Technische Universität Braunschweig

iPAT Institut für Partikeltechnik

BATTERY LABFACTORY BRAUNSCHWEIG

Densification of cathodes and separators with sulfide-based solid electrolyte for all-solid-state batteries

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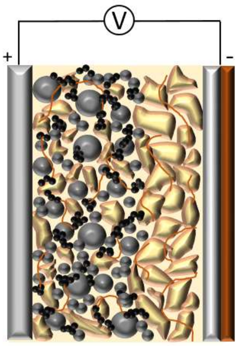
Sulfide solid state batteries

- ✓ High ionic conductivity
- ✓ Higher power density
- ✓ Higher security
- X Scalability has to be evaluated
- X High sensibility to moisture

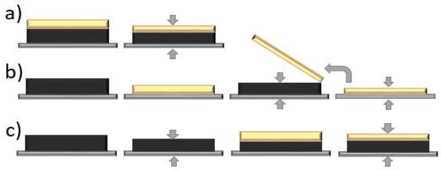


- Conductive additive
- Cathode active material
- Solid electrolyte
- Binder

Densification

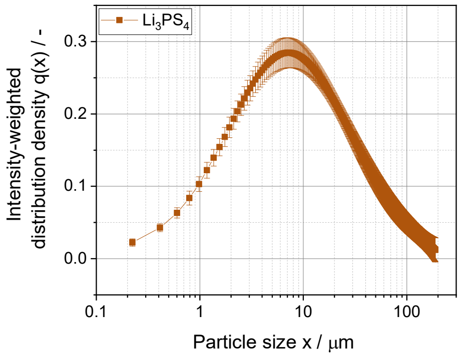
- Increased ionic conductivity with increased densification pressure[1]
- Improved electrical conductivity of the cathode[2]
- Reduction of the porosity
- Densification by a uniaxial lab press is well established especially for powder cells
- Evaluation of calendering has to be driven forward

Densification strategies



- Densification
- Separator
- Cathode
- Current collector

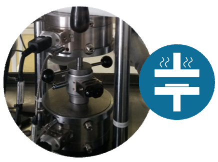
Densification of Li_3PS_4-based separator by a uniaxial lab-press



Wide particle size distribution of the Li_3PS_4 electrolyte

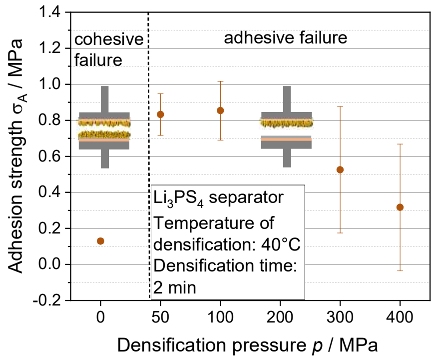
Xylene-based, 30 wt% solids content

Compound	wt%
Li_3PS_4	97
Binder	3

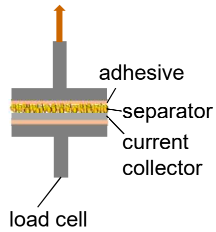


Lab-press with regulated temperature setting in a glovebox

Effect of the densification pressure

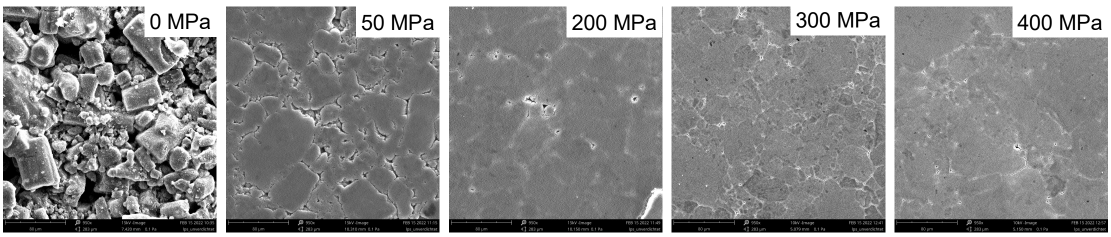


Test procedure[3]



- Initial increase in adhesion strength for compressed separators followed by a decrease with an increment in pressure
- Embrittlement at higher pressure results in high standard derivation

SEM images of the separators

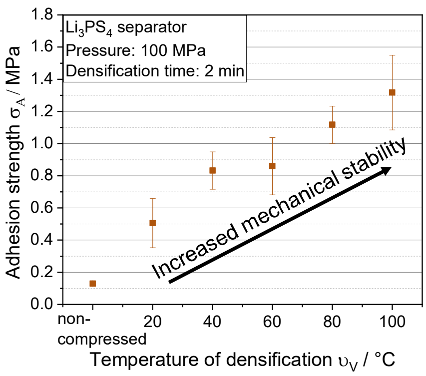


Flaking of the separator

Increased densification pressure → Increased interlocking of particles → Increased embrittlement of separator → Higher risk of short circuit

Effect of the densification temperature

- Increase in adhesion strength with increasing densification temperature
- Improved processability and lower risk of short circuit
- Presumably due to a softening of the sulfidic particles or an effect of the binder



References

[1] Doux et al., J. Mater. Chem. A, 2020, 8. 5049-5055

[2] Chen et al., J. Power Sources, 2010, 195, 2851-2862

[3] Haselrieder et al., Int. J. of Adhes. Adhes., 2015, 60, 1-8

Conclusion

- Li_3PS_4-based separator shows low mechanical stability especially for higher densification pressure
- Higher temperature during the densification by a uniaxial press can improve the stability significantly

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