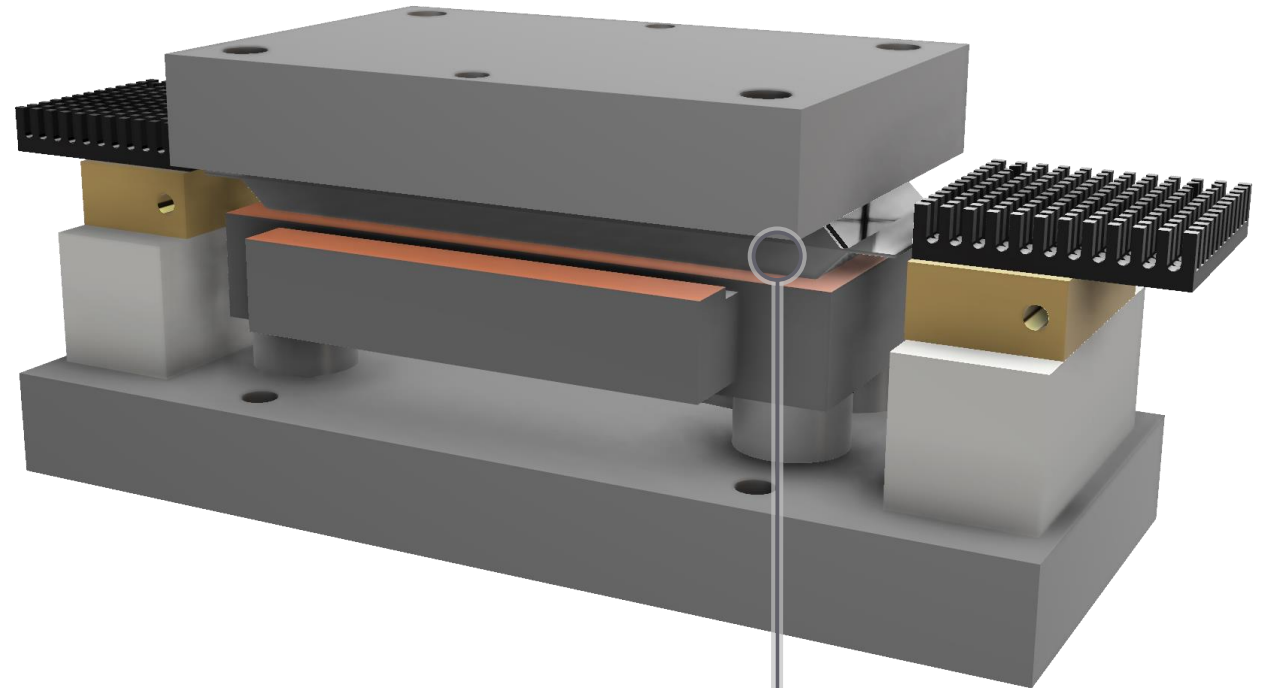


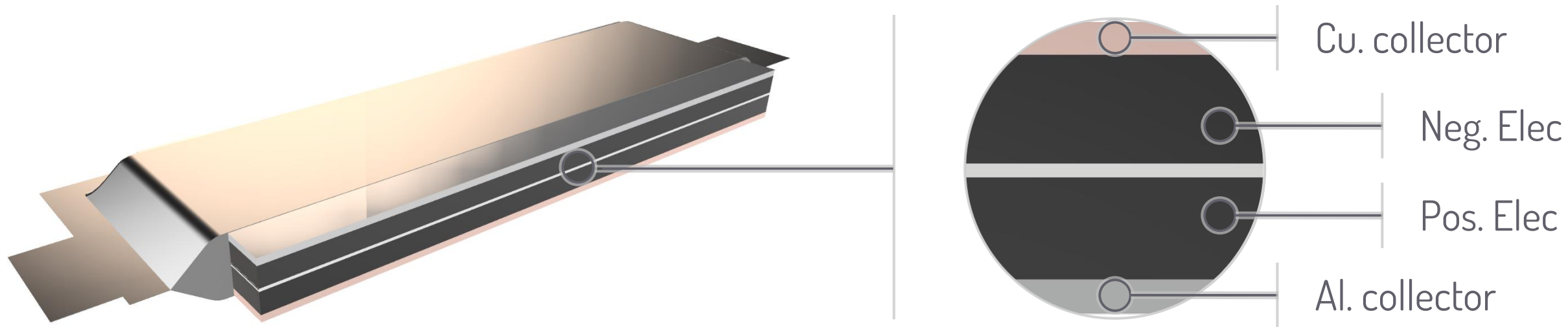
Ian Campbell | Alex Holland | Yan Zhao  
Dr. Yatish Patel | Dr. Greg Offer

# Li-ion Mechanics

**Imperial College**  
London



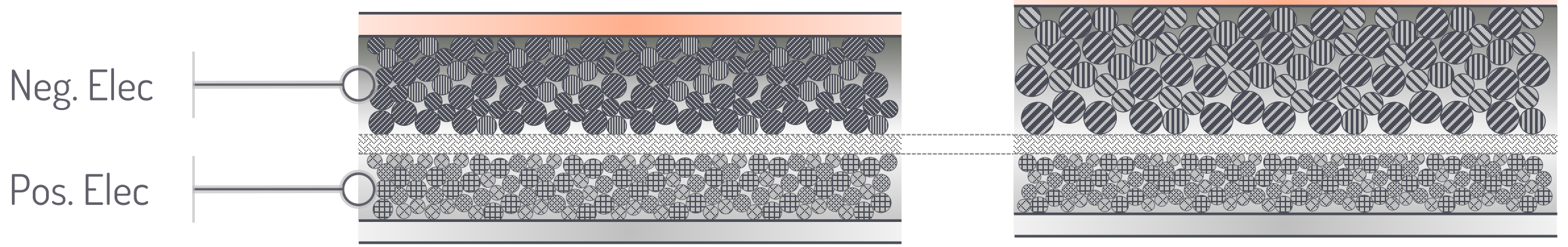
Pouch cell



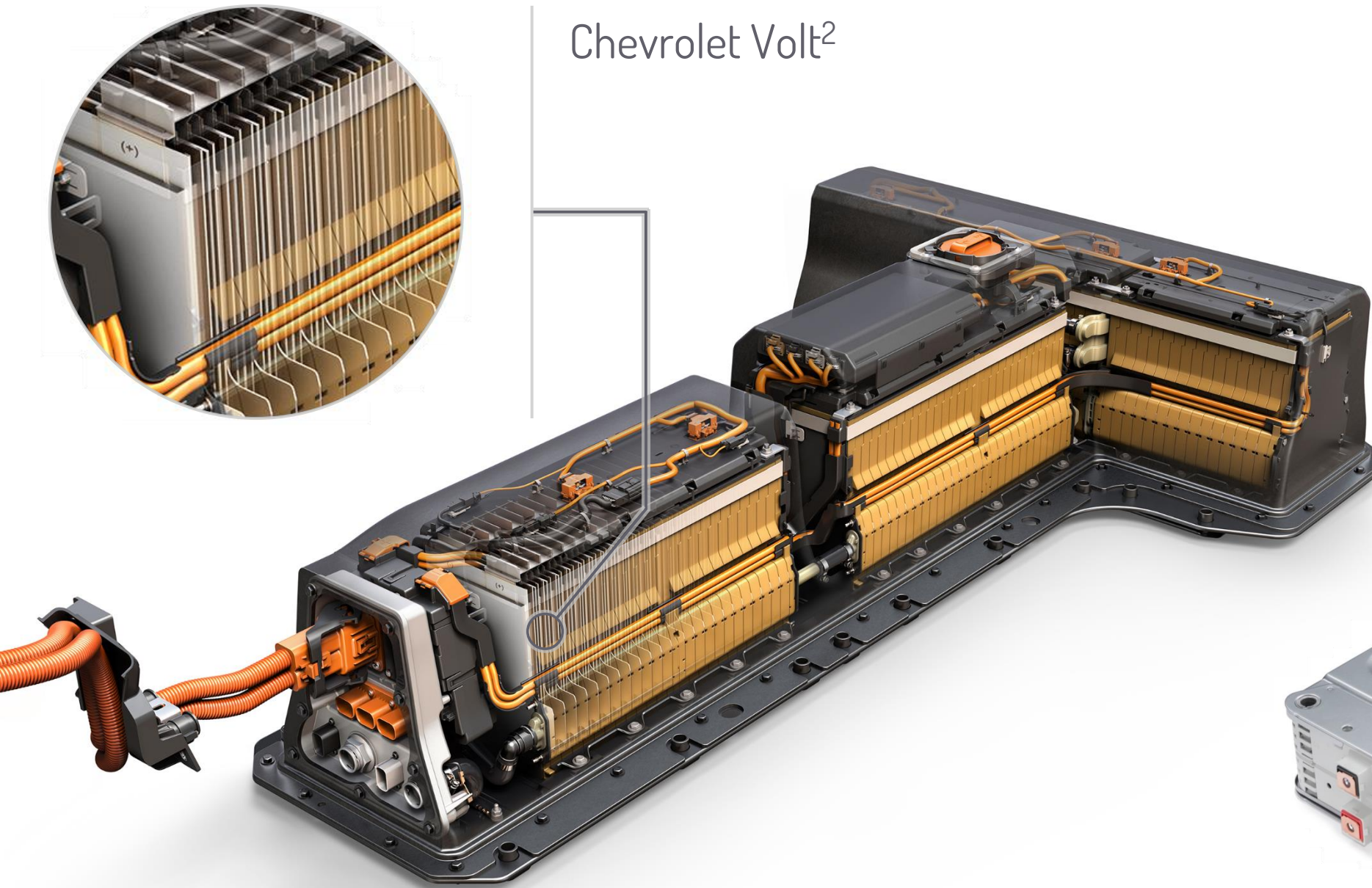
Discharged State



Charged State



Chevrolet Volt<sup>2</sup>



Nissan Leaf<sup>1</sup>



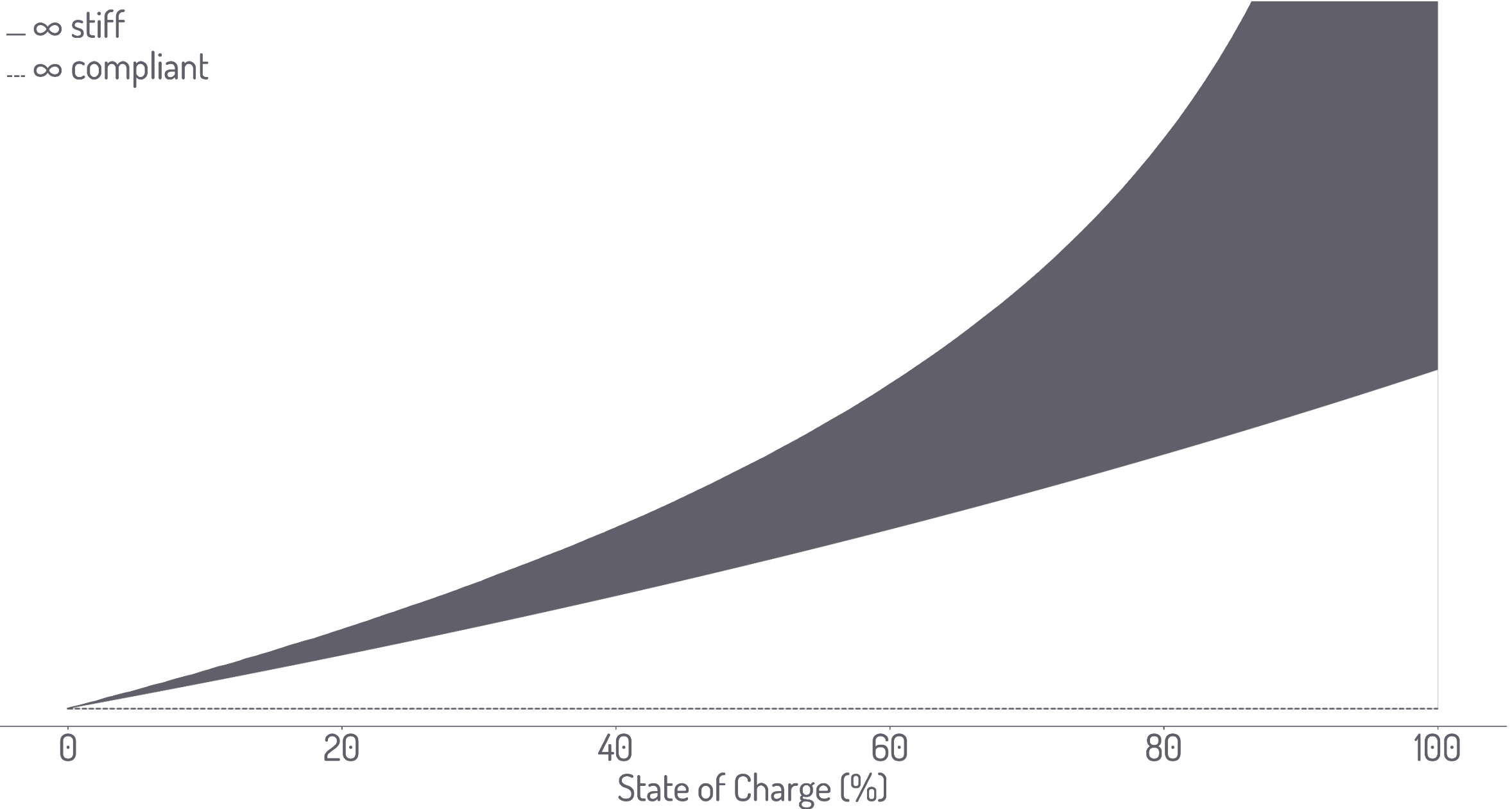
<sup>1</sup> [https://carlypso.com/blog/wp-content/uploads/2017/02/Nissan\\_Leaf\\_Cells.jpg](https://carlypso.com/blog/wp-content/uploads/2017/02/Nissan_Leaf_Cells.jpg)

<sup>2</sup> [https://s1.cdn.autoevolution.com/images/news/gallery/2016-chevrolet-volt-propulsion-system-detailed-video-photo-gallery\\_2.jpg](https://s1.cdn.autoevolution.com/images/news/gallery/2016-chevrolet-volt-propulsion-system-detailed-video-photo-gallery_2.jpg)

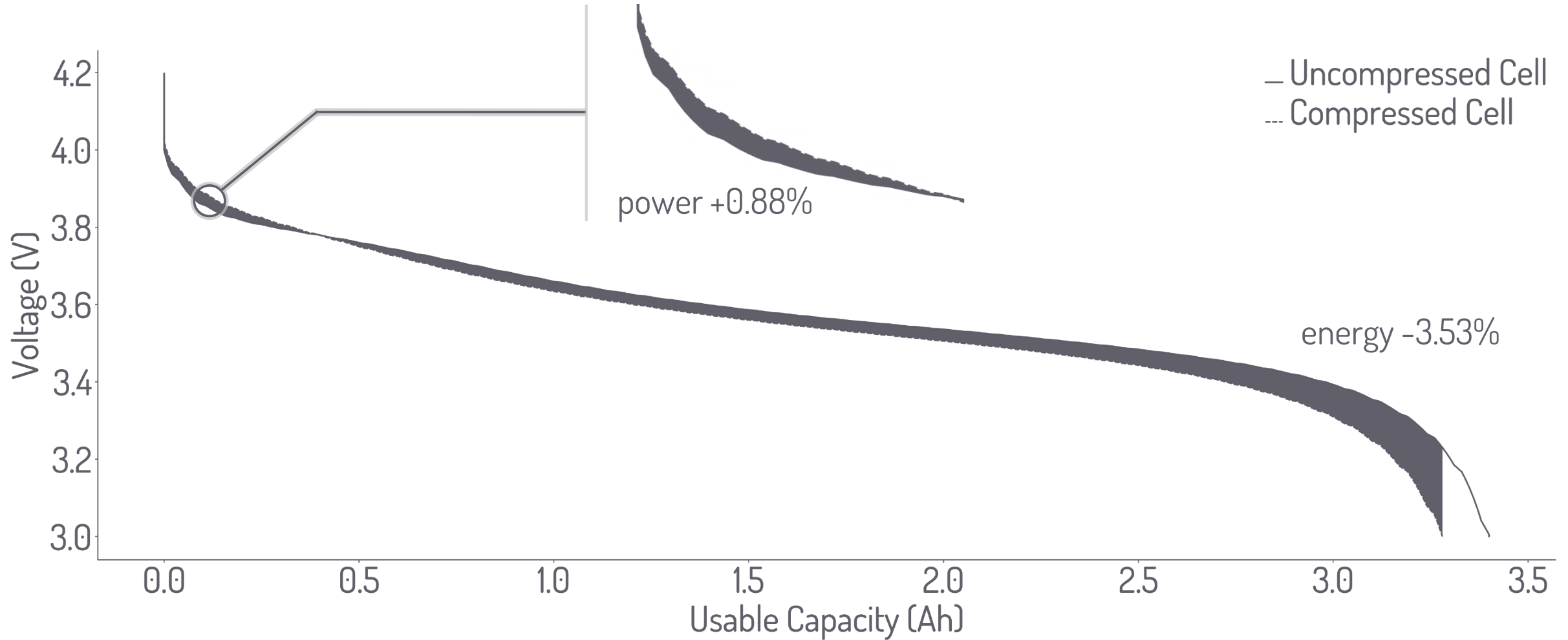
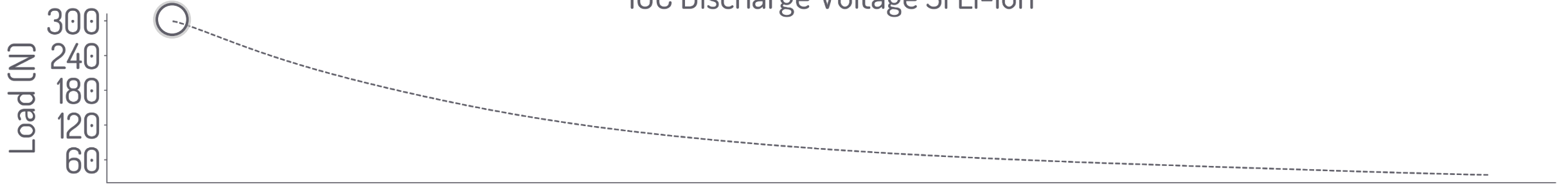
# Electrode Stress

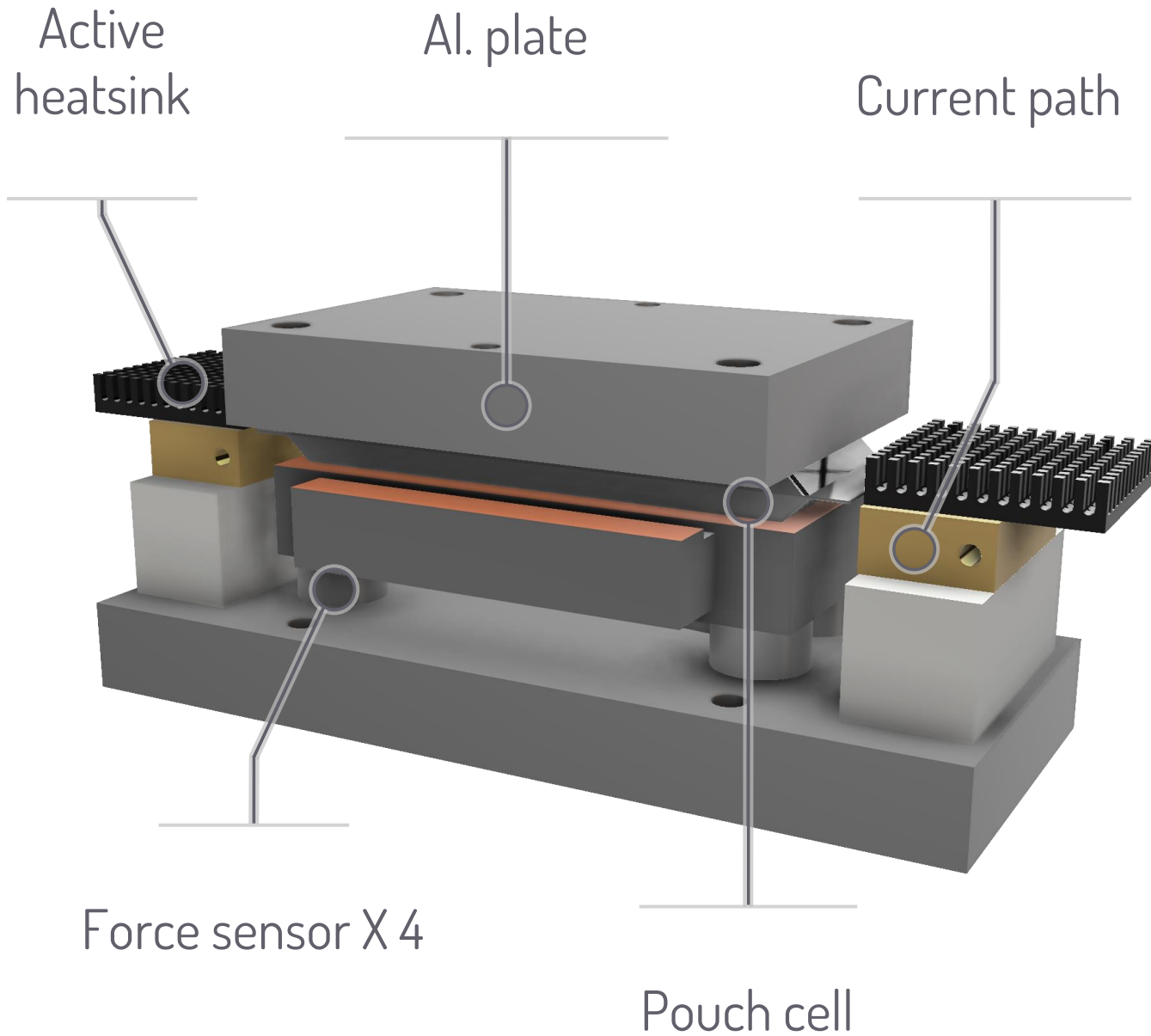
—  $\infty$  stiff  
- - -  $\infty$  compliant

Stress (SOC, BC,  $V_{ratio}$ ) (MPa)



# 10C Discharge Voltage Si Li-ion

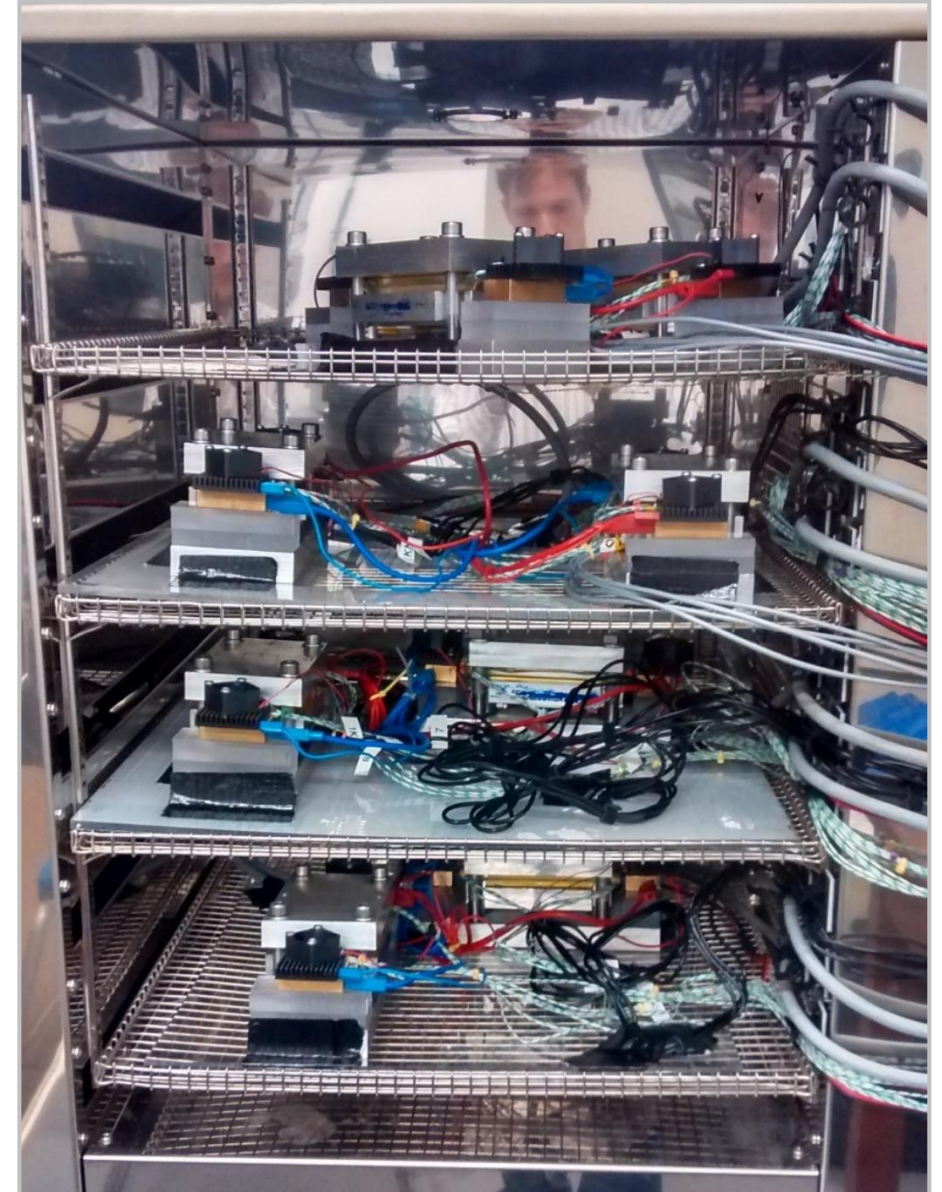
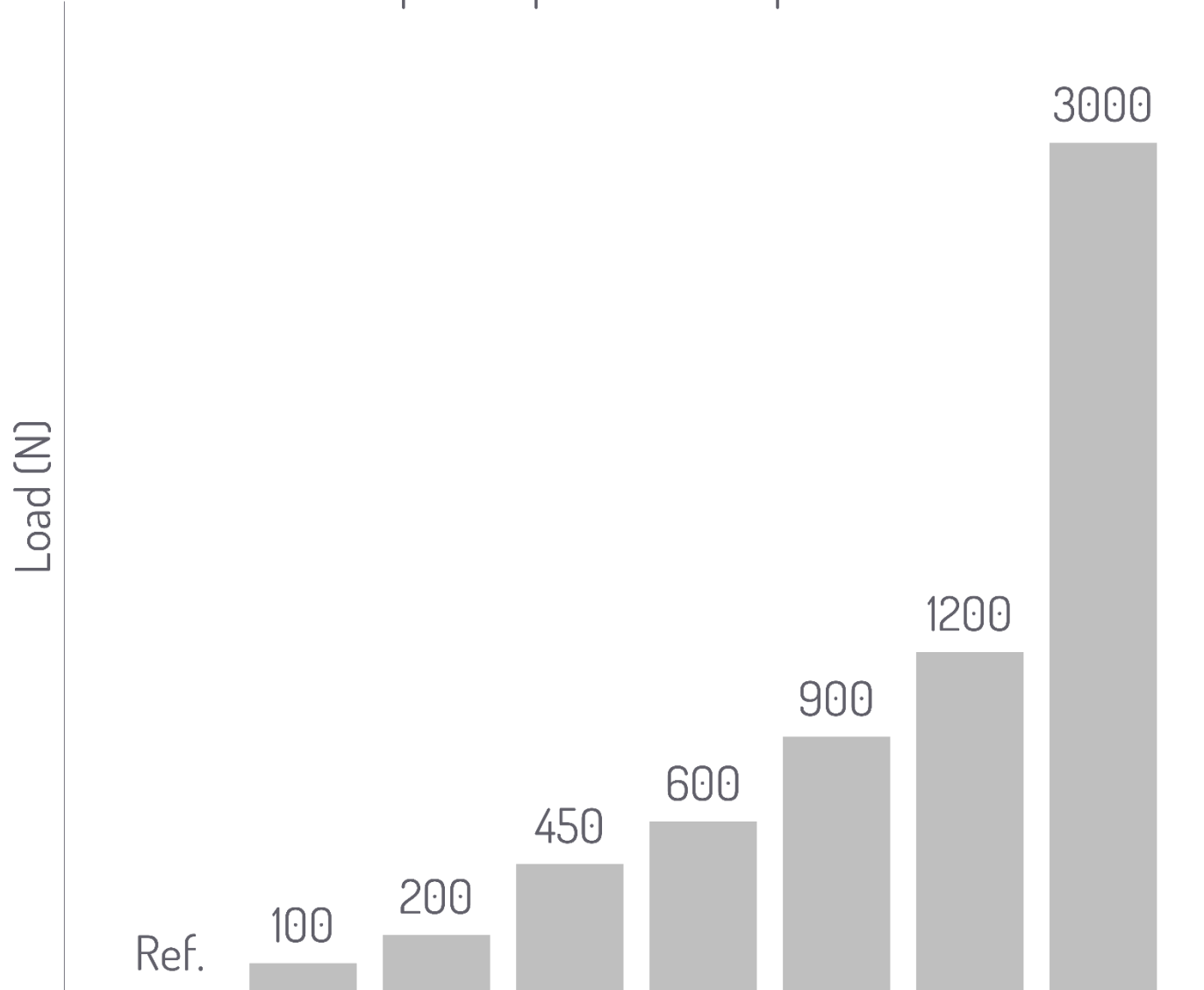




5Ah NMC-graphite  
Uniaxial compression  
7 Loads, 8 cells, 2k cycles  
Force distribution  
2C (10A) at 40°C

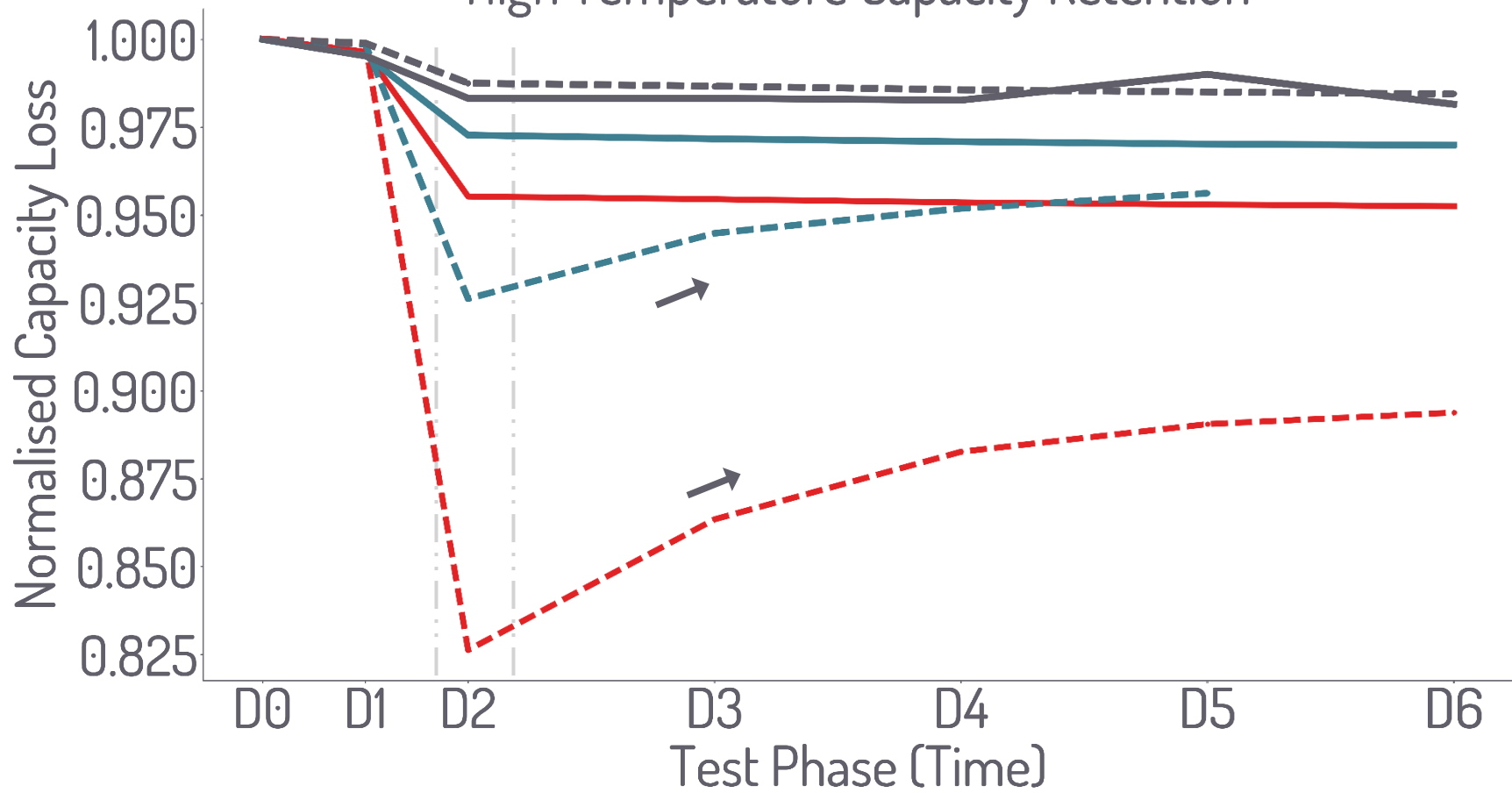


# Search Space: Optimum Compression Level



— Compressed, 80 ° C  
-- Uncompressed, 80 ° C

### High Temperature Capacity Retention



D1 → D2

80°C: -0.07% capacity

90°C: +4.95% capacity

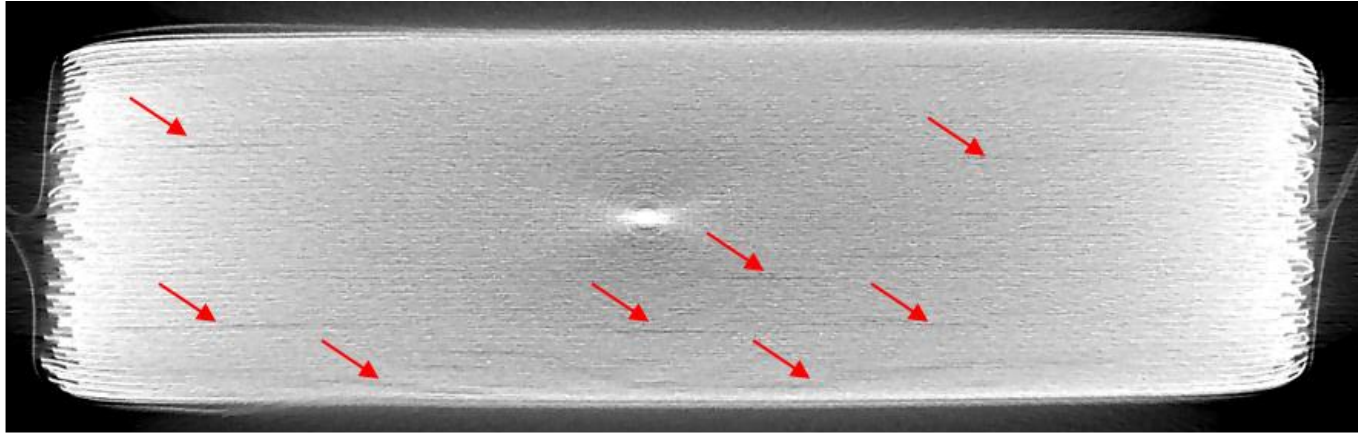
100°C: +13.10% capacity



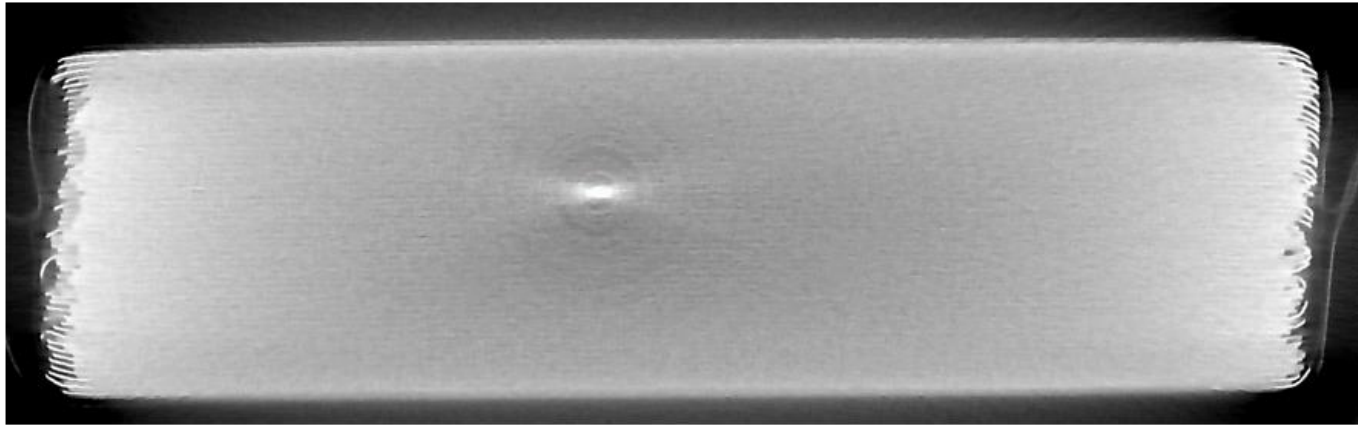
Ah retention

Ah recovery

Uncompressed



Compressed



5mm

Gas evolution & swelling



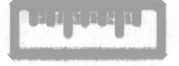
Time

Precipitation

Electrode re-wetting

## Next Steps

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1.  Expandable, degradation-aware electrochemical simulations
2.  Mechanical model coupling & model aggregation
3.  Bridge understanding across scales:  $10^{-6}$  to  $10^{-2}$  metres

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