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Investigation of the drying-behaviour of solvent-reduced granule-based battery coatings

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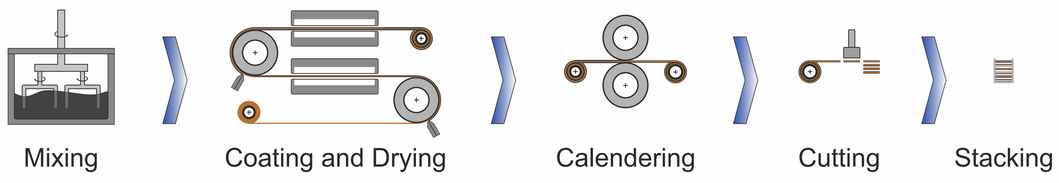
Motivation

State of the art electrode coating processes require relatively low solid contents (45-50 wt.%)

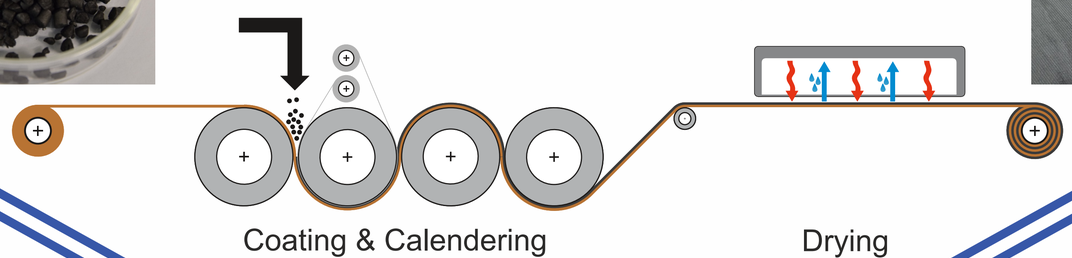
- high solvent content causes segregation of inactive electrode components
- calendering as additional process step
- long drying times
- high energy and investment costs



One-step electrode production line

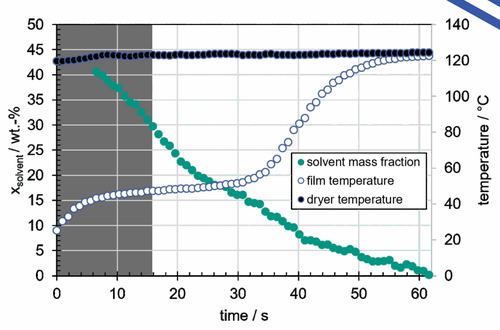
- usage of granules from energy-efficient extruder process as input material
- reduction of the solvent content in electrode-processing
- storage stability of the input material over several weeks
- increase in production flexibility due to decoupling of material and electrode production
- coating and calendering in one process step

granules produced at the Institute for Particle Technology (iPAT), TU Braunschweig



anode sheet produced at the Thin Film Technology-Lab (TFT), Karlsruhe Institute of Technology (KIT)

Influence on drying

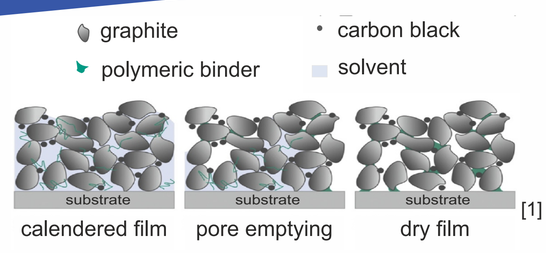


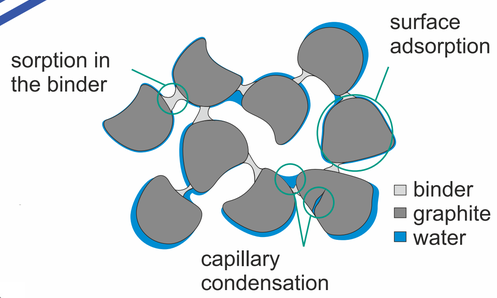
Possible time and energy saving during drying process

- starting at lower solvent loading

Compacted microstructure due to calendering step

- saturated film without film shrinkage
- different pore structure with smaller pores
- positive effect on binder migration?



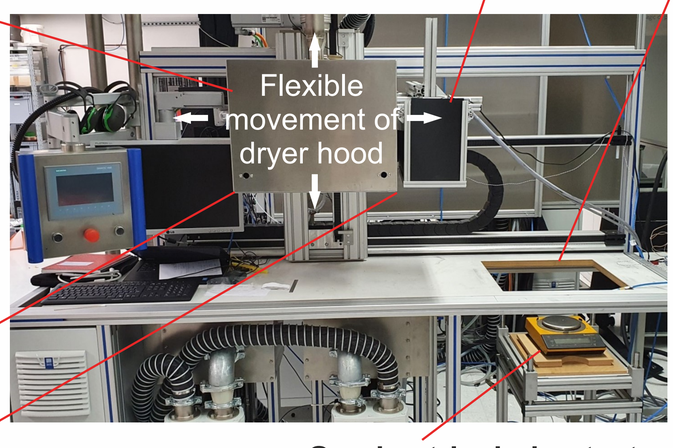


Post-drying step

- sorption behavior of new material system?

multi-stage drying tests possible

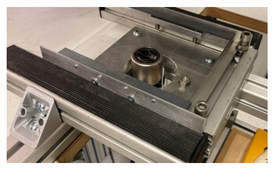
IR-emitter for drying with energy input via radiation



homogeneous drying conditions due to honeycomb-shaped nozzle array

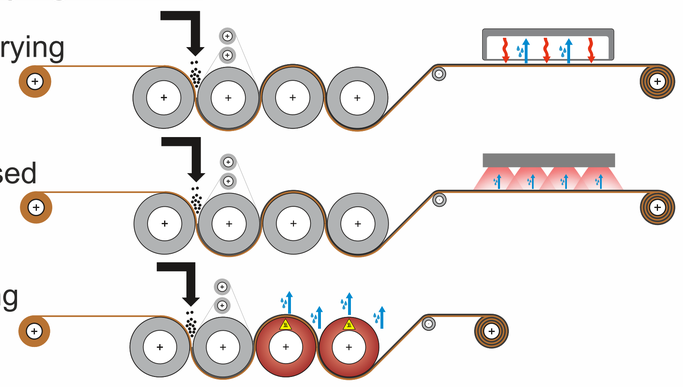
Digital microscope

- coating on transparent substrate
- investigation of the pore emptying behavior



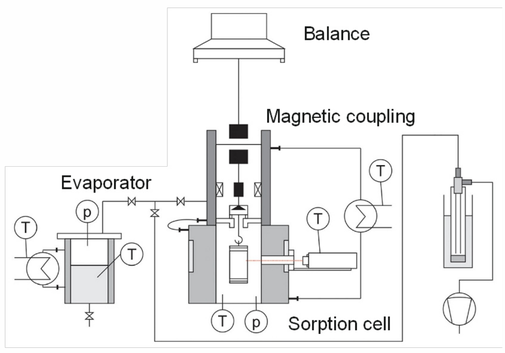
Alternative drying methods

- convective drying
- radiation based drying
- contact drying



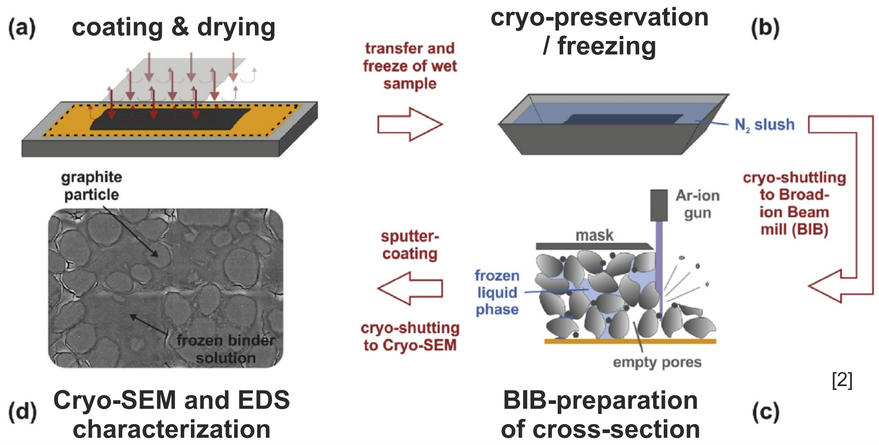
Gravimetric drying test

- drying under defined conditions
- investigation of the drying kinetics



Magnetic suspension balance

- experimental investigation of the sorption equilibria of the electrodes
- disclosure of the sorption behaviour



Cryo-BIB-SEM

- freezing of electrode layers at specific solvent loading
- visualizing microstructure evolution during drying
- elucidation of pore emptying mechanism

Methods

[1] Jaiser, S.; Funk, L.; Baunach, M.; Scharfer, P.; Schabel, W. (2017): Experimental investigation into battery electrode surfaces: The distribution of liquid at the surface and the emptying of pores during drying. In: Journal of colloid and interface science 494, S. 22–31. DOI: 10.1016/j.jcis.2017.01.063.

[2] Jaiser, S.; Kumberg, J.; Klaver, J.; Urai, J. L.; Schabel, W.; Schmatz, J.; Scharfer, P. (2017): Microstructure formation of lithium-ion battery electrodes during drying – An ex-situ study using cryogenic broad ion beam slope-cutting and scanning electron microscopy (Cryo-BIB-SEM). In: Journal of Power Sources 345, S. 97–107. DOI: 10.1016/j.jpowsour.2017.01.117.

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