Karlsruhe Institute of Technology

Thin Film Technology
Thilo Heckmann
www.tft.kit.edu

Thin Film Technology
Jochen Eser
www.tft.kit.edu

TFT
Thin Film Technology

Humidity management and post drying of electrodes for Li-ion batteries

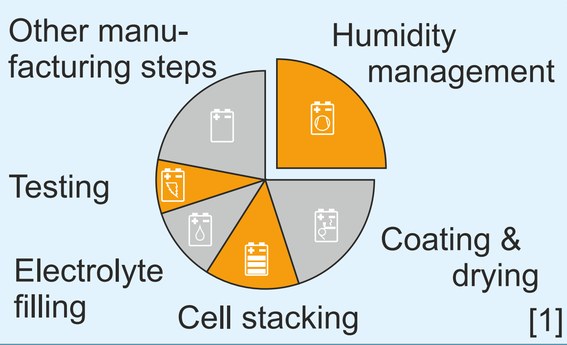
Thilo Heckmann[1,2], Jochen Eser[1,2], Andreas Altvater[1,2], Philip Scharfer[1,2], Wilhelm Schabel[1,2]

[1] Thin Film Technology (TFT), Karlsruhe Institute of Technology (KIT), Karlsruhe
[2] Material Research Center for Energy Systems (MZE), Karlsruhe

Motivation

Manufacturing Costs (material exclusive)

Large potential for optimizing the battery value chain

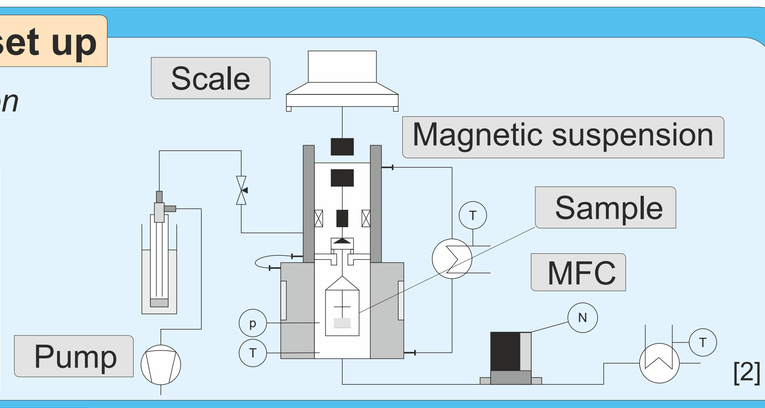


[1]

Experimental set up

Magnetic suspension balance

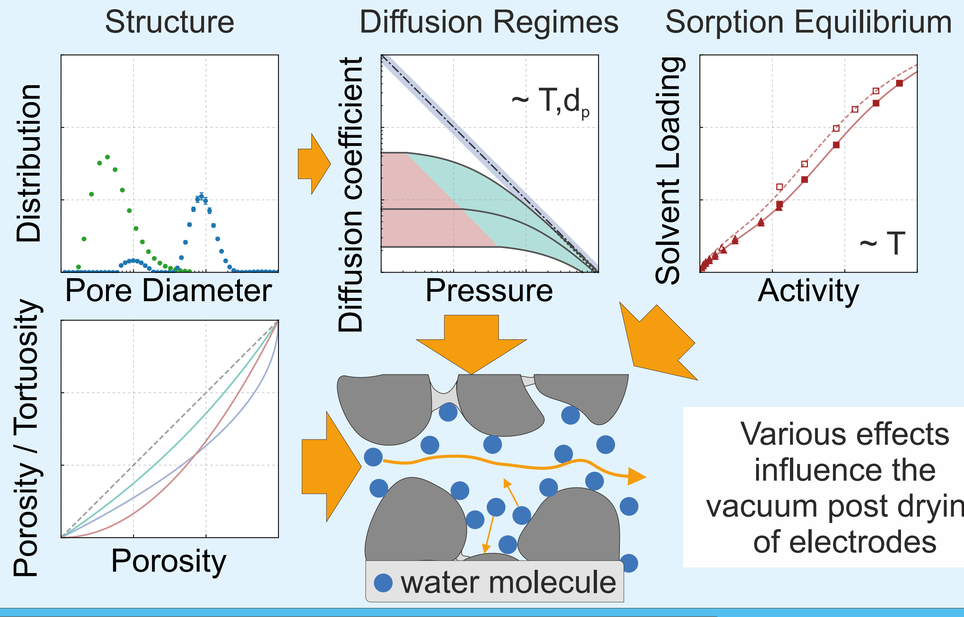
Gravimetric measurement technique
- Sorption equilibria
- Kinetics of mass transport



[2]

4 Vacuum post drying

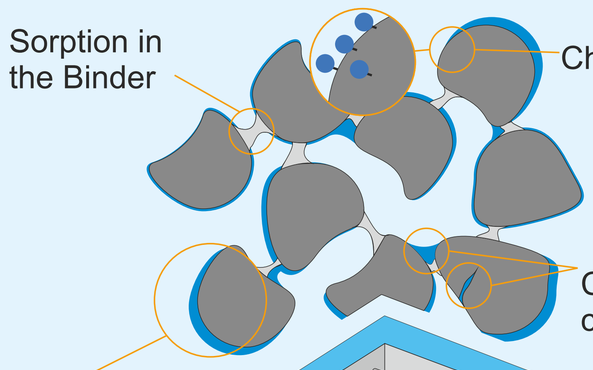
Influencial meachanism on diffusion in porous structure



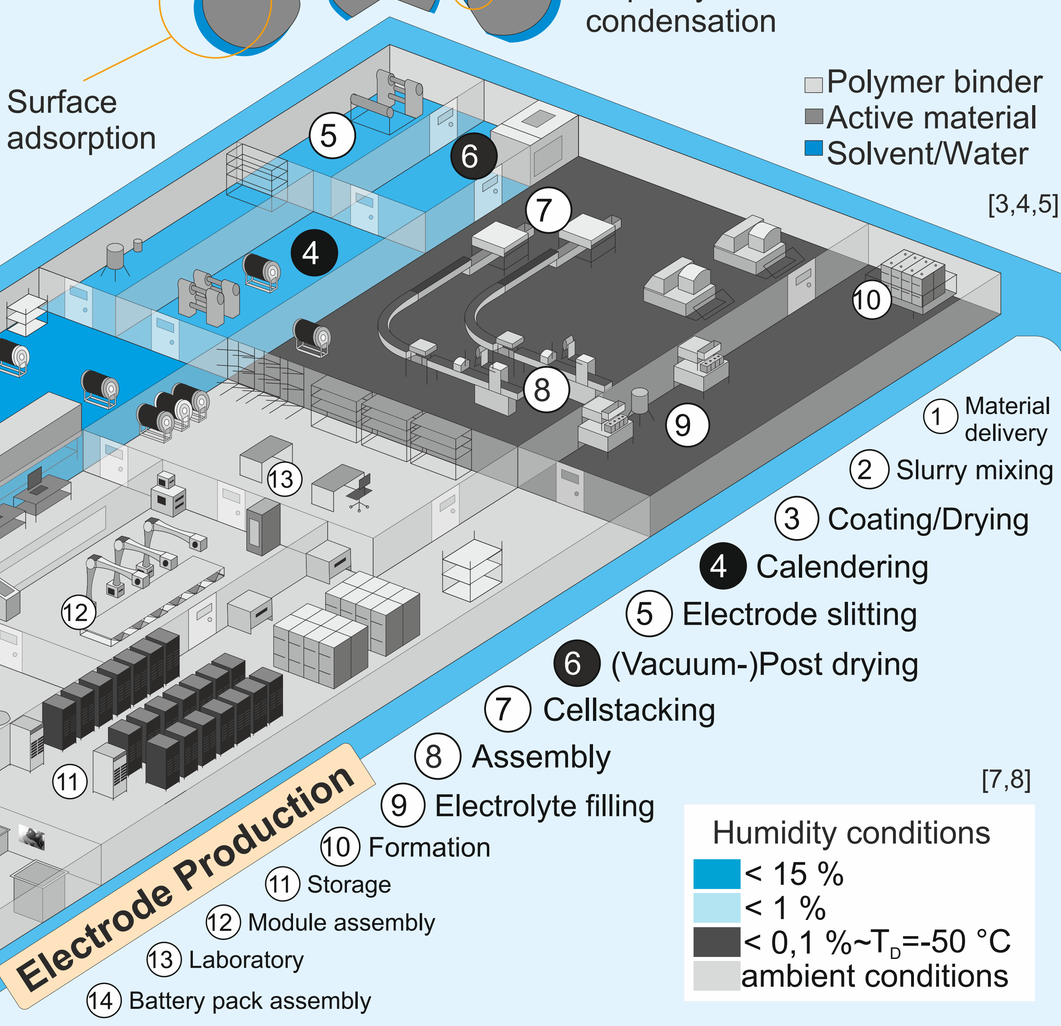
Various effects influence the vacuum post drying of electrodes

Sorption behaviour 3 4 5 6 7 8

Sorption equilibria affect most electrode production steps



Various sorption mechanisms occur depending on material and solvent properties



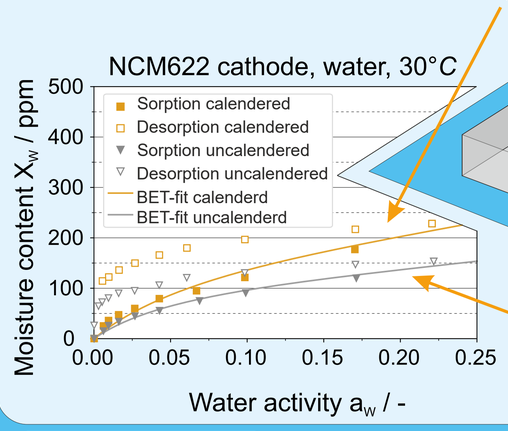
[3,4,5]

6 Calendering affects humidity sensitivity

[6]

Collaboration iPAT - TU Bs and TFT - KIT

Calendered electrodes absorb more water than uncalendered electrodes



Cracked particles

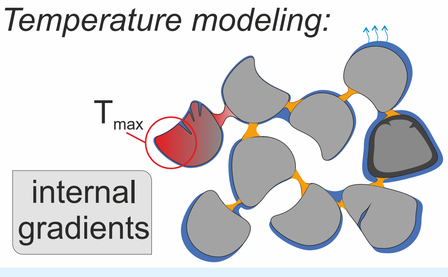
Solid particles

[7,8]

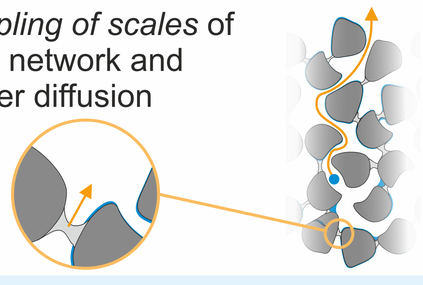
Humidity conditions
- < 15 %
- < 1 %
- < 0,1 %~T_D=-50 °C
- ambient conditions

Challenges

Temperature modeling:

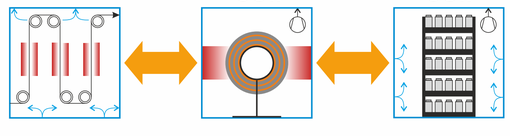


Coupling of scales of pore network and binder diffusion



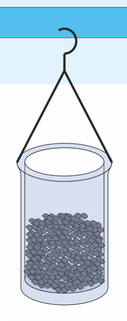
Outlook

Comparing post drying processes



Investigation of cathode materials

- sorption behaviour
- humidity sensitivity



NMC 811 | NMC 622 | NCA

[1] Schünemann, J.-H.; et al.; Kwade, A. (2016) Smart Electrode Processing for Battery Cost Reduction. In: ECS Transactions, 73 (1) 153-159.
[2] Schabel, W. et al.; (2003) Messungen von Sorptionsisothermen und Diffusionskoeffizienten in Polymerlösungen. In: Chemie Ingenieur Technik, 1, 2I2003 (s. 36-41).
[3] Eser, J. C.; et al.; Scharfer, P. ; Schabel, W. (2020) Diffusion kinetics of water in graphite anodes for Li-ion batteries. In: Drying Technology, 2020, 1–16
[4] Eser, J. C.; et al.; Scharfer, P. ; Schabel, W. (2020) Hysteresis Behavior in the Sorption Equilibrium of Water in Anodes for Li-Ion Batteries. In: Langmuir, 36, 6193−6201.
[5] Eser, J. C.; et al.; Scharfer, P.; Schabel, W. (2020) Moisture Adsorption Behaviour in Anodes for Li-Ion Batteries. In: Energy Technology, 8, 1801162 (1-10).
[6] Huttner, F.; et al.; Kwade, A. (2021) Increased Moisture Uptake of NCM622 Cathodes after Calendering due to Particle Breakage. In: J. Electrochem. Soc. 168 090539.
[7] Stich, M. (2019) Wasserverunreinigungen in Lithium-Ionen-Batterien. Dissertation.
[8] Eser, J. C. (2021) Über das Stofftransport- und Sorptionsverhalten im Nachtrocknungsprozess von Elektroden für Li-Ionen-Batterien. Dissertation.

Acknowledgements
The authors would like to acknowledge financial support of the Federal ministry of Education and Research (BMBF) via the ProZell cluster-projects “Sim4Pro” (Grant number: 03XP0242C) and “Epic” (Grant number: 03XP0295A).

CELEST | ProZell | Bundesministerium für Bildung und Forschung