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Increase in efficiency of manufacturing battery electrodes
by multilayer concepts and edge geometry optimization

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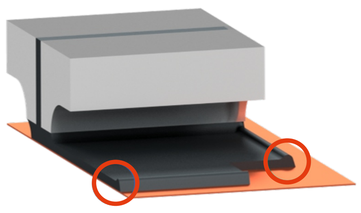
Challenges

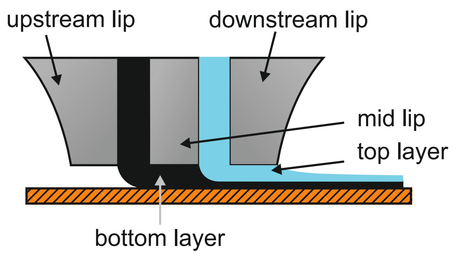
Coating homogeneity

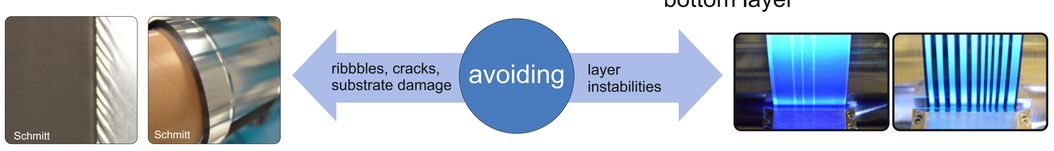
Homogeneous (multilayer) coatings require:

Uniform wet-film height
(minimized edge elevations)



Process stability
(individual layer properties)



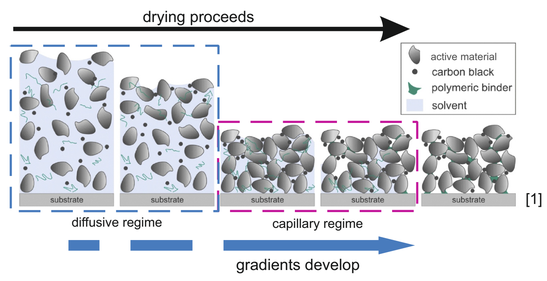


Binder migration

Microstructure formation:

gradients in polymer- and solvent loading

pore emptying in consolidated film



[1]

Issues with binder gradients:

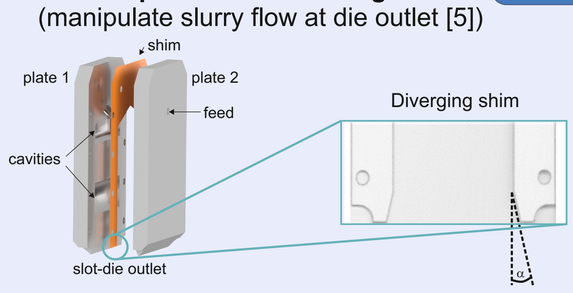
gradient in ionic resistance

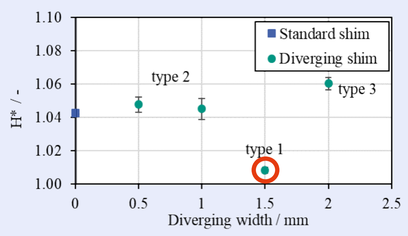
poor adhesion & possibly delamination

State of the art

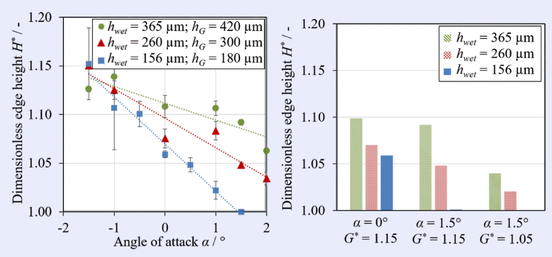
How to reduce edge formation?

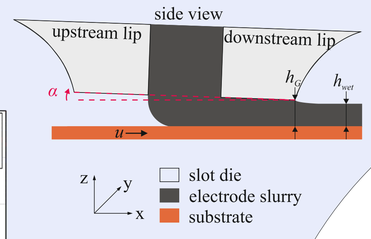
Optimized shim design
(manipulate slurry flow at die outlet [5])





Optimized die position
(angle of attack, gap height [6])





How to utilize multilayer structures?

Distinct influence of CMC and SBR additives

CMC → viscosity η

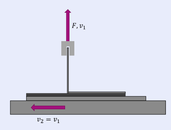
SBR → adhesion F_H

$m_\eta \approx 1$

Layer setup influences adhesion

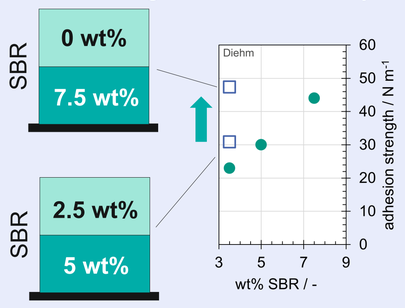
variation of only SBR → $m_\eta \approx 1$

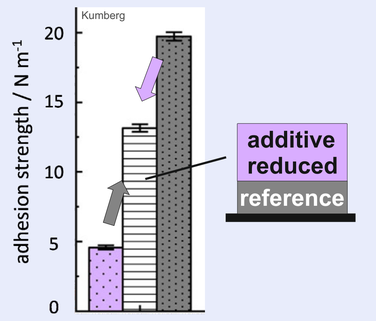
variation of SBR, CMC, CB → $m_\eta \neq 1$



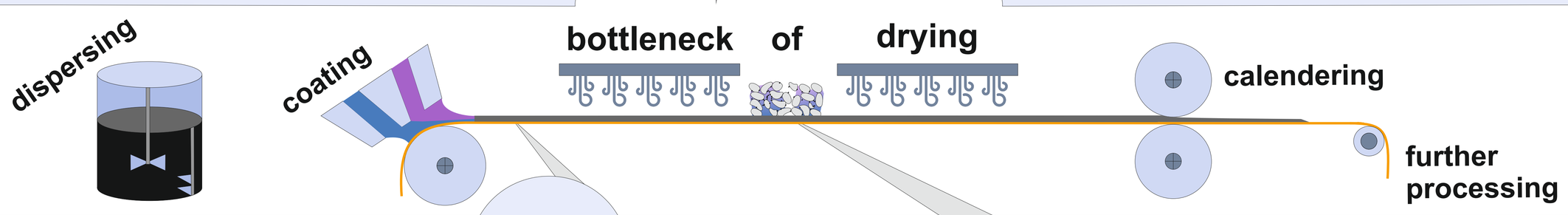
adhesion strength

dominating substrate near layer [2]





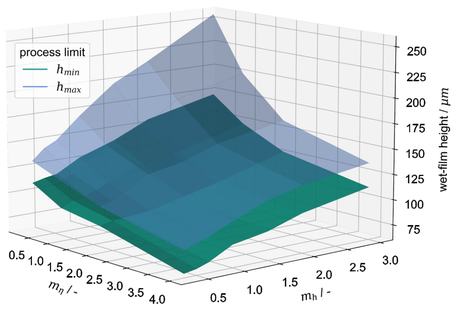
or influenced by both layers [3]

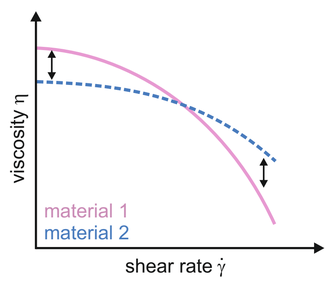


Experimental approach

Actuators in the multilayer coating process

wet-film-height ratio $m_h = \frac{h_{top}}{h_{bottom}}$ viscosity ratio $m_\eta = \frac{\eta_{top}}{\eta_{bottom}}$

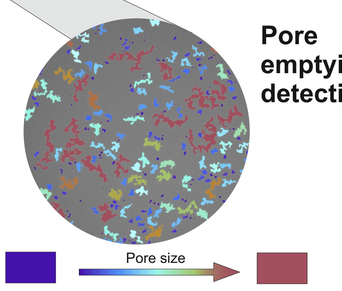




structure of slurry & coating

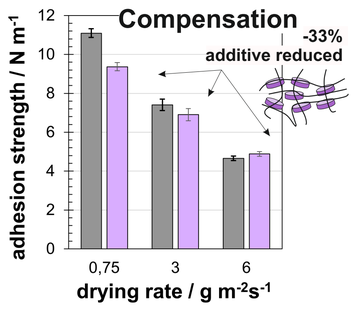
drying

microstructure electrode



Pore emptying detection

linking of microstructure formation and microstructure



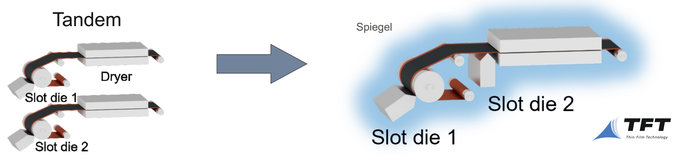
additive reduction by clay-polymer networks

Outlook

Further approaches

From tandem coating towards

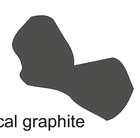
Simultaneous double-sided coating and drying



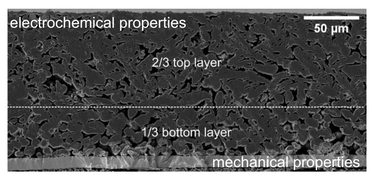
Combination of particle morphologies [3]

Primer Layer [4,3]

(N)IR / Infrared drying [7]



2/3 nonspherical graphite



Kumberg, REM: KIT, IAM-ESS

1/3 spherical graphite

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Acknowledgements
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