

The role of inactive materials in the development of water-based pastes for 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 applied for manufacturing of electrodes

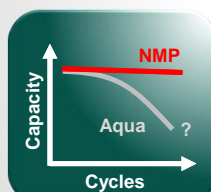
Disadvantages of NMP:

- Toxic
- Irritating
- Teratogenic
- Flammable
- Expensive (30-50 €/l)
- High efforts and costs for:
 - Operational safety
 - Explosion protection
 - Waste management

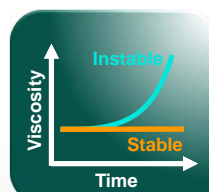


Issues of water-based processing

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



Possible degradation of active materials

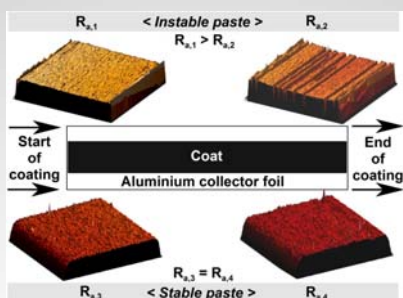


Poor paste stability

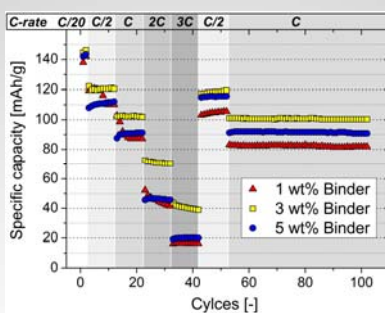
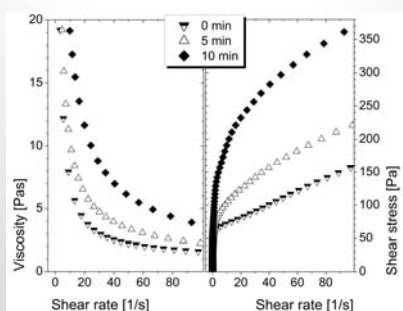


Narrow processing window

Water-based NMC cathodes: Challenges, properties and the role of inactive materials

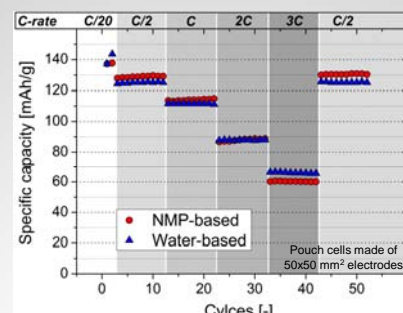
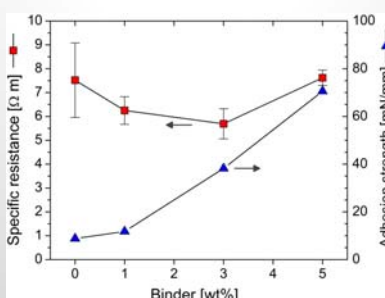


- Inappropriate combination of inactive materials and process parameters may result in **poor paste stability** and **inhomogeneous coatings**
- Paste instability evident by **time-dependent flow behaviour**



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)
- **Improvement** of adhesion strength required, e.g. by thermal treatment



CC-tests, 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 materials (e.g. binder)
- **Interaction of NMC with water** to be studied
- **Long-term cell performance** (>> 100 cycles) to be tested