Nickel-Zinc Batteries: Cell Level Modelling and Simulation

Felix K. Schwab[1,2,*], Britta Doppl[1,2], Niklas Herrmann[1,2] and Birger Horstmann[1,2,3]

[1]German Aerospace Center (DLR), Wilhelm-Runge-Str. 10, 89081 Ulm, Germany
[2]Helmholtz Institute Ulm (HIU), Helmholtzstr. 11, 89081 Ulm, Germany
[3]Ulm University, Albert-Einstein-Allee 11, 89069 Ulm, Germany
(corresponding author email address:) felix.schwab@dlr.de

Nickel-zinc (NiZn) batteries are a promising candidate for sustainable energy storage. Such technology is necessary to upgrade the electricity grid to be able to successfully combine the increasing share of renewable energy sources with the growing demand for electric energy. Besides their competitive specific energy and power, NiZn batteries have the advantage to rely on abundant and low-cost resources, environmentally friendly and recyclable materials and non-flammable components[1,2].

While these properties make NiZn cells in principle suitable for this task, the chemical and physical processes taking place are not yet fully understood, which is the basis to create a battery design with high cycle life. Important research topics, which influence cell performance and degradation, are zinc conversion at the anode, proton intercalation at the NiOOH/Ni(OH)2 cathode and gas formation consuming electrolyte, which leads to a dry-out of the cell.

A physics-based 3D+1D model working on volume averages is implemented, which was derived from existing models[3]. Using this thermodynamic framework, a NiZn cell is cycled to examine transport processes and electrochemical reactions. This allows for example to study the distribution of phases (Fig. 1) and chemical species in the battery cell[4].

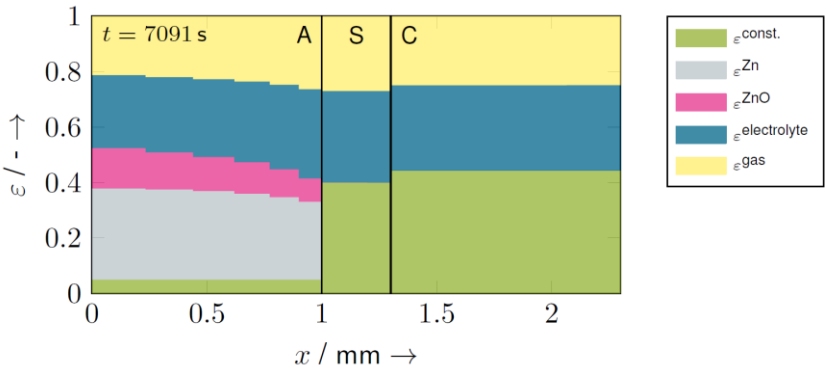

Figure 1: Volume fractions of different phases along the cell's x-direction at time t = 7 091 s.

***Keywords**:* nickel-zinc, physical modelling, charge/discharge simulation, zinc shape change

1. McBreen, J. *Journal of Power Sources* **1994**, *51* (1-2), 37–44. DOI: 10.1016/0378-7753(94)01954-1
2. Reddy, T. B. *Linden's Handbook of Batteries*, 4th ed.; McGraw-Hill: New York, NY, 2011
3. Latz, A.; Zausch, J. *Journal of Power Sources* **2011**, *196* (6), 3296–3302. DOI: 10.1016/j.jpowsour.2010.11.088
4. Schmitt, T.; Arlt, T.; Manke, I.; Latz, A.; Horstmann, B. *Journal of Power Sources* **2019**, *432*, 119–132. DOI: 10.1016/j.jpowsour.2019.126649