

Energy sources for heat and mass transfer in the production of battery electrodes

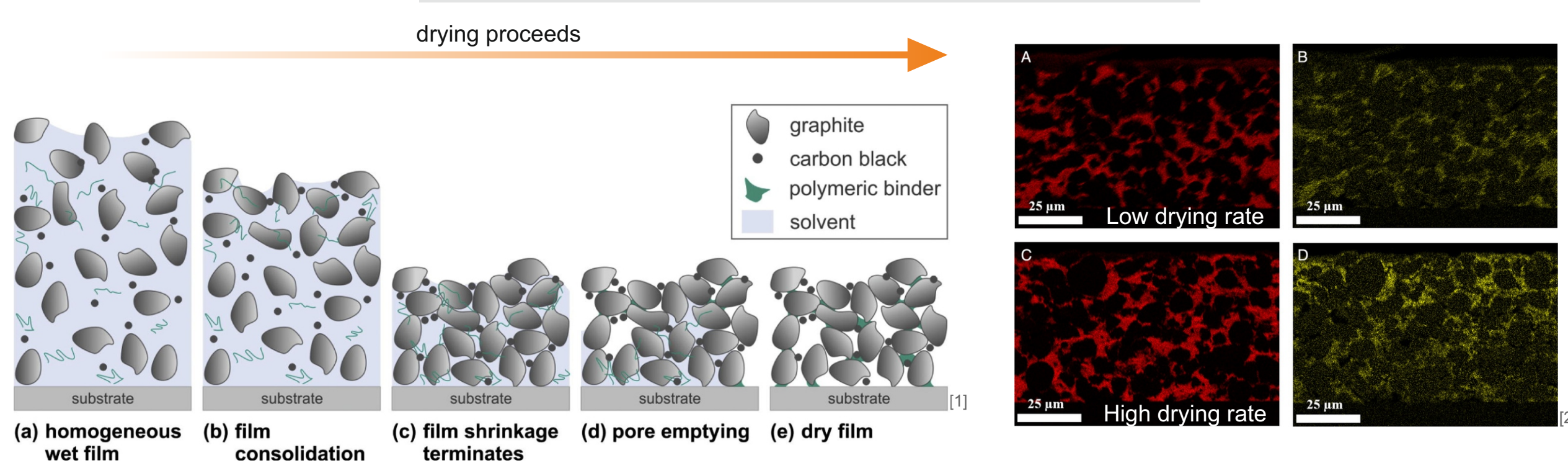
Towards higher production speed

J. Borho^{1,2}, K. Ly^{1,2}, P. Scharfer^{1,2}, W. Schabel^{1,2}

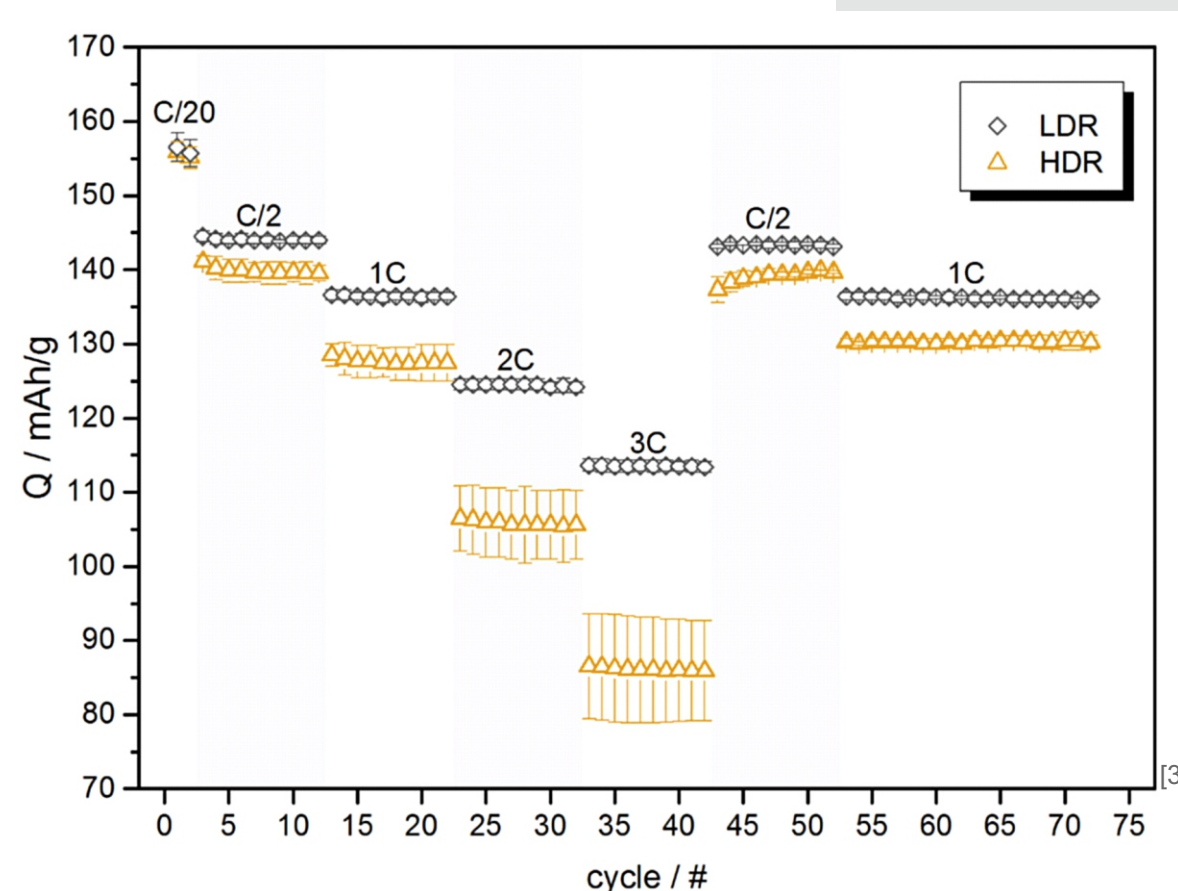
¹Thin Film Technology (TFT), ²Material Research Center for Energy Systems (MZE), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Motivation and challenges in battery electrode drying

Microstructure formation during drying



Process-dependent properties

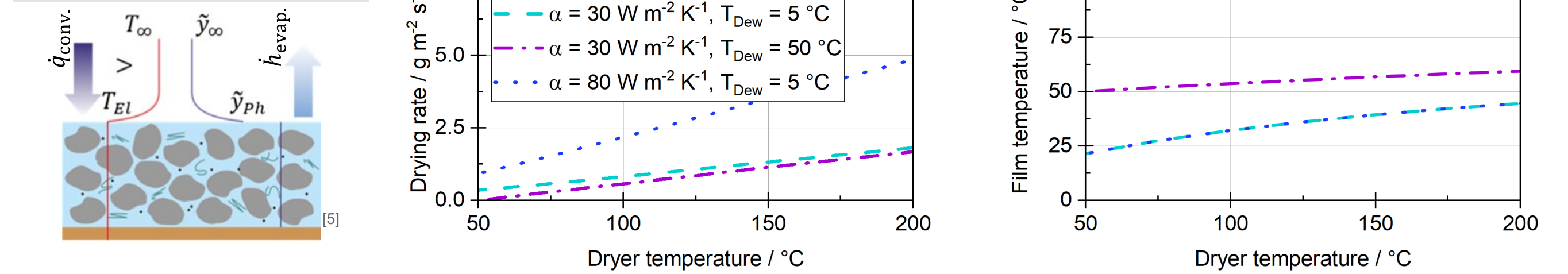


- Gradients in polymer and solvent loading
- Pore emptying in consolidated film

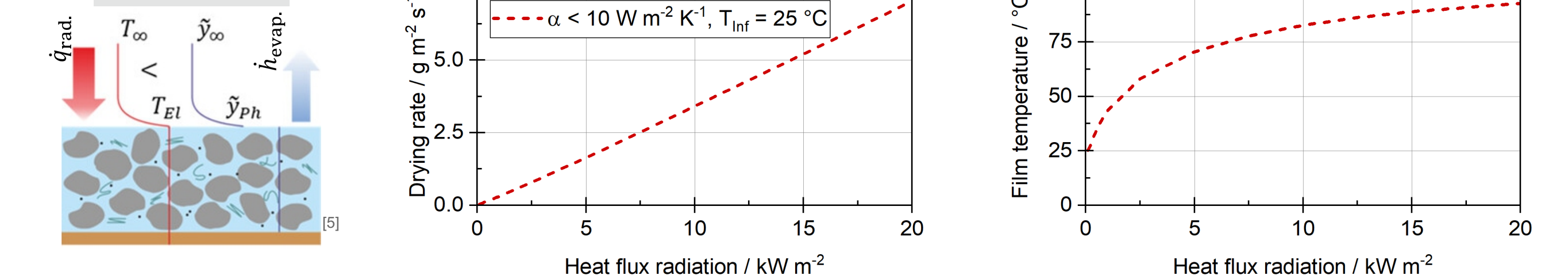
Challenge: applied drying conditions are crucial for electrode properties

Theory: Drying rate and film temperature

Forced convection



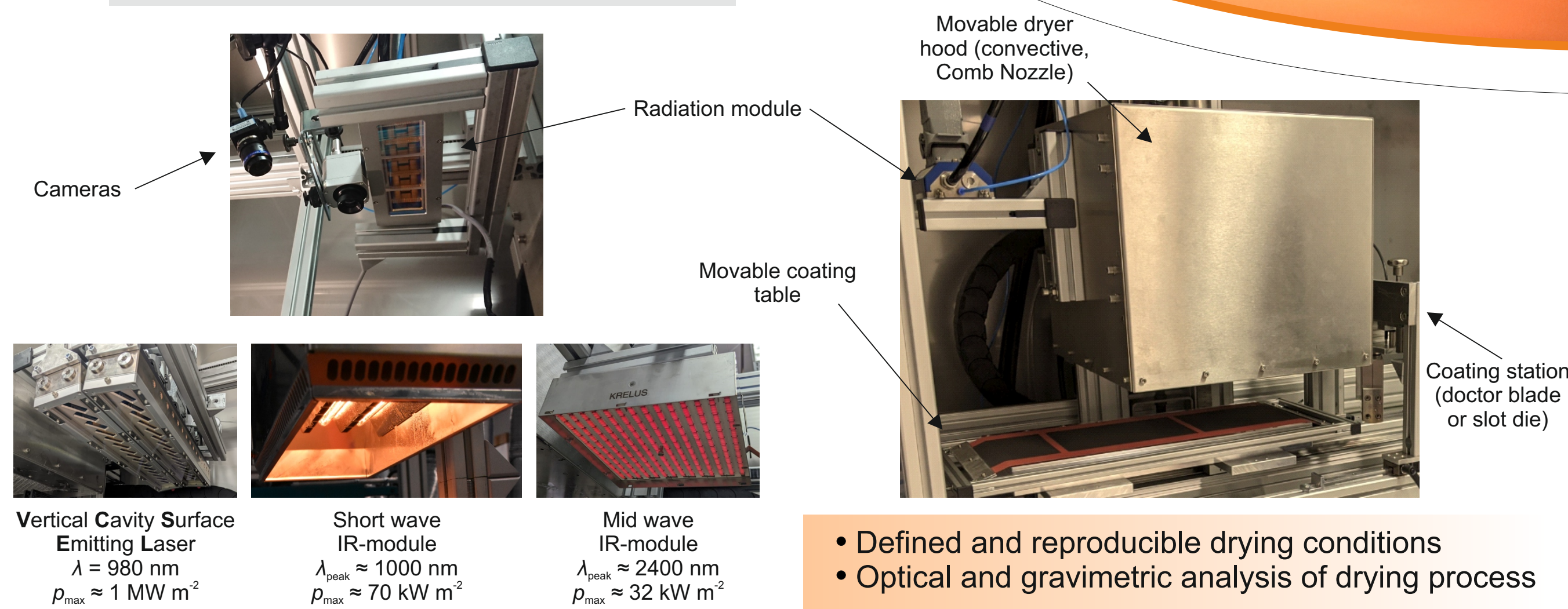
Radiation



- Limited film temperature with forced convection
- Higher wet bulb temperatures with radiation
- Advantage radiation: easy and fast control

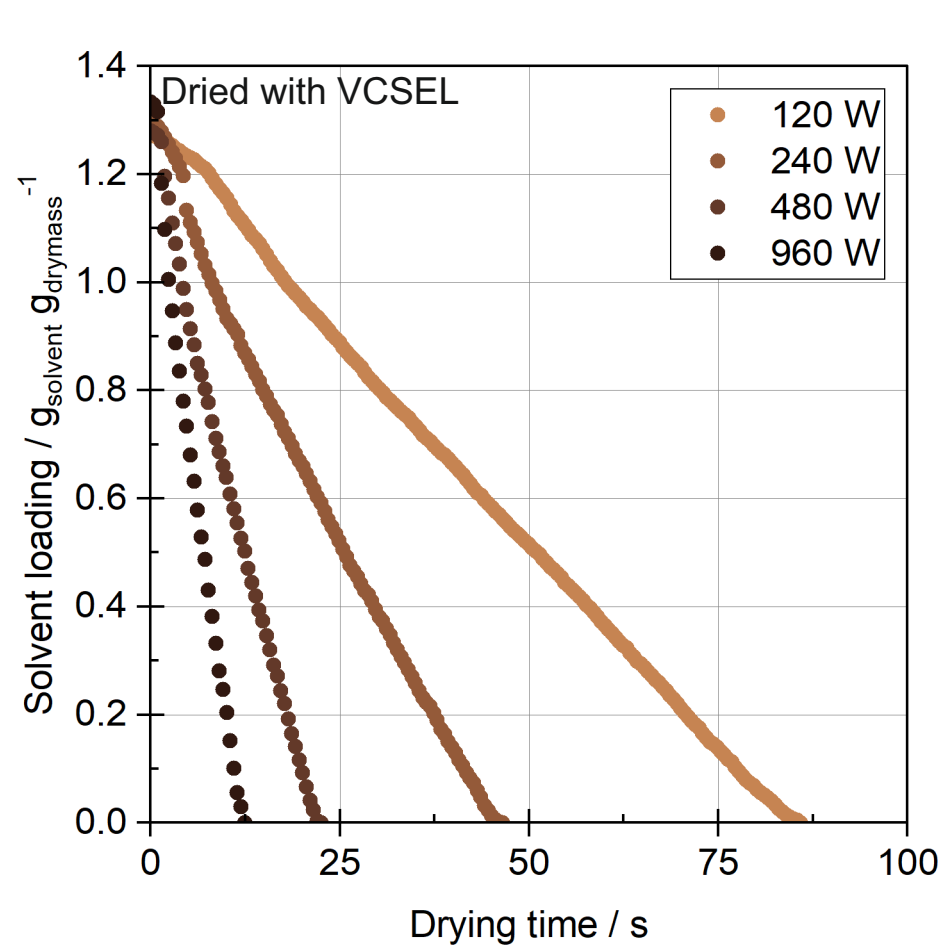
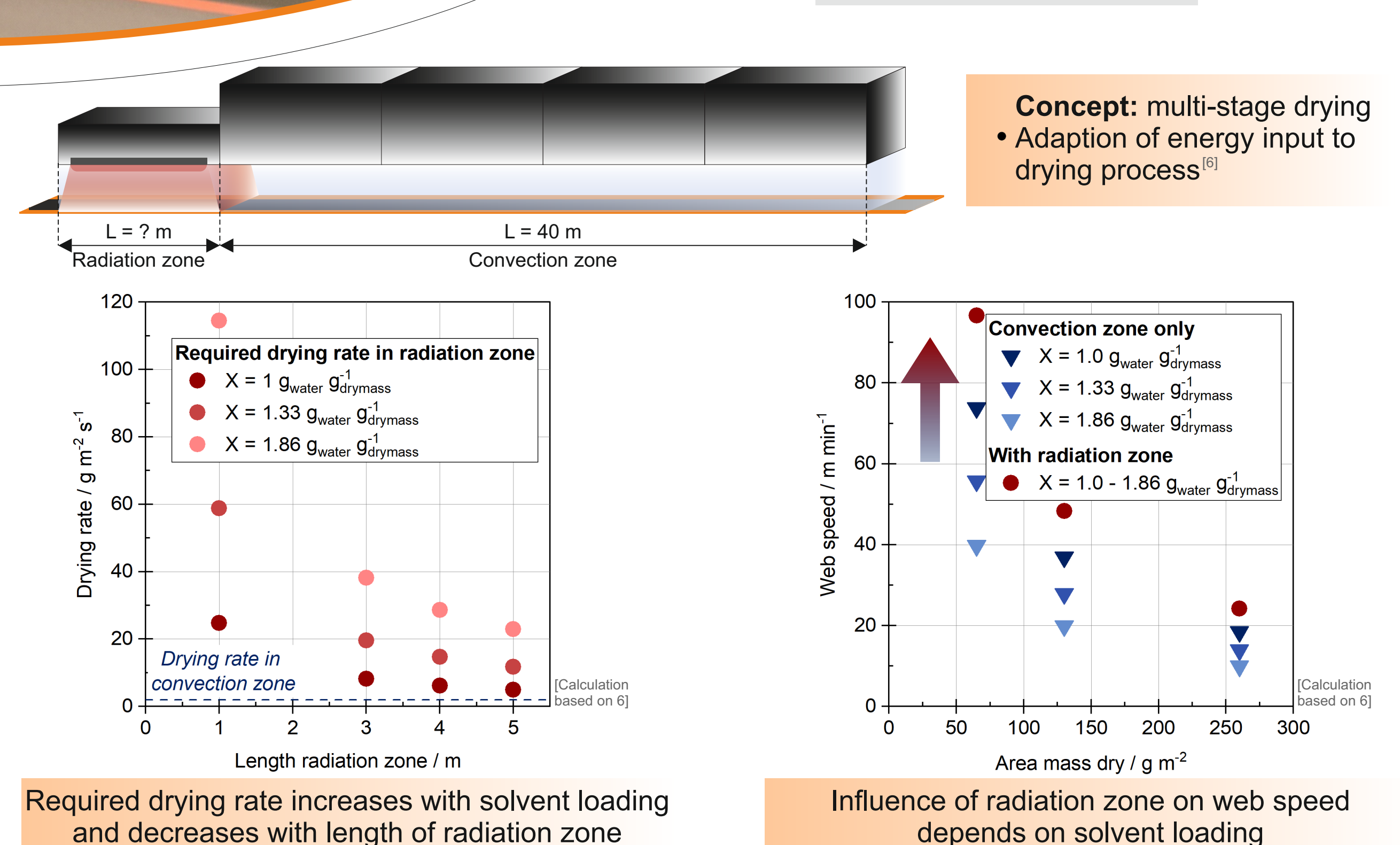
Research on lab scale

Batch plant for drying experiments

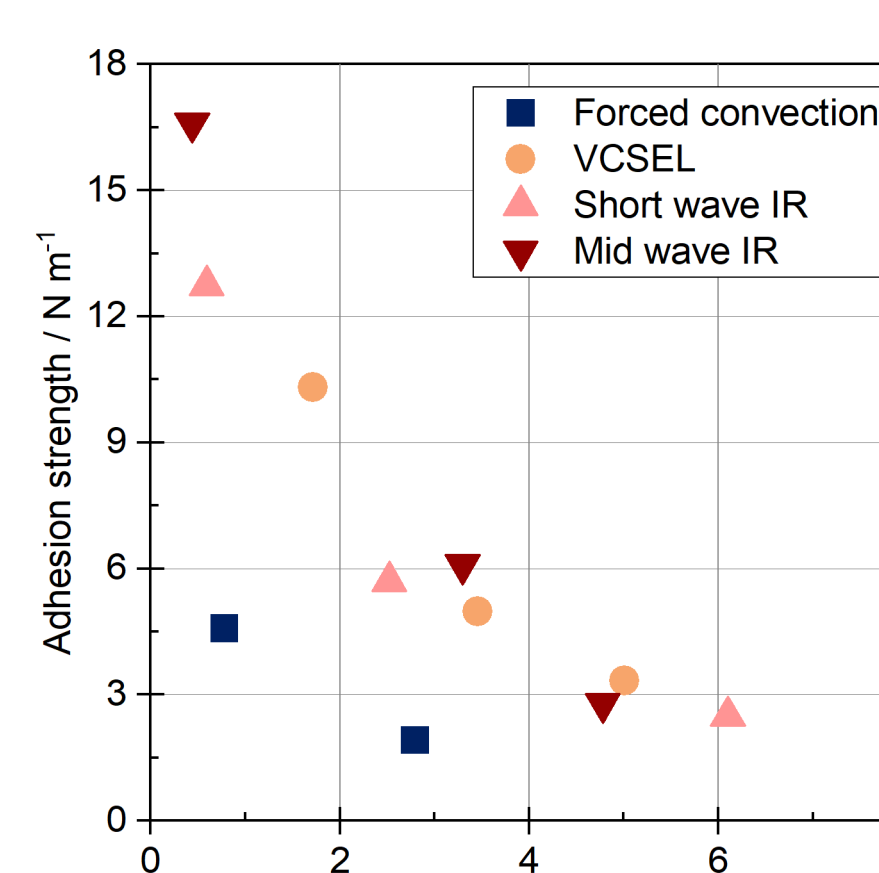


Transfer to larger scales

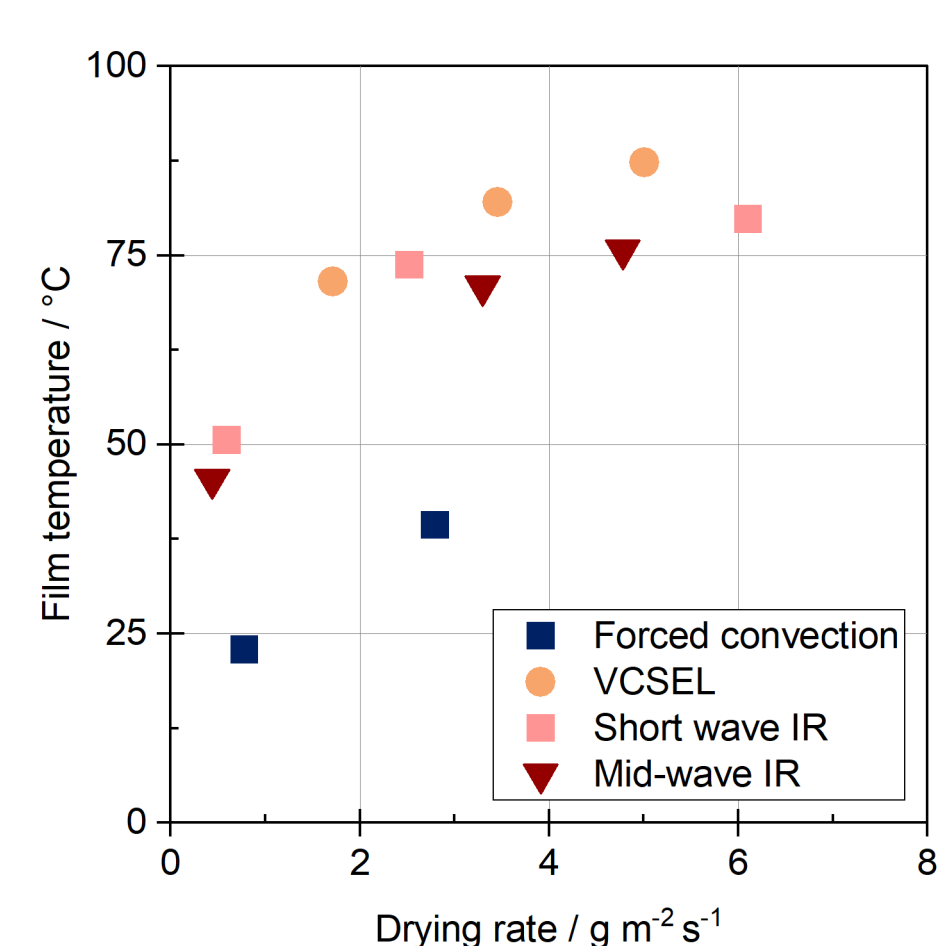
Theoretical case study



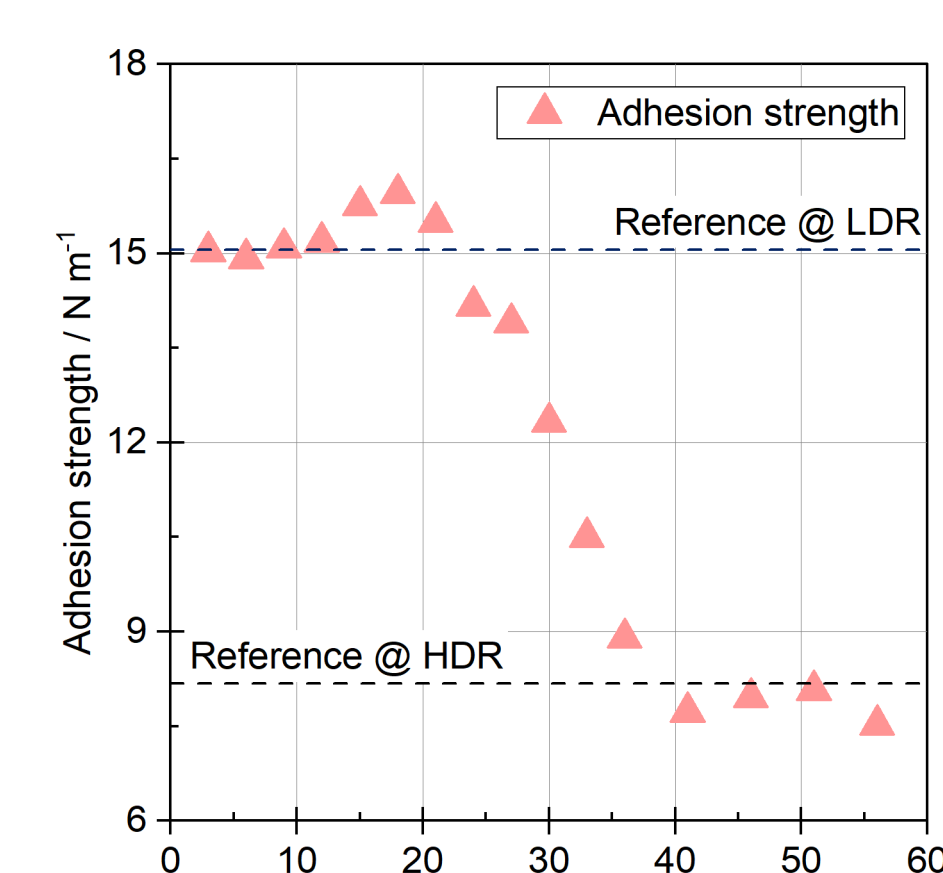
Drying controlled by gas side



Increase of adhesion strength at same drying rate compared to forced convection^[4]

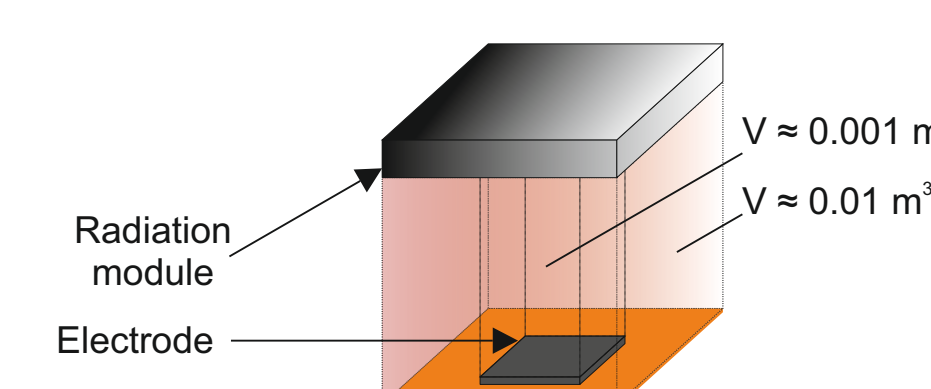
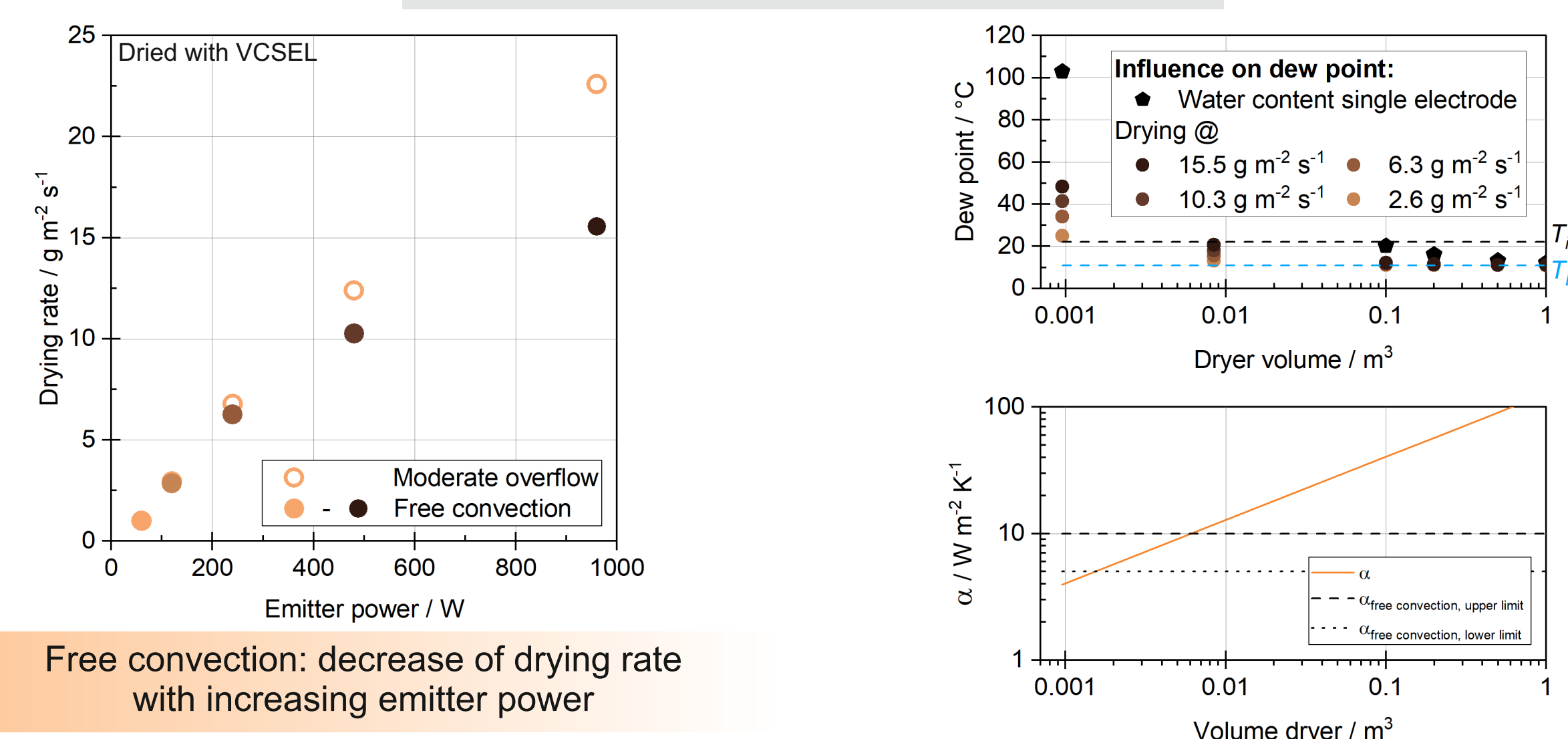


Increase of film temperature at same drying rate due to decoupling of heat and mass transfer



Multi-stage drying experiments: influence of drying rate on electrode properties is not linear

Upcoming challenges and further steps



Next steps:
Experimental setup for studying radiation and convection

[1] Jaiser et al., Scharfer, Schabel, Experimental Investigation into Battery Electrode Surfaces [...], Journal of Colloid and Interface Science, 2017.
[2] Klemens et al., Scharfer, Schabel, Drying of NCM Cathode Electrodes with Porous, Nanostructured Particles [...], Energy Technology, 2022.
[3] Jaiser et al., Scharfer, Schabel, Investigation of Film Solidification and Binder Migration [...], Energy Technology, 2016.

[4] Kumborg et al., Scharfer, Schabel, Drying of Lithium-Ion Battery Anodes for Use in High-Energy Cells [...], Energy Technology, 2019.
[5] Allvater et al., Scharfer, Schabel, (Near-) Infrared Drying of Lithium-Ion Battery Electrodes [...], Energy Technology, 2022.
[6] Allvater et al., Scharfer, Schabel, Application of Multistage Drying Profiles for Accelerated Production [...], Energy Technology, 2024.