Karlsruhe Institute of Technology

Institute for Applied Materials
Material Process Technology (IAM-WPT)

IAM Institute for Applied Materials

Importance of processing conditions on cell performance of water-based NMC cathodes

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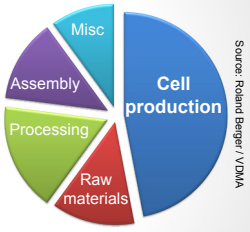
Motivation: Substitution of NMP by water

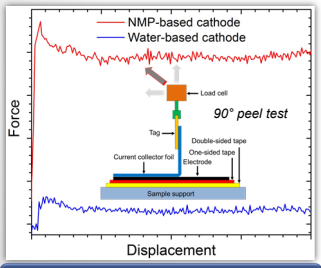
- **NMP (N-Methyl-2-pyrrolidon)** is widely and successfully used as an organic solvent for paste formulations
- **Disadvantages of NMP**:
  - Toxic
  - Irritating
  - Teratogenic
  - Flammable
  - Expensive (30-50 €/l)
  - High efforts & costs for:
    - *Operational safety*
    - *Explosion protection*
    - *Waste management*

Battery costs

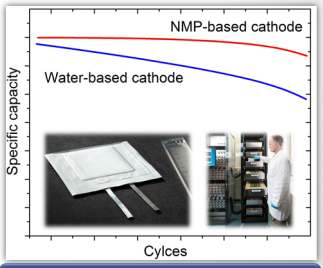


Issues of water-based processing

- Water-based processing as …
  - … state-of-the-art for the mass production of anodes
  - … not expanded yet into the mass production of cathodes
- **Main issues provoking concerns with cathodes:**



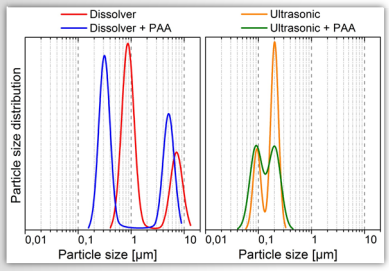
Adhesion of electrodes

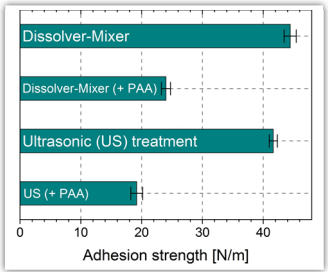


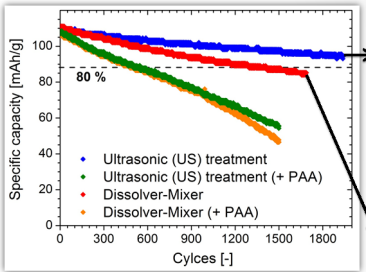
Long-term cell performance

How processing conditions affect the properties and performance of water-based NMC cathodes

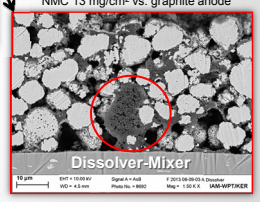
Impact of mixing technique and dispersant on carbon black distribution, electrode adhesion and cell performance





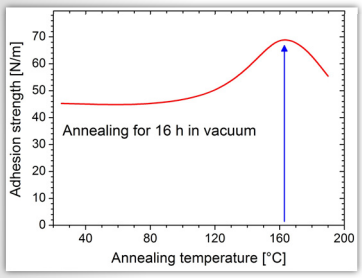


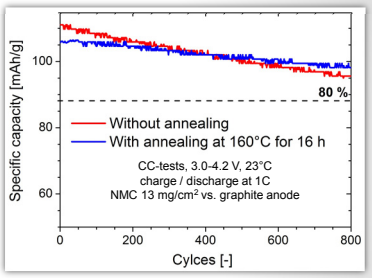
CC-tests, 3.0-4.2 V, 23°C
charge / discharge at 1C
NMC 13 mg/cm² vs. graphite anode



- Ultrasonic treatment results in improved carbon black dispersion
- Additional PAA dispersant results in further enhancement of carbon black dispersion
- Electrodes fabricated via dissolver and US treatment exhibit similar adhesion
- PAA dispersant causes decrease of adhesion
- Enhanced cycling performance due to improved carbon black distribution via US treatment
- Low adhesion strength (+ PAA) results in capacity degradation

Annealing and its influence on adhesion and cell performance





- Increase of adhesion strength by thermal post-processing (annealing) of electrodes
- Annealing results in improved long-term cycling performance of NMC cathodes

Summary & Outlook

- Improved carbon black dispersion by appropriate mixing techniques (e.g. ultrasonic treatment) results in enhanced long-term cell performance
- PAA as dispersant was found to downgrade electrode adhesion and, with it, cell performance
- By annealing of electrodes for 16 h at 160°C (in vacuum) an increase in adhesion strength could be observed that, in turn, enhances the long-term cell performance
- Relation among dispersants and influence on adhesion of electrodes to be studied in detail

KIT – University of the State of Baden-Wuerttemberg and
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