Development of electrodes based on sulfurized polyacrylonitrile (SPAN) for Li-S batteries and evaluation in pouch cells

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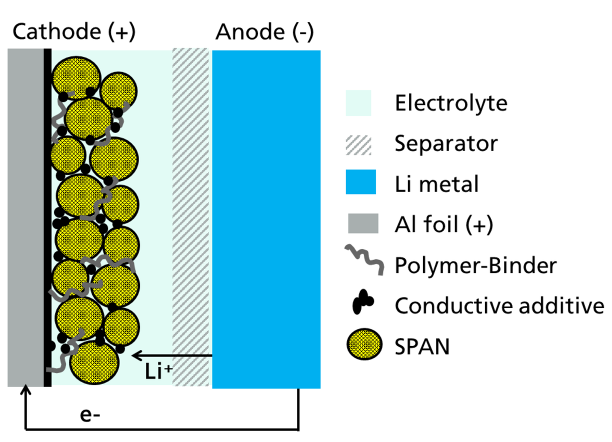
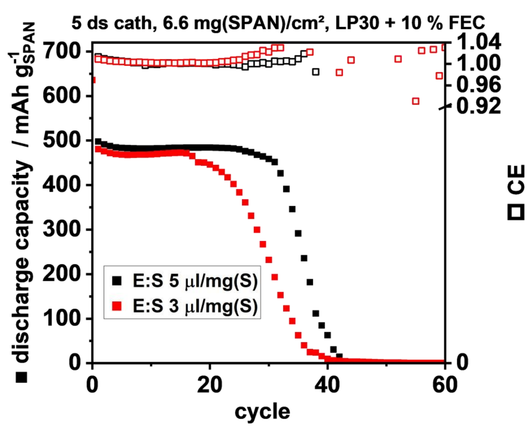
Motivation

- SPAN represents a cathode material with covalently bound sulfur as active species.
- This material concept enables a high specific capacity, but avoids the formation of polysulfides and enhances cathode conversion kinetics and reversibility.



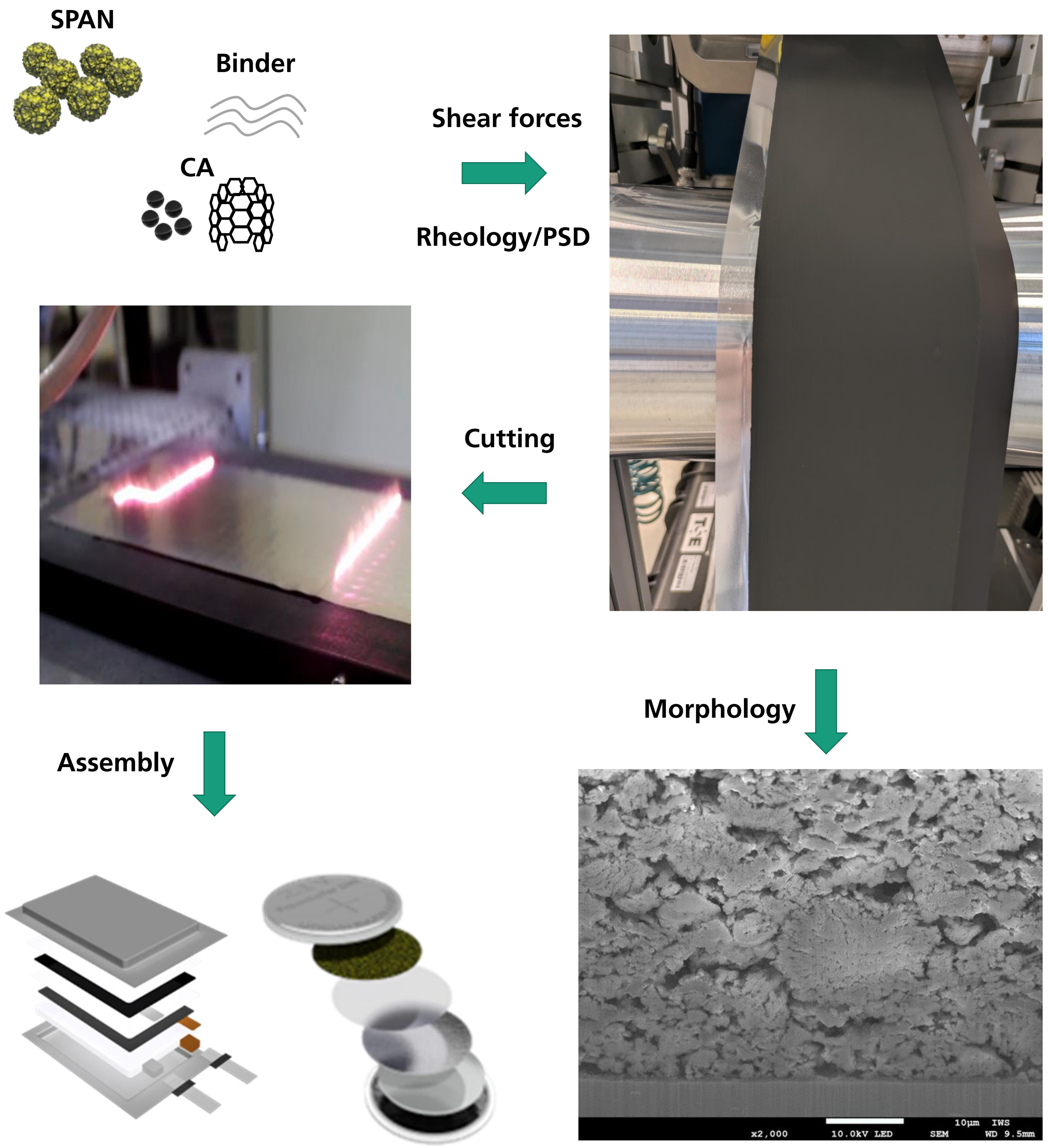
Challenges

- Utilizing SPAN in high performance battery cells requires specific development of
  - Cathode microstructure, composition and processing
  - Tailored electrolyte development



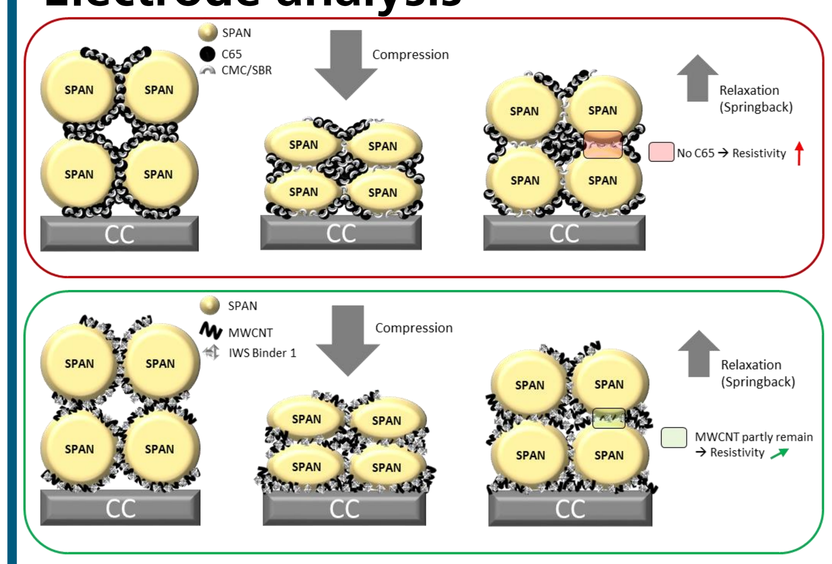
Methods

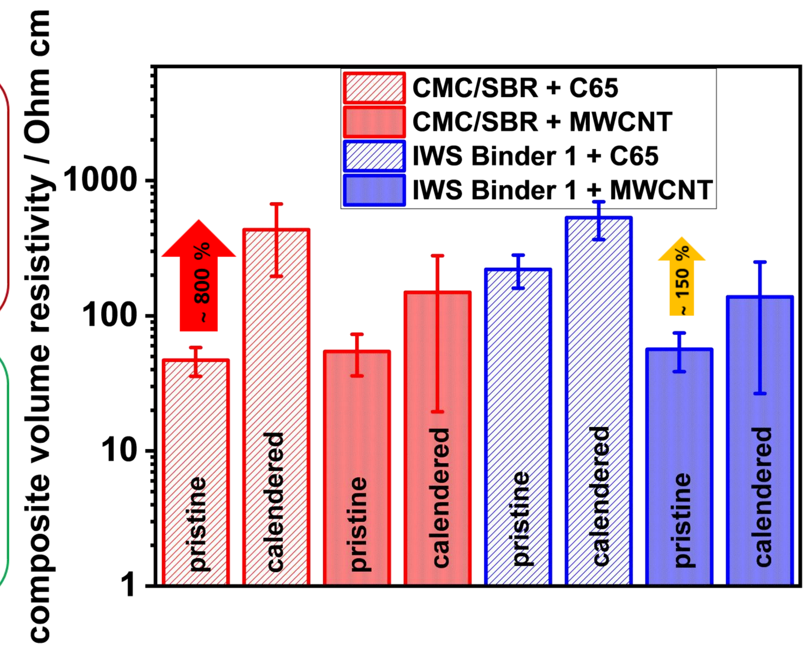
- Industrial produced SPAN as active material
- Water-based suspensions prepared by dissolver
  → Variation of binder system and conductive additive (CA)
- Small scale coating via doctor blade and large scale via comma bar on roll-to-roll device
- Electrochemical analysis on coin cells and multi-layered pouch cells
  → Investigation of new electrolyte systems



Results

Electrode analysis

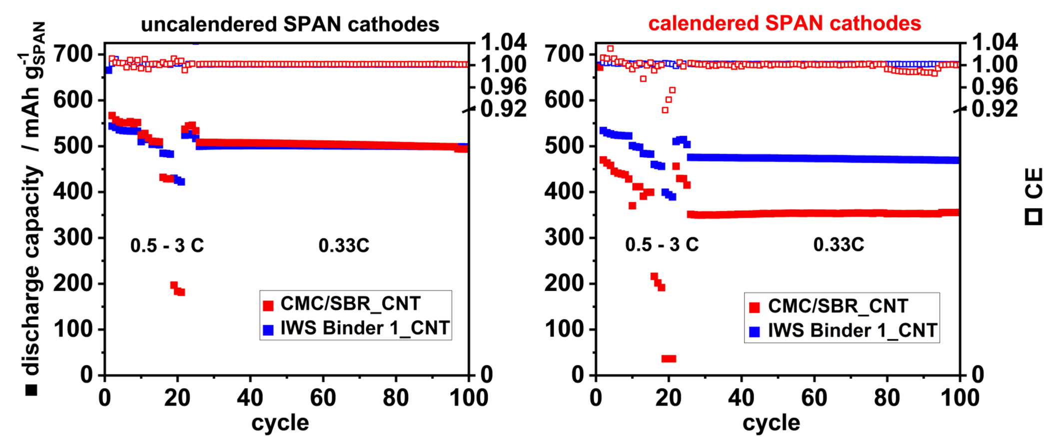




- Springback after calendering
- IWS Binder 1 + MWCNT partly compensate this effect

Coin cell testing – binder and CA adaption

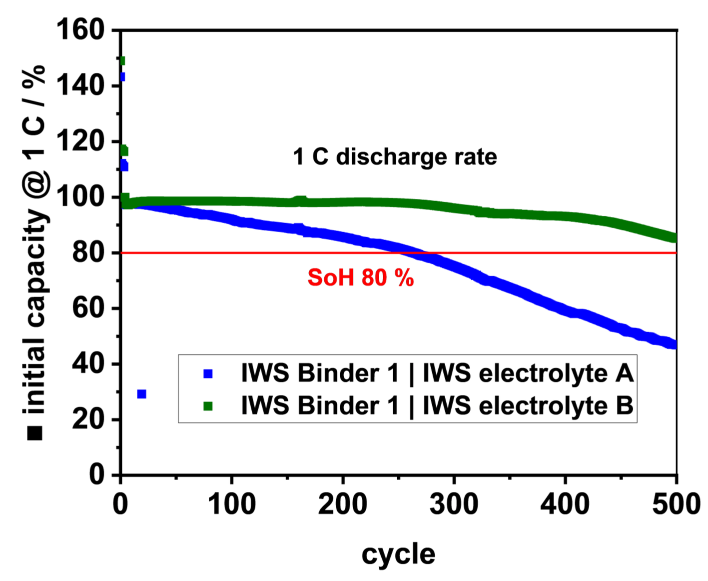
- Coin cells CR2016
- 5.3 mg(SPAN)/cm²
- Theo. Cap.: 530 mAh/g(SPAN)
- IWS electrolyte A
- 1.0 – 3.0 V
- Ch 0.1C + Dch 0.05C / 0.1C / 0.5C / 1C / 2C / 3C
- Dch/Ch 0.33C



- CMC/SBR and IWSA Binder 1 with good active material utilization
  → When C-rate > 1 C, CMC/SBR-system with capacity loss
- After calendering, IWS Binder 1 almost with same performance
  → Less active material utilization observable for CMC/SBR

Pouch cell testing – electrolyte adaption

- 1 Ah pouch cell
- 5.3 mg(SPAN)/cm² (2 mg(S)/cm²)
- Binder 1 + CNT
- E/S. 5 µl/mg(S)
- 50 µm Li
- 1.0 – 3.0 V
- 1 Dch 0.05C/Ch 0.1C; 2-5 Dch 0.1/Ch 0.1C; 6-500 Dch 1.0C/Ch 0.33C



- IWS electrolyte B with > 85% capacity retention after 500 cycles
- IWS electrolyte A with higher capacity but constant loss
  → 85 % of initial capacity reached after 200 cycles

Conclusion

- CNT as conductive additive enables enhanced performance after calendering
- New electrolytes show improvement regarding stability

High performance Li-SPAN cells with extended cycle life (> 500 cycles) and rate capabilities up to 3C were obtained by engineering the cathodes and through electrolyte adaption.

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