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COUPLED ELECTRICAL POTENTIAL AND IN_PLANE LOAD RESPONSE IN STRUCTURAL BATTERIES

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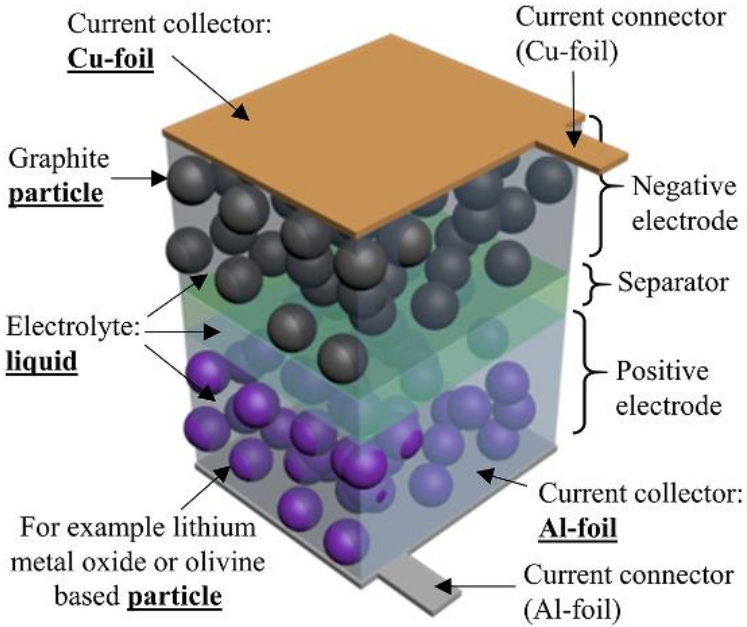
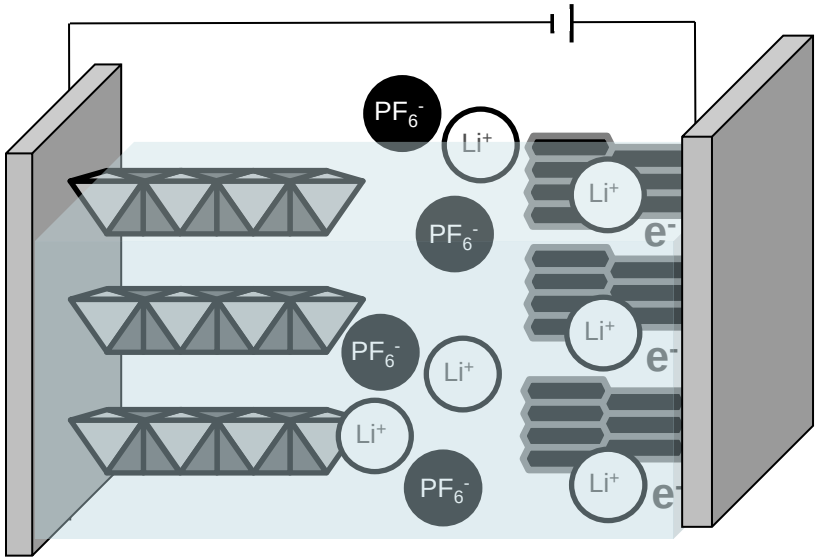
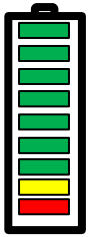
Working principle of a lithium ion battery

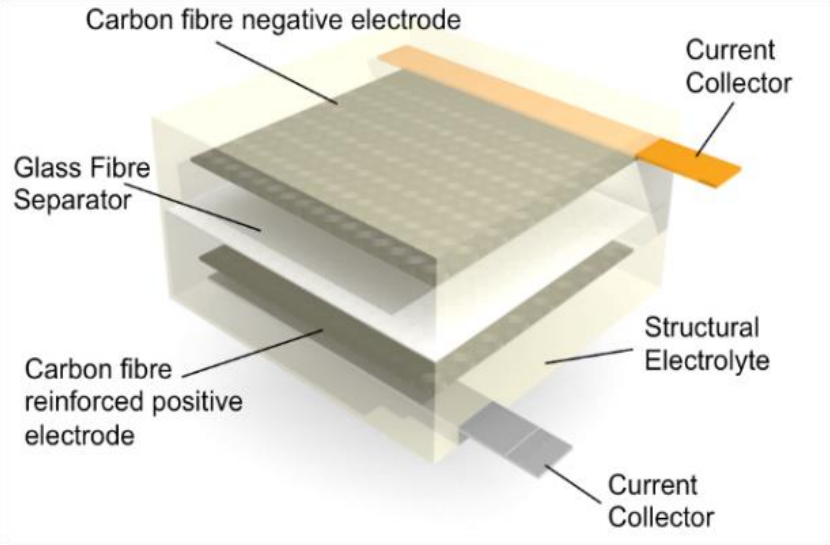


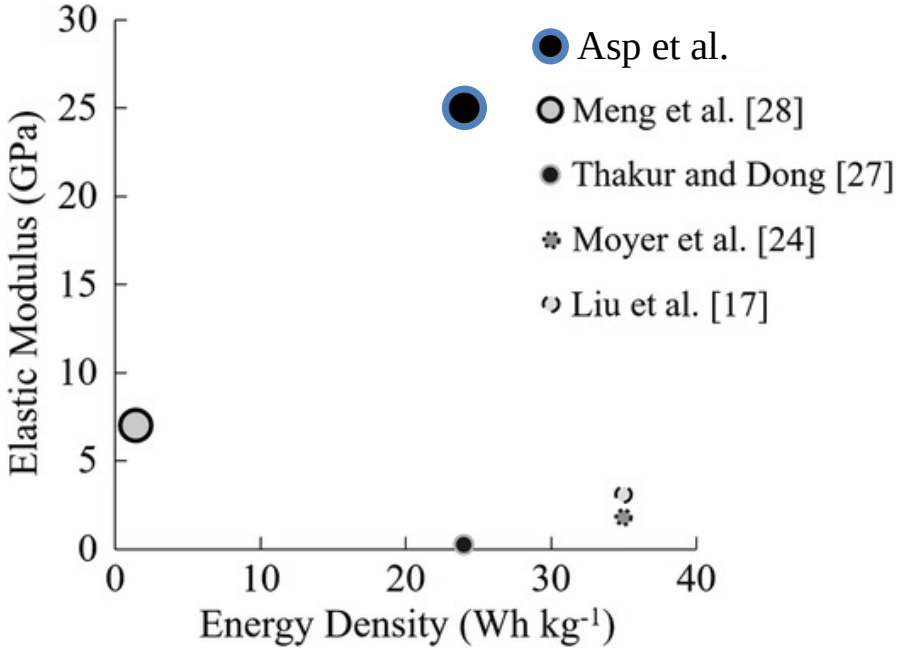




Carlstedt et al., Electro-chemo-mechanically coupled computational modelling of structural batteries, Multifunct. Mater. 3 (2020). doi:10.1088/2399-7532/abc60d.

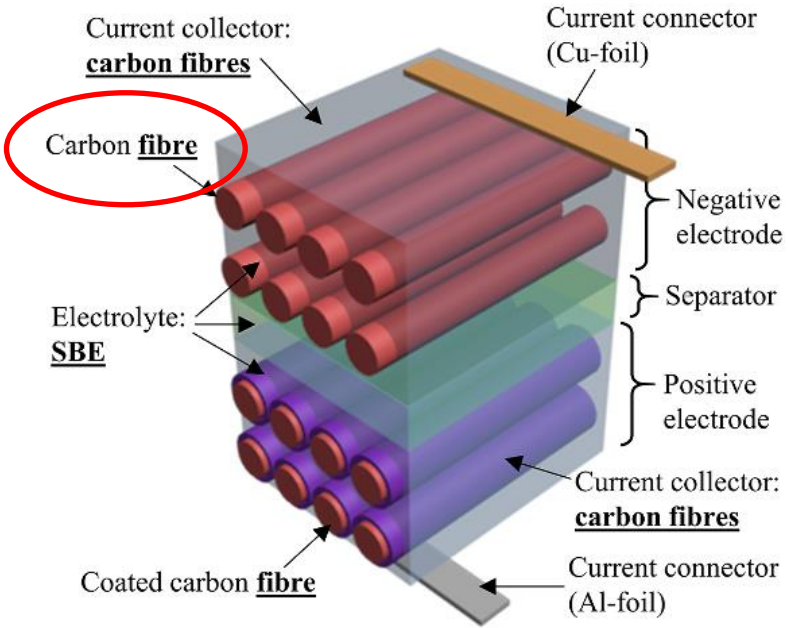
Design, realisation and characterization of structural battery composites

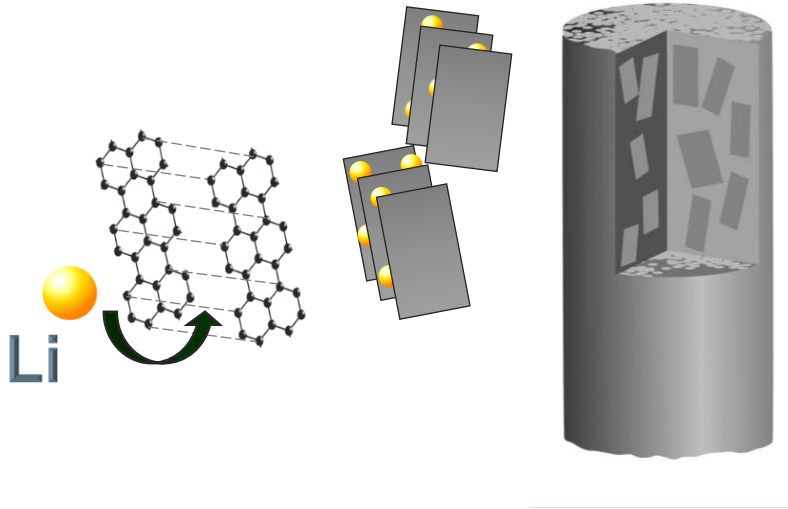




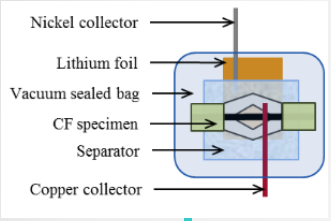
Asp et al., A Structural Battery and its Multifunctional Performance, Adv. Energy Sustain. Res. 2000093 (2021) 2000093. doi:10.1002/aesr.202000093.

Carbon fibres in a structural battery composite

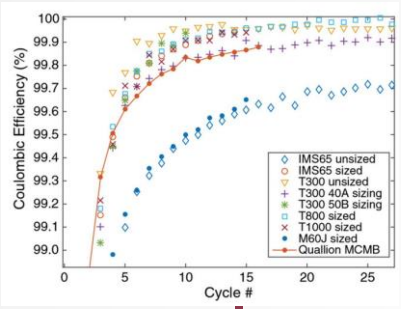




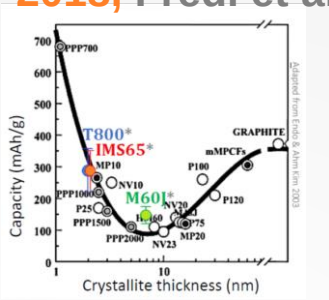
- 2014, KTH



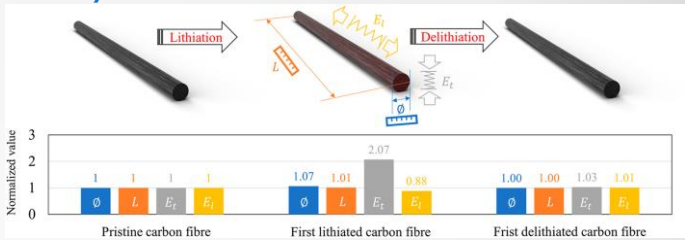
2016, Hagberg et al.



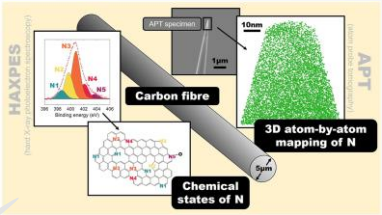
2018, Fredi et al.



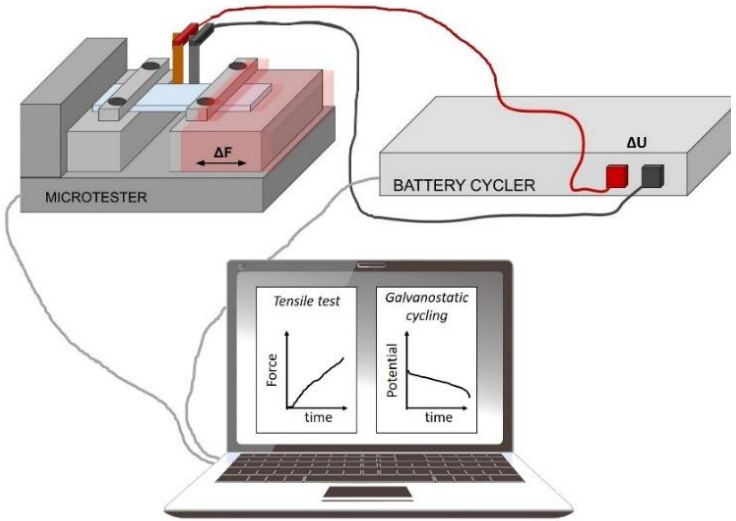
2022, Duan et al.

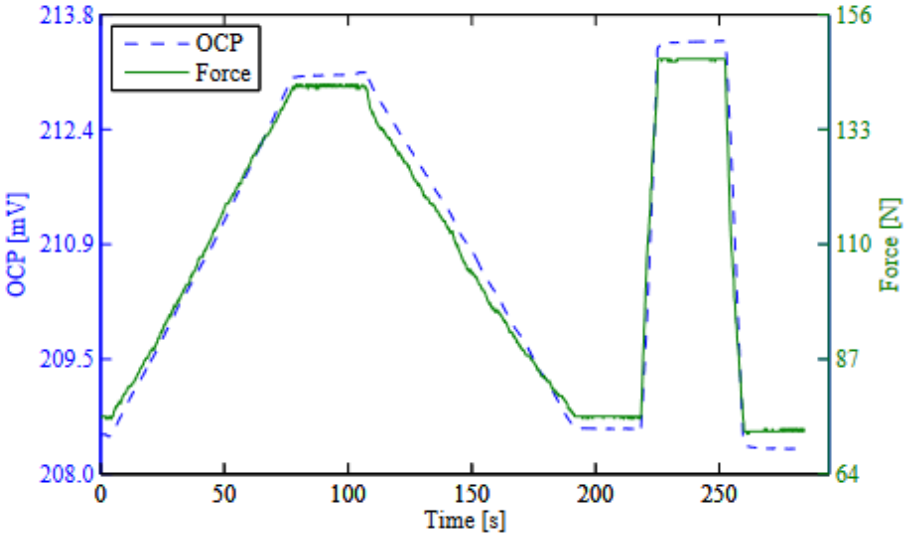


2021, Johansen et al.



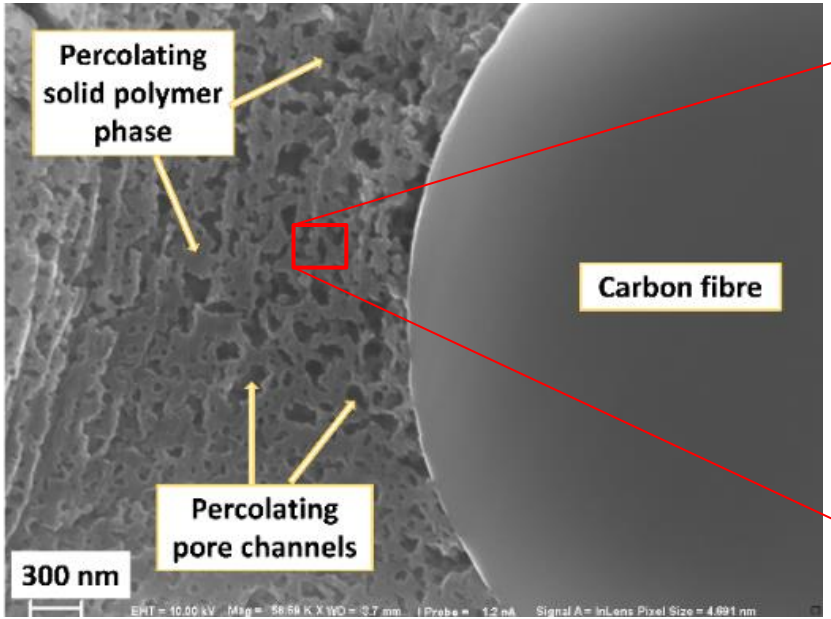
Piezo-electrochemical effect in lithium-intercalated carbon fibres

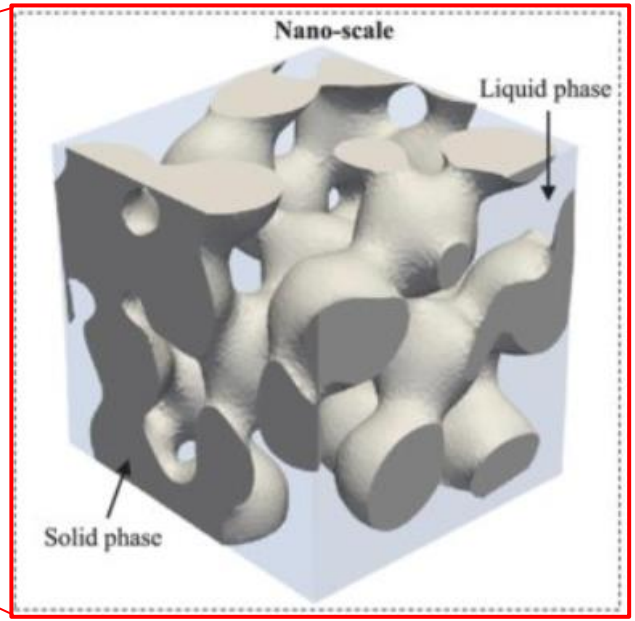




Jacques E. Electrochem. Commun. 35 (2013) 65–67

PECT-effect in structural battery composite negative electrode

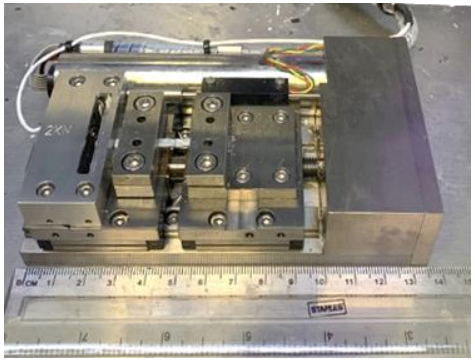




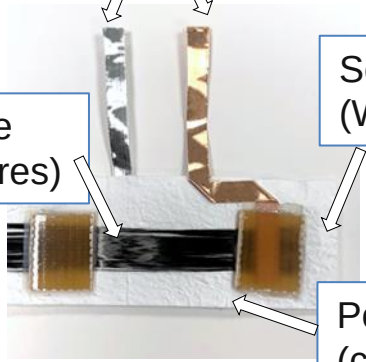
How is the structural battery affected by mechanical loading?

Material and method

Gamry potentiostat

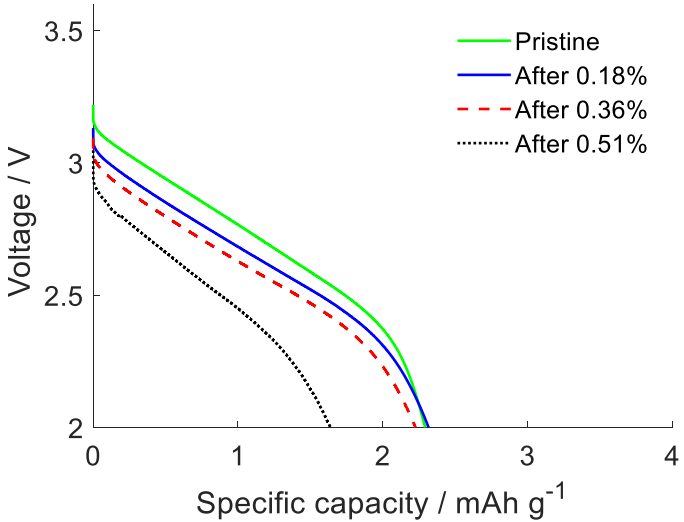


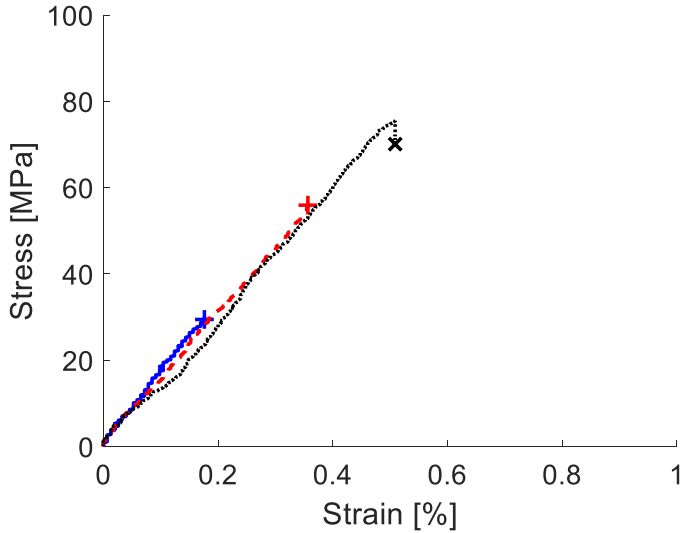
Deben 2kN micro tester



Tabbed specimen

Alternating mechanical and electrochemical loads

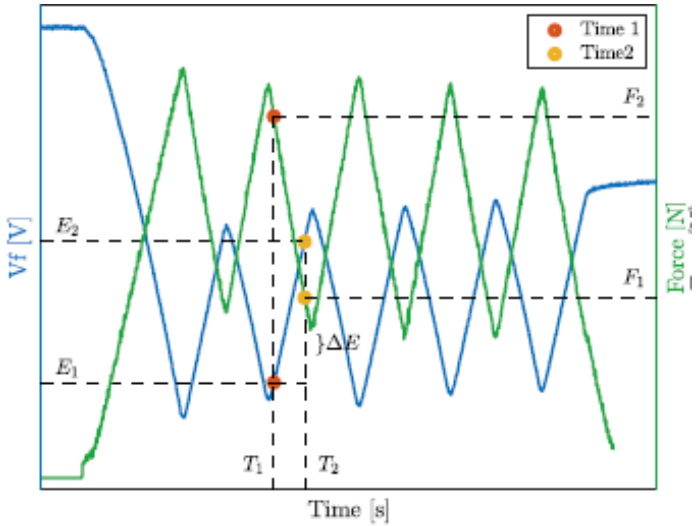




What is the effect on potential from *simultaneous* mechanical loading?

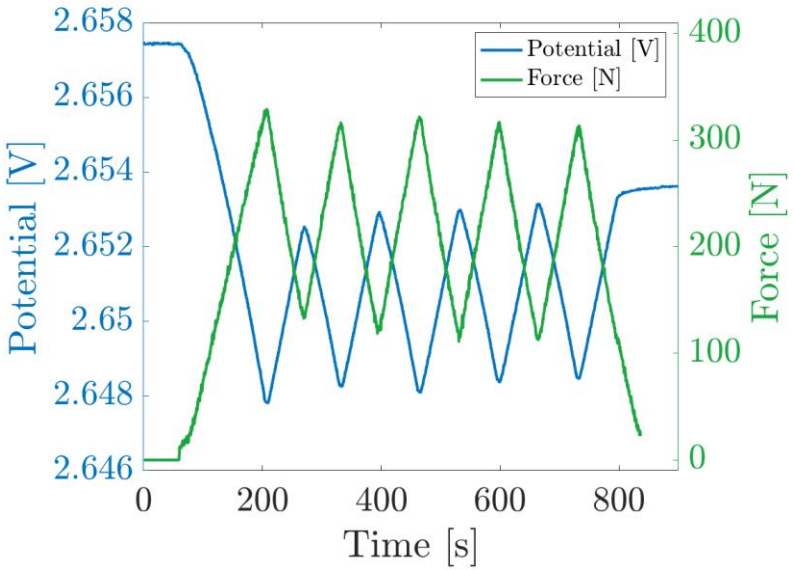
Strain sensitivity in structural batteries
k- coupling factor

$$k = \Delta E / \Delta \varepsilon$$

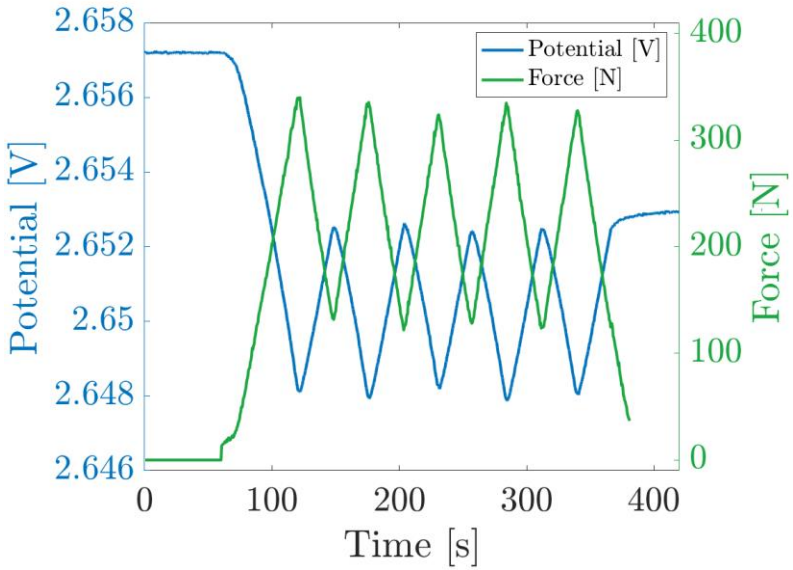


Results
Cell A – discharged

Displacement rate 0.2 mm/min (Strain rate 95 · 10^{-6} s^{-1})

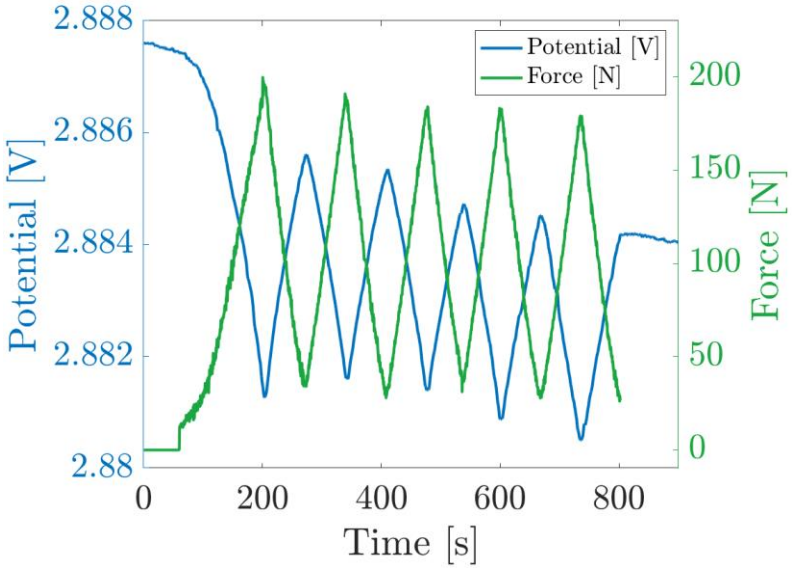


Displacement rate 0.5 mm/min (Strain rate 24 · 10^{-5} s^{-1})

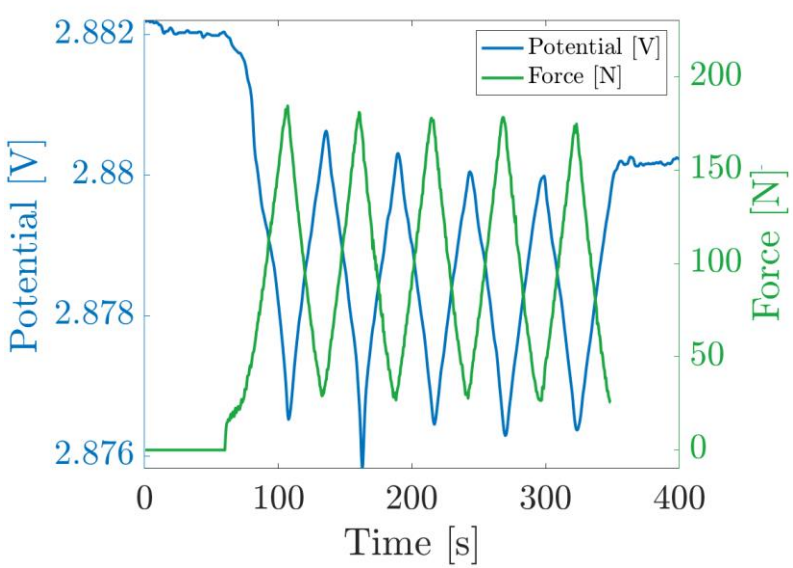


Results
Cell B – fully charged

Displacement rate 0.2 mm/min (Strain rate 95 · 10^{-6} s^{-1})



Displacement rate 0.5 mm/min (Strain rate 24 · 10^{-5} s^{-1})



Results

Coupling factor $k = \Delta E / \Delta \varepsilon$

Cell	State of charge [%]	Displacement rate [mm/min]	Coupling factor [V / unit strain]
A	0	0.2 0.5	0.84 0.82
B	100	0.2 0.5	0.64 0.69

Conclusions

- Establishment of the test method.
- Increase in mechanical load ⇾ decrease in potential
- Linear elastic behavior of the coupling factor

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