Karlsruhe Institute of Technology

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

Ecology meets economy: Processing of aqueous cathode pastes for lithium nickel manganese cobalt oxide (NMC) batteries

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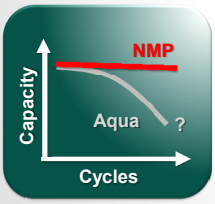
Motivation: Substitution of NMP by water

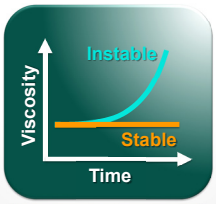
- **NMP (N-Methyl-2-pyrrolidon)** is widely and successfully used as an organic solvent for paste formulations applied for manufacturing of electrodes
- **Disadvantages of NMP**:
  - Toxic
  - Irritating
  - Teratogenic
  - Flammable
  - Expensive (30-50 €/l)
  - High efforts and costs for:
    - *Operational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

Issues of water-based processing

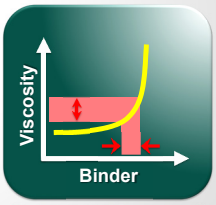
- **Anode electrodes**: Water-based processing as state-of-the-art for industrial fabrication
- **Cathode electrodes**: Water-based processing unusual for industrial fabrication
- **Main issues provoking concerns with cathodes:**



Possible degradation of active materials

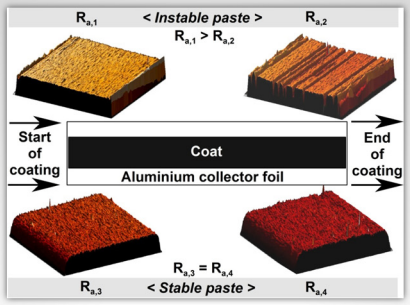


Poor paste stability

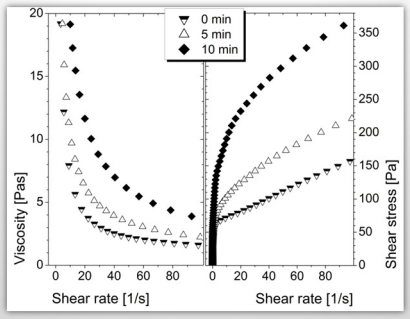


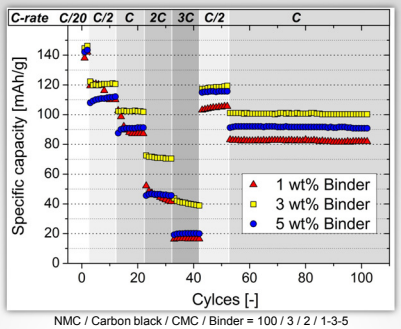
Narrow processing window

Water-based NMC cathodes: challenges and properties



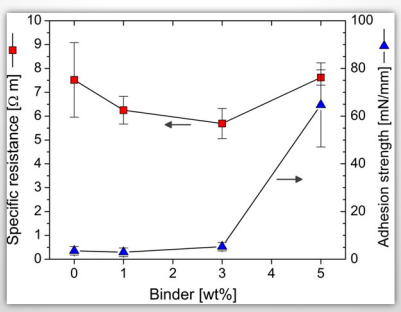
- Inappropriate combination of additives and process parameters may result in **poor paste stability** and **inhomogeneous coatings**
- Paste instability evident by **time-dependent flow behaviour**

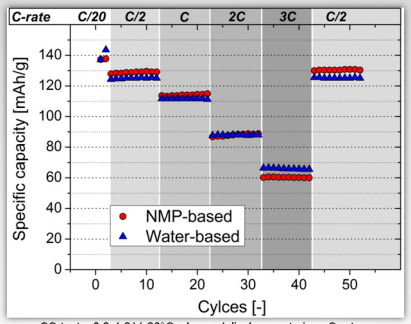




NMC / Carbon black / CMC / Binder = 100 / 3 / 2 / 1-3-5
Toda NM3100 / Super C65 / CRT2000PA / TRD202A

- Best cell performance found to be at addition of **3 wt% latex binder** (JSR Micro TRD202A)
- **Optimization** of adhesion strength required, e.g. by thermal treatment





CC-teste, 3.0-4.2 V, 23°C, charge / discharge at given C-rates
NMC 14 mg/cm², vs graphite anode

Summary & Outlook

- **Water-based NMC cathode pastes** prepared, resulting in cell performance comparable to NMP-based cathodes
- **Paste stability & coating quality** depends on type and amount of inactive additives (e.g. binder)
- **Interaction of NMC with water** to be studied
- **Long-term cell performance** (>> 100 cycles) to be tested

KIT – University of the State of Baden-Wuerttemberg and National Research Center of the Helmholtz Association

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