Polymer-SSB Recycling – How mechanical processes can be adapted and optimized for efficient recycling

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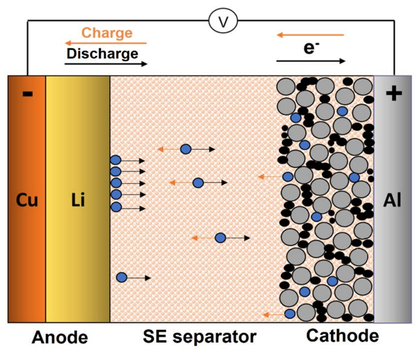
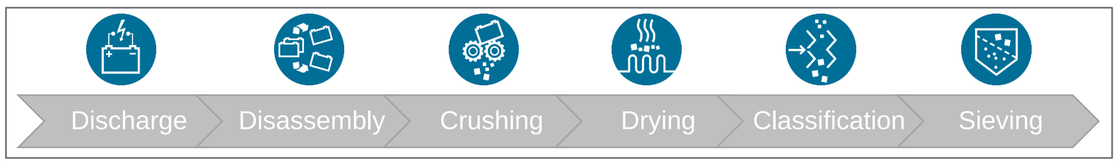
Composition and Relevant Recycling Rates

- Single-layer pouch cells consisting of a lithium anode, a polymer-based separator with a dispersed lithium salt and a composite cathode with LFP as active material
- CEID recommendation and EU proposal on recycling rates only partially affects Polymer-SSB's with LFP as cathode material



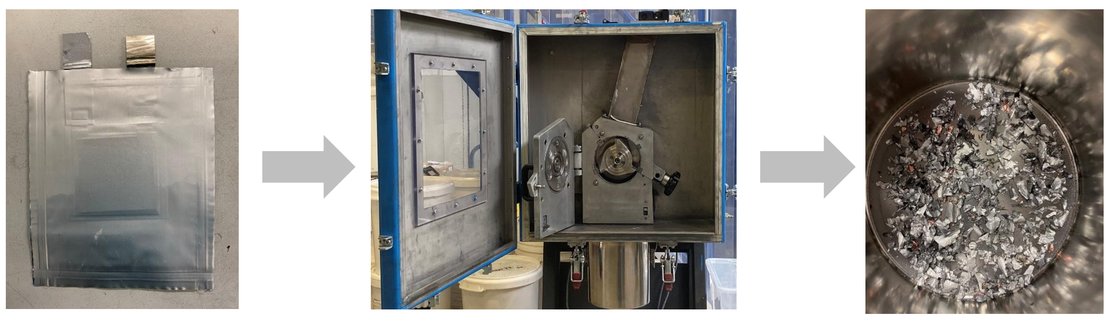
Material	Recovery rates **EU Directive** [1] 2025 [%]	2030 [%]	Relevant for Polymer SSB
Total battery	65	70	✓
Lithium	35	70	
Copper	90	95	
Cobalt	90	95	✗
Nickel	90	95	
Steel	-	-	
Aluminium (without foil)	-	-	

Potential Adaptation of Conventional Mechanical Recycling Processes to Solid State Batteries



- Partially reduced hazard potential and modified requirements because of strongly divergent materials and their properties
- Drying step to remove the liquid electrolyte is not required due to the absence of liquid electrolyte
- Composite cathode increases mechanical separation effort due to higher adhesion and cohesion forces

Crushing of Polymer-SSB Pouch Cells

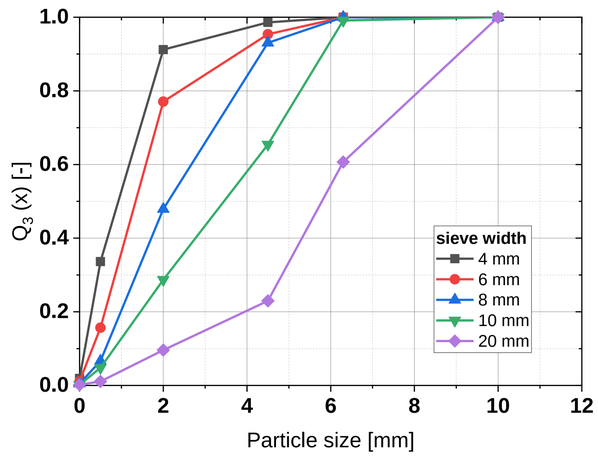


Formation of a foil fraction due to elastic properties of the used polymer
→ No black mass after first crushing

Target: Exposure of the active material and separation of valuable materials in further process steps

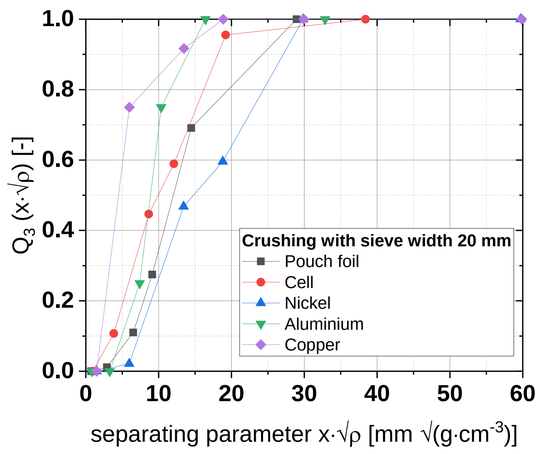
Comminution of Polymer-SSB with cutting mill

- High influence of the pouch foil due to large mass fraction
- Particle size distribution is significantly influenced by the screen width of cutting mill
- Wider particle size distribution with larger screen width
- Small sieve widths lead to increased impurities in the fine fraction (e. g. copper foil)

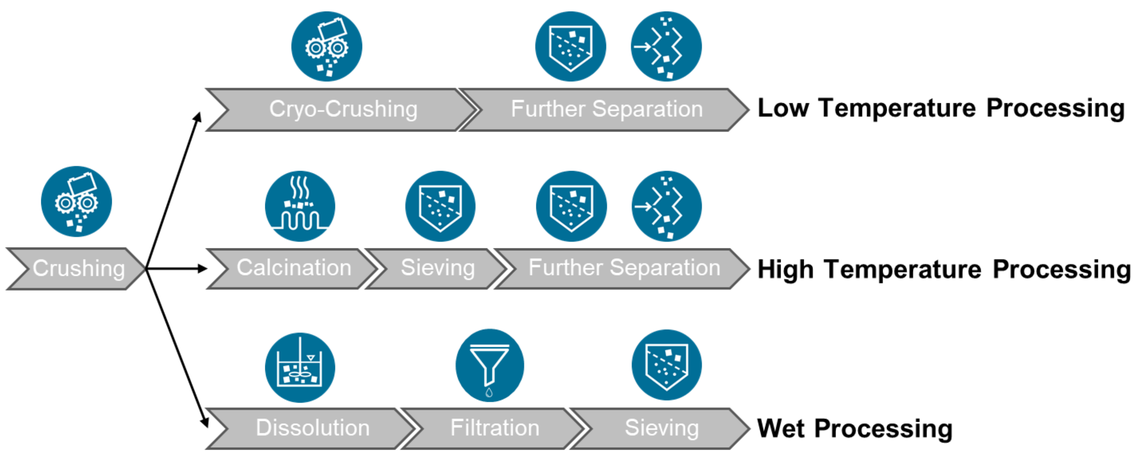


Sieving Analysis of Shredded Polymer-SSB

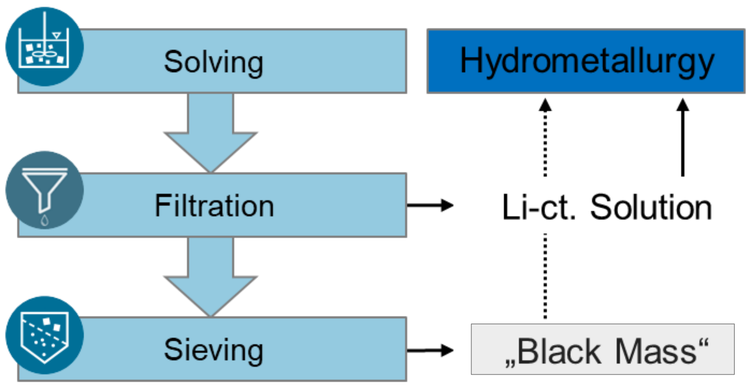
- Separating parameter for estimating the possibility of mechanical separability
- Narrow distribution of the distribution curves indicates impossible separation
- Larger sieve width of cutting mill leads to broader distributions and possibly easier separation



Treatment Options for Shredded Polymer-SSB



Wet Processing



Conclusion

- Low material values of Polymer-SSB and necessary further development of mechanical recycling processes as a challenge for the future
- First Crushing generates film fraction that cannot be separated by mechanical separation processes and must be further processed
- Wet Processing of Polymer solid-state batteries allows recovery of recyclables including lithium to the greatest extent possible

References

[1] Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) No 2019/1020

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