Dry electrode processing of NFM layered oxide cathodes and evaluation in pouch cells

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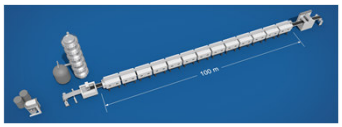
Motivation

- limited resource availability and rising material costs are drivers to search for alternative materials and chemistries for secondary batteries
- Sodium-ion battery (SIB) is a promising cell chemistry due to
  - high abundance of Na
  - "drop-in" to LIB technologies
- besides the material driven costs, also costs for processing need to be further reduced
- common slurry coating process for LIB (and SIB) cathode materials
  - usage of toxic substances (e.g. N-Methyl-2-pyrrolidone NMP)
  - high energy and space requirements of the drying process
  - solvent recovery necessary
- Dry transfer electrode coating – DRYtraec®
  - Proprietary solvent-free electrode coating process
  - Reduced process costs + low equipment footprint
  - Applicable to LIB and next generation batteries

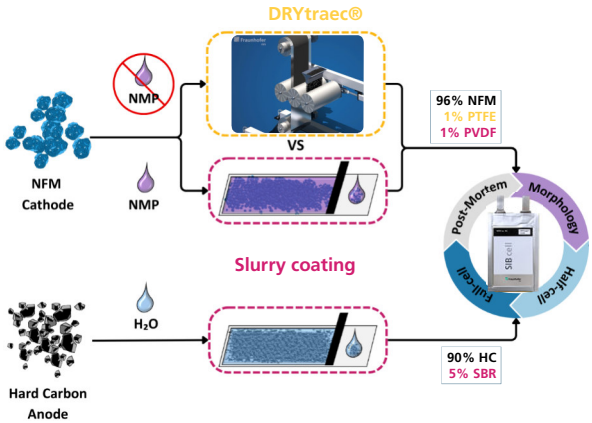


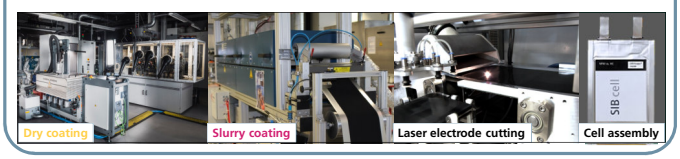
State of the art wet coating and drying line in LIB production

DE102017208220A1; EP3625018B1; KR102416449B1; CN115071025B1; JP2022062188B1; US20210320288A1, US11990599B2

DRY transfer electrode coating at IWS

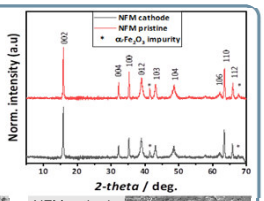
Methods

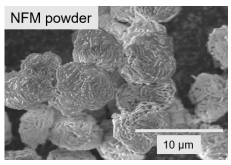


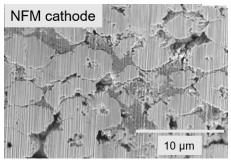


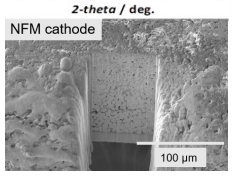
Electrode Morphology

- NFM ($Na_{0.75}[Ni_{0.25}Fe_{0.25}Mn_{0.5}]O_2$) electrode crystal structure and particle morphology is retained during dry-processing





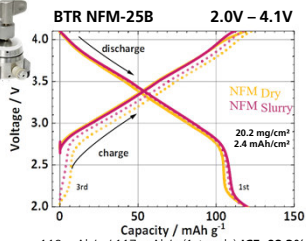




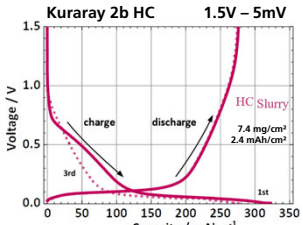
Half-cell (3-electrode)

- determination of the specific capacities and voltage curves in half-cells for balancing and voltage limits of the full-cells

[4]



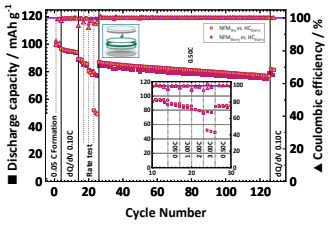
119 mAh/g / 117 mAh/g (1st cycle) **ICE: 98.3%**
117 mAh/g / 115 mAh/g (3rd cycle) **CE: 98.3%**

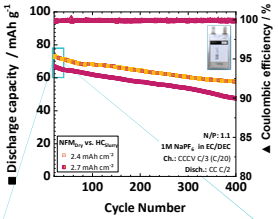


323 mAh/g / 273 mAh/g (1st cycle) **ICE: 84.5%**
277 mAh/g / 274 mAh/g (3rd cycle) **CE: 98.9%**

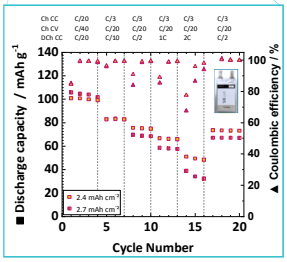
Full-cell characterization

- comparable performance of dry-processed to wet-processed cathode
- influence of electrode loading on rate capability





- at full cell level more then 400 cycles (CE=99.88 %) were demonstrated with a capacity decay of 26% or 23% depending on cathode areal loading.
- a rate capability of up to 2C was achieved



Conclusion

- Demonstration of NFM dry cathode production with loadings in the range of 10.5 – 27.9 mg cm^{-2}
- Stable cycling in single-layer pouch cell over 400 cycles