

# Sodium Inventory in Na-Ion Batteries: Pre-Sodiation Strategies and Anode-Free Cell Concepts

Sonia Dsoke

<sup>a</sup>*Fraunhofer Institute for Solar Energy Systems, Dep. Electrical Energy Storage, Heidenhofstr. 2, 79110 Freiburg, Germany*

<sup>b</sup>*Freiburg Materials Research Center (FMF), Stefan-Meier-Straße 21, 79104 Freiburg, Germany*

<sup>c</sup>*University of Freiburg, Department of Sustainable Systems Engineering (INATECH), 79110 Freiburg, Germany*

*e-mail: sonia.dsoke@inatech.uni-freiburg.de,*

Sodium-ion batteries (SIBs) are a promising alternative to lithium-based systems; however, their performance and lifetime are strongly limited by irreversible sodium loss during cell formation and early cycling. In contrast to Li-ion batteries, the use of sodium-deficient cathode materials and the higher reactivity of sodium exacerbate alkali metal inventory losses, making cell balancing a critical design challenge [1].

This lecture focuses on sodium inventory loss in SIBs, with particular emphasis on pre-sodiation strategies and “anode-free” cell concepts. Different pre-sodiation approaches are discussed and classified according to their underlying principles, implementation level, and impact on cell performance, safety, and scalability [2]. Anode-free SIBs are then introduced as a limiting case, highlighting the fundamental challenges associated with sodium metal nucleation, interphase formation, and reversibility [3].

Rather than providing a catalogue of techniques, the lecture aims to develop a conceptual understanding of how sodium inventory, interphases, and cell design are intrinsically linked. The transferability and applicability to other battery chemistries are highlighted, and open research questions are discussed to stimulate critical thinking among PhD students.

## References

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