An Investigation of Constant Pressure Methods and the Impact on Lithium-Ion Pouch Cell Lifetime

Aiden Leonard[a], Brady Planden[a], Katie Lukow[a]

[a]*High Voltage Energy Storage Group, School of Engineering, Computing, and Mathematics, Oxford Brookes University, Oxford, UK, OX4 1FY*

Keywords: Lithium-Ion, Pouch Cell Pressure, Cell Degradation

Lithium-Ion packs that use pouch cells typically apply a stack pressure for improved lifetime and performance. Fixtures are used to mimic this at the cell level, and conventionally prescribe a constant displacement onto the cell. This increases stack pressure, but also causes pressure to vary [1, 2]. Despite this, applying an initial stack pressure improves cell conductivity [2], as well as cell lifetime [1]. This applied stack pressure results in an effective surface area increase, but is limited to the minimal plastic deformation stress of the anode, cathode, or separator. Stack pressure varies during charging and discharging due to elastic swelling, and over time due to anode growth [3]. These variations in pressure over time can cause premature breakdown of the cell materials. More novel fixtures use buffer layers of foam to reduce this effect, but pressure still varies, changing with respect to the compression of the foam [3, 4].

A fixture has been designed that applies a constant pressure to the cell independent of displacement. This prevents pressure variation during charging and discharging, and from permanent swelling that occurs over time. The fixture uses pneumatics to apply a constant stack pressure independent of elastic and plastic swelling, revealing the performance and degradation effects of maintaining uniform pressure. The results of comparing degradation from constant pressure to constant displacement on the cell level could influence pack design in order to minimize degradation and impedance growth.

References

[1] Gert Berckmans et al. "Analysis of the effect of applying external mechanical pressure on next generation silicon alloy lithium-ion cells". In: *Electrochimica Acta* 306 (2019), pp. 387–395. DOI: https://doi.org/10.1016/j.electacta.2019.03.138.

[2] Jean-Marie Doux et al. "Pressure effects on sulfide electrolytes for all solid-state batteries". In: *J. Mater. Chem. A* 8 (10 2020), pp. 5049–5055. DOI: 10.1039/C9TA12889A.

[3] Severin Hahn et al. "Pressure Prediction Modeling and Validation for Lithium-Ion Pouch Cells in Buffered Module Assemblies". In: *Journal of Energy Storage* 40 (2021), p. 102517. DOI: https://doi.org/10.1016/j.est.2021.102517.

30th October, 2021

[4] Yihui Jiang et al. “A stack pressure based equivalent mechanical model of lithium-ion pouch batteries”. In: *Energy* 221 (2021), p. 119804. DOI: https://doi.org/10.1016/j.energy.2021.119804.