mA/cm$^2$), one-directional testing.
- Use classical electrochemical methods, such as electrochemical impedance spectroscopy (EIS), to further understand Na|NaSICON interface and detect initial dendrite formation.
- Use interfacial coating to eliminate dendrite formation and identify key properties for effective coatings.

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**Conclusions and Future Work**

- Initially, high current densities (100 mA/cm$^2$) can be achieved in molten Na|NaSICON symmetric cells with a stable voltage profile.
- After some time, the voltage profile becomes noisy.
- EIS can be used to measure the cell impedance and a decrease in impedance corresponds to the increasingly noisy voltage profile.
- NaSICON degradation can occur by both Mode I (pressure-induced cracking) and Mode II (ion-electron recombination) mechanisms.
- Tin coating enables a more stable voltage profile in symmetric cells.

**Next Considerations:**

- What features (porosity, etc.) cause early degradation?
- How are mechanical properties related to sodium penetration?
- For further details regarding battery performance, see “Low Temperature Molten Sodium Batteries” presentation by Leo Small and Erik Spoerke.

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