Key Influencing Factors along the Production Chain of a Dry Coating Process

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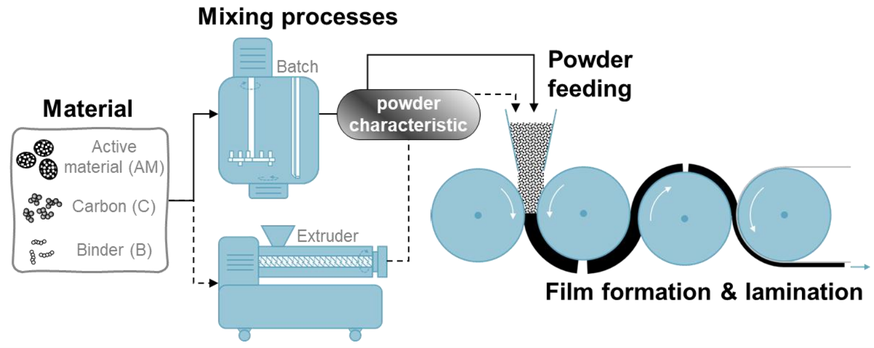
Motivation

- Reduced energy and space requirements
- Lower CO_2 emissions, no toxic solvent
- Reduced electrode production costs

The efficiency, sustainability, and quality of dry coating processes are governed by **key influencing factors**, including *material properties*, *mixing processes*, *powder feeding* accuracy, and *film formation* dynamics.



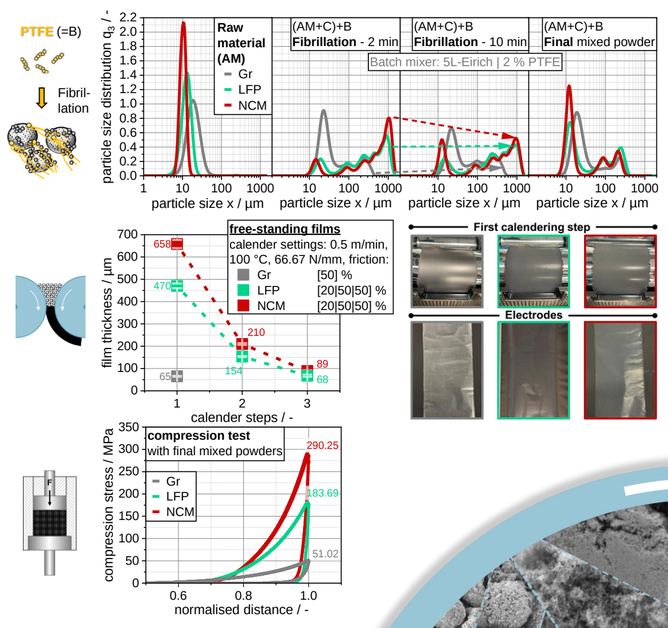
Active Material

Influence of the active material morphology: [1]

Graphite: Slower PTFE fibrillation, thinner films, lower compression stress

LFP: Prolonged PTFE fibrillation due to fine particles, moderate results

NCM: Faster PTFE fibrillation, thicker films, higher compression stress

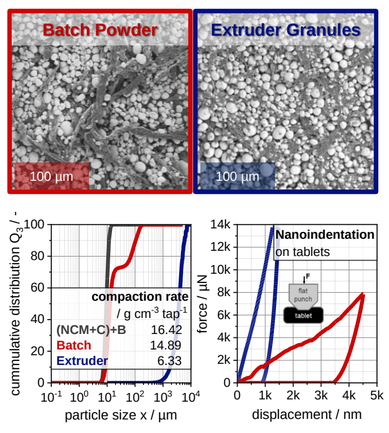


[1] M. Horst, F. Beverborg; 10.1016/j.powtec.2024.120451 | Content of the ProLiT project

Dry Mixing Process

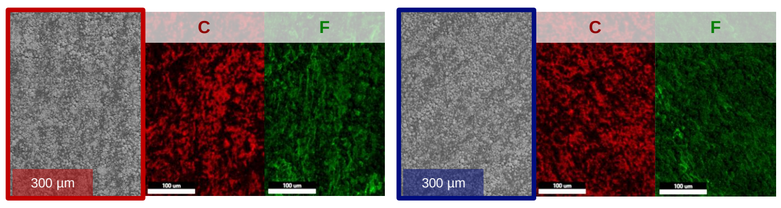
Impact of different kinds of mixing processes:

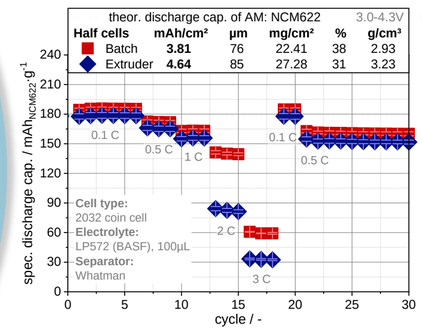
- Material: 95.5% NCM622, 3% C65, 1.5% PTFE
- Batch = 5L-Eirich, Extruder = Thermo Scientific



- **Batch**: Powders with macro fibrils = less fibrils, high compaction rate, softer tablet
- **Extruder**: Large granules with nano fibrils = more fibrils, low compaction rate, harder tablet

Dry-coated electrode





- Dense granules result in thicker and denser films → Sensible to higher C-Rates
- Powders result in thinner, more porous films → Good C-Rate capability

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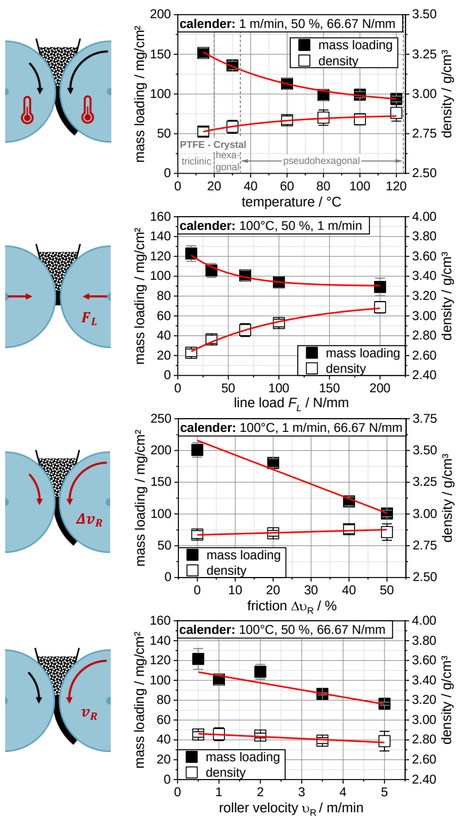
Film Formation Process

Influence of calender parameters:

- Batch, Material: 95.5% NCM, 3% C65, 1.5% PTFE



- Increasing roller **temperature** results in softer PTFE and thinner and denser films
- Increasing **line load F_L** of calender gap results in denser (and slightly thinner) films
- Increasing **differentical roller velocity Δv_R (friction)** reduces film thickness and slightly increases film density, perhaps due to minor particle fracturing
- Increasing **roller velocity v_R** results in thinner films due to additional shear and more porous films due to reduced dwell time

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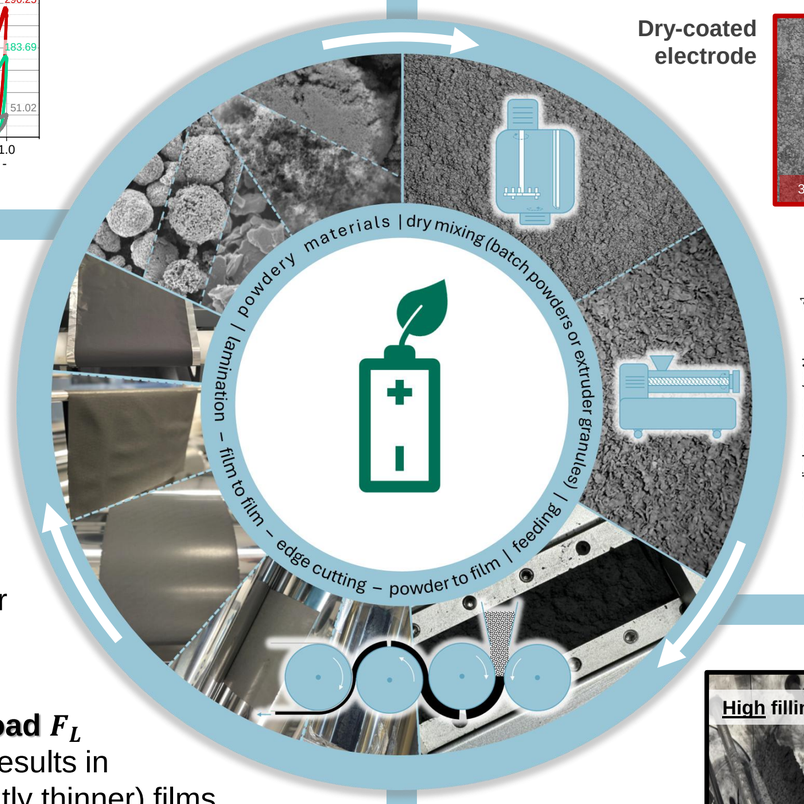
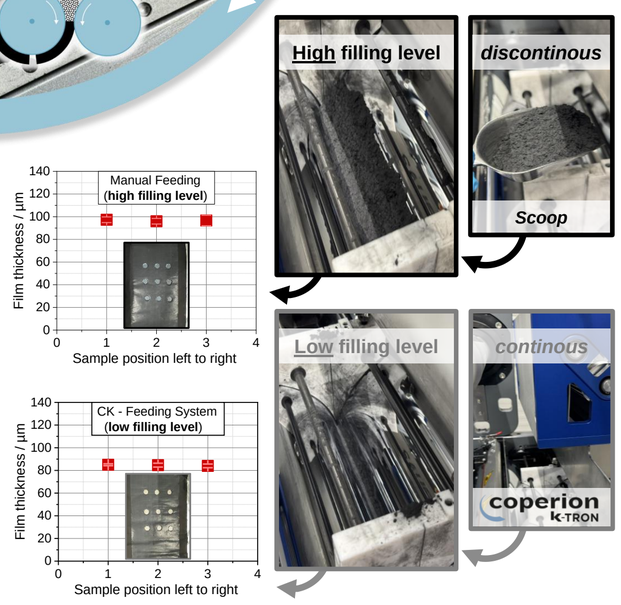


Feeding Process

Comparison of filling levels:

- Batch, Material: 95.5% NCM, 3% C65, 1.5 % PTFE
- Film formation: 4-Roll Calender, same calendering parameters



- **Manual feeding** (high filling level) produces thicker films
- **Continous feeding** with a Coperion K-Tron (CK) Feeder (low filling level) results in thinner films

Content of the ProLiT project

Conclusion and Outlook

Active material morphology has a significant impact on PTFE fibrillation, necessitating **customized mixing** and downstream processes. The choice of mixing method for fibrillated products (batch mixer, extruder) influences particle structure, requiring an **adjusted calendering process** to achieve consistent electrode properties. Precise feeding with low filling level produces thinner films, potentially **reducing the required calendering steps**. Trends in calendering parameter variations provide a foundation for a **mathematical model,** advancing process optimization efforts.

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