Zentrum für Sonnenenergie- und Wasserstoff-
Forschung Baden-Württemberg

Solvent-free processing of cathodes for high-energy lithium ion batteries

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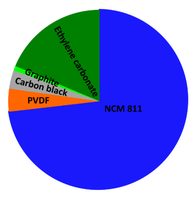
Introduction

Lithium ion batteries (LIBs) have become a pervasive part of our society. With the increasing adaption of LIBs in EVs, interest in more environmentally friendly ways to produce LIBs has risen.
Today, the dominant process for the production of electrodes for LIBs is the solvent-based casting process. For the production of cathodes, the toxic and environmentally harmful solvent N-Methyl-Pyrrolidone (NMP) is generally used. In order to make battery production more environmentally-friendly, new production processes are needed, that don't rely on the use of toxic solvents.
Extrusion is one promising technique to produce electrodes in a continuous, solvent-free process.

Experimental

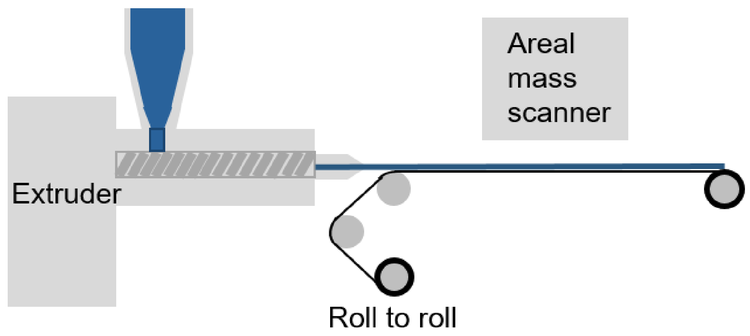
Recipe optimized in measurement kneader



NCM 811:	73,2 %
PVDF:	4,0 %
Carbon black:	3,3 %
Graphite	0,8 %
Ethylene carbonate:	18,7 %

Promising recipe applied on pilot-scale twin-screw extruder

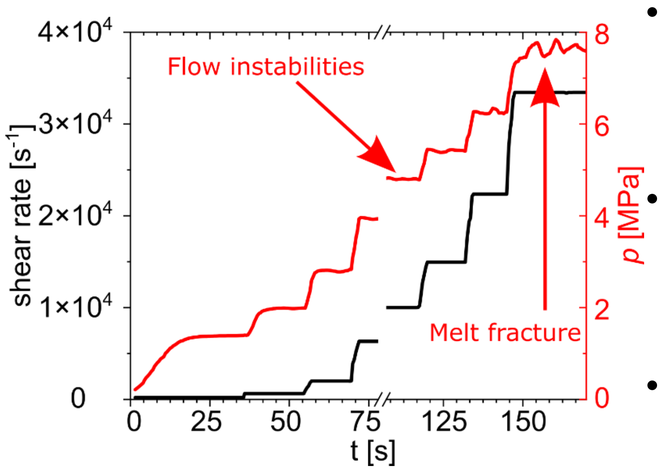
Extrusion and roll-to-roll transfer setup



Rheological properties of extrudate investigated in capillary rheometer

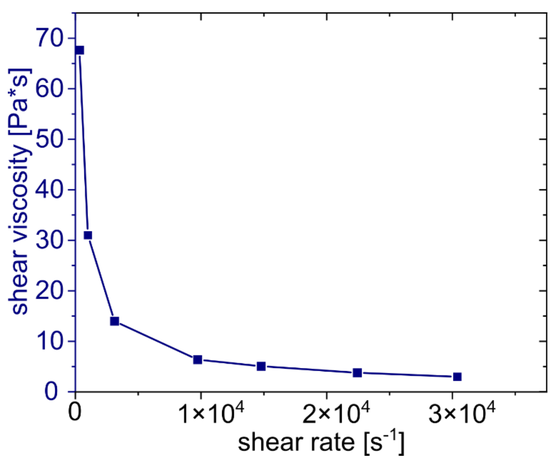
Results: Rheological properties of extrudate

- Rheological behaviour was measured at different shear rates from 200 s^{-1} to 30000 s^{-1}



- Flow instabilities can be identified by pressure variations
- Flow instabilities start at shear rates of approximately 15000 s^{-1}
- Melt fracture starts at 30000 s^{-1}

→ Optimal processing conditions below 15000 s^{-1}

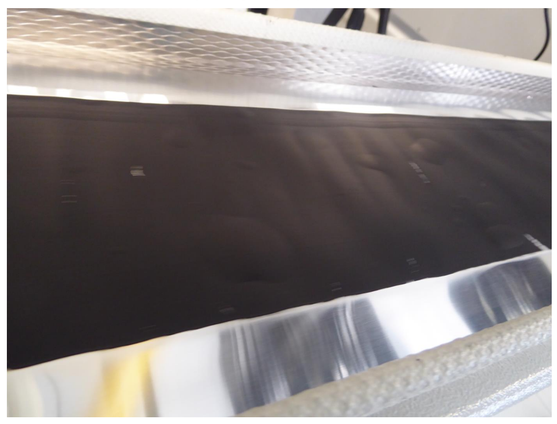


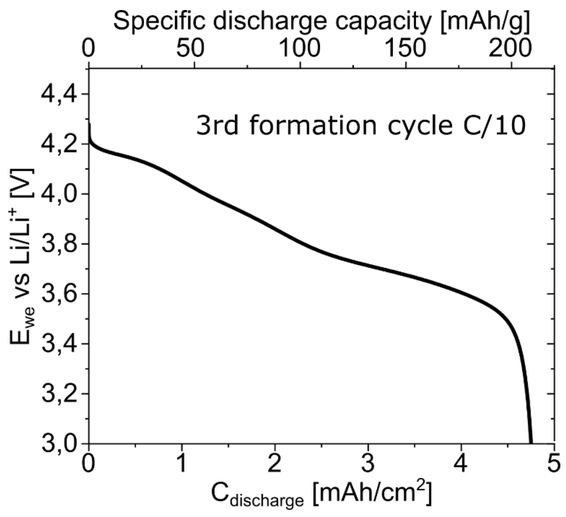
- Viscosity curve shows shear thinning behaviour

→ Suitable behaviour for coating through slot die

Results: Electrode

Final electrode





- Ethylene carbonate was removed for calandering step
- Electrodes were calandered to a thickness of 3.2-3.3 g/cm^3
- 90% active material in composite
- Electrode was calandered with a pressure of 50 N/mm
- Adhesion test shows an good adhesion of 1,92 +/- 0,24 N/mm
- Resulting electrodes had high, but useful areal capacities around 5 mAh/cm^2
- First electrochemical results show complete active material utilization

Summary

- Recipe and process for preparation of solvent-free cathodes was successfully elaborated
- Processing limitations were determined with a capillary rheometer
- High active material content of 90 wt%
- The resulting films had a high, but useful areal capacity of 5 mAh/cm^2

Acknowledgements

This work was financially supported by the European Union (Project number: 101069528). Views and opinions expressed are however those of the authors and do not necessarily reflect those of the European Union or European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the granting authority can be held responsible for them. We also thank André Ilgen for his help in the execution of the extrusion experiments