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Influence of the Stretching on the Ionic Conductivity of Solid Polymer Electrolyte.

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Introduction

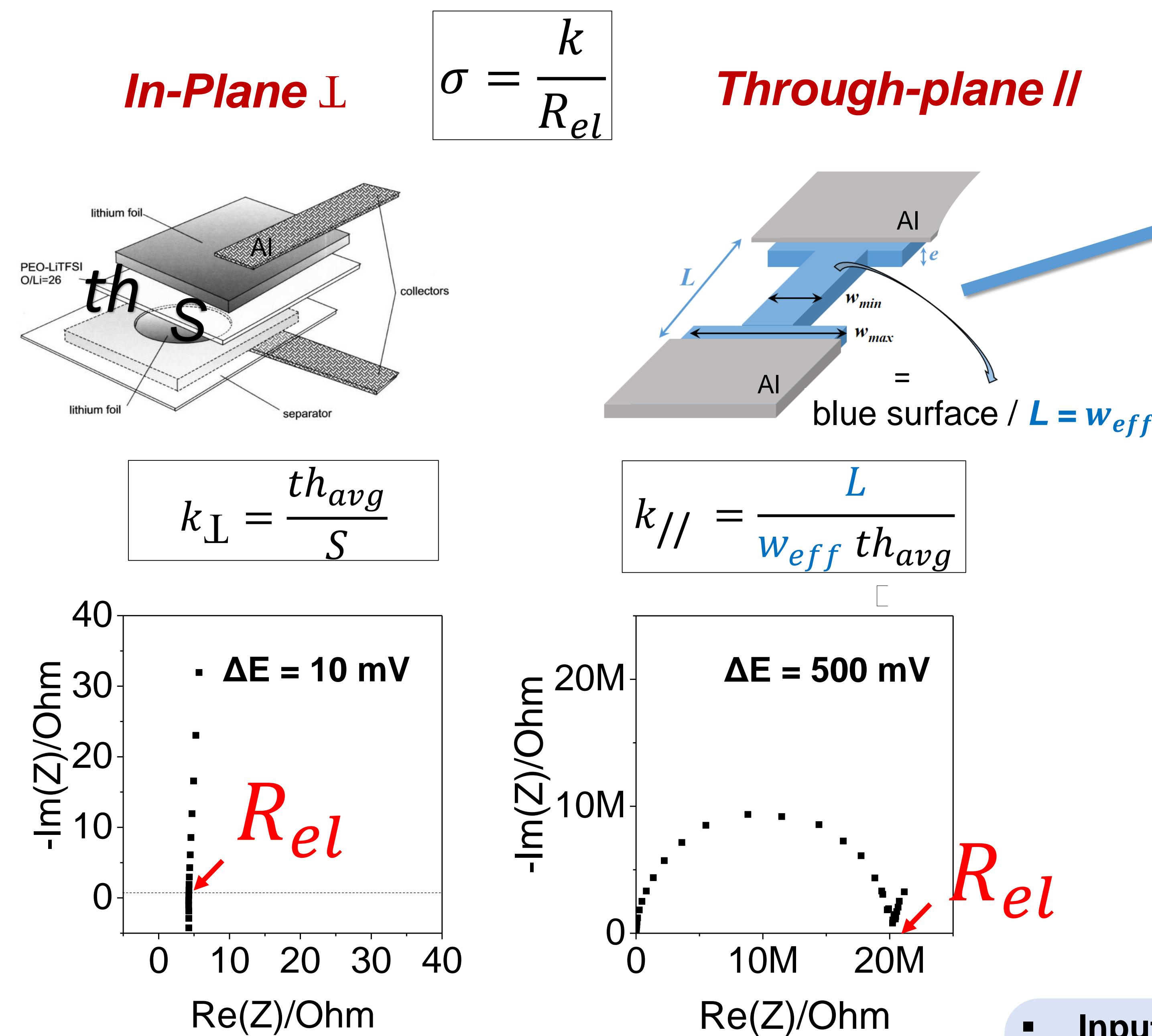
- Context:** Conventional Li-ion batteries can leak and react. [1]. *Solution?* Replace the liquid electrolyte by a non-flammable dry **Solid Polymer Electrolyte (SPE)**.
- Interest:** Flexibility, process easiness, lack of volatile compounds, and chemical and electrochemical stability toward Li metal [2].
- Targeted application:** Room temperature Li battery comprising SPE.

Objectives

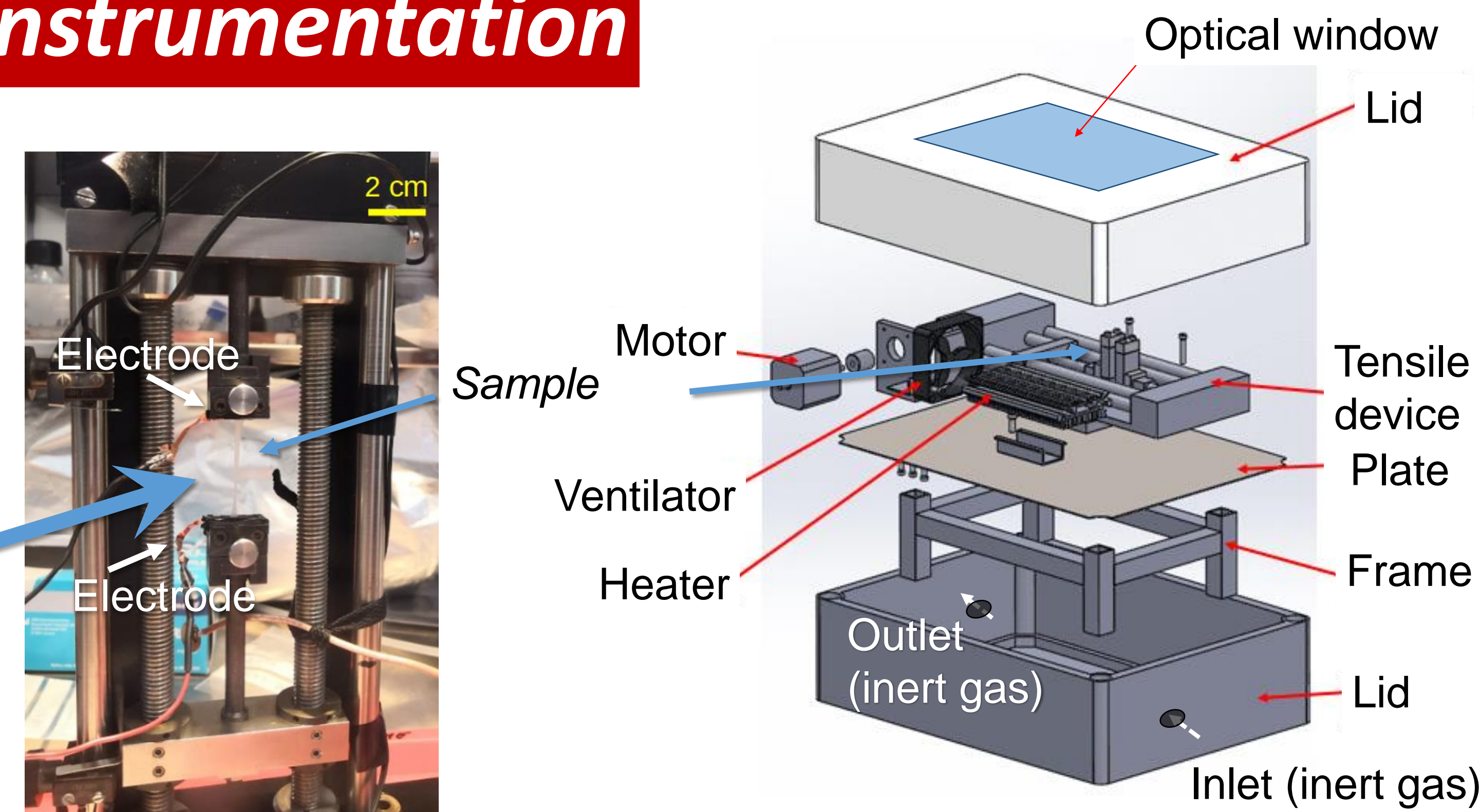
- 1 - Ionic transport:** Develop a solid methodology to determine ionic conductivity σ upon SPE stretching: *through-plane* (σ_{\perp}) vs. *in-plane* (σ_{\parallel}).
- 2 - Instrumentation:** Design of a setup to couple electric measurements and elongation as a function of temperature and under inert gas.
- 3 - Modeling:** Determination of the current vector density depending on the SPE geometries (elongation effect) to calculate accurately σ_{\parallel} and σ_{\perp} .

1- Ionic transport

The SPE electrolyte resistance R_{el} is determined by Electrochemical Impedance Spectroscopy (EIS) [1]



2- Instrumentation

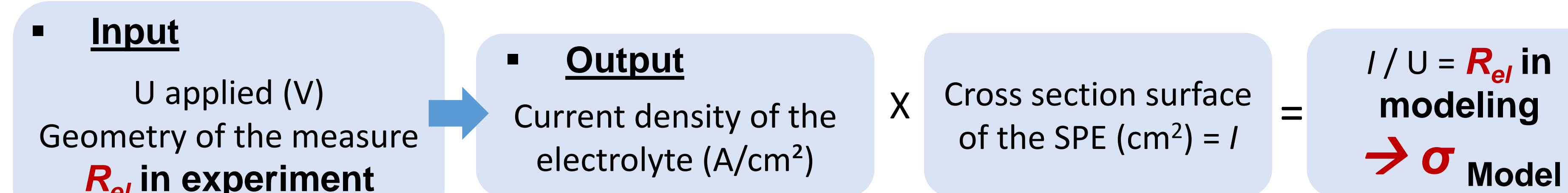
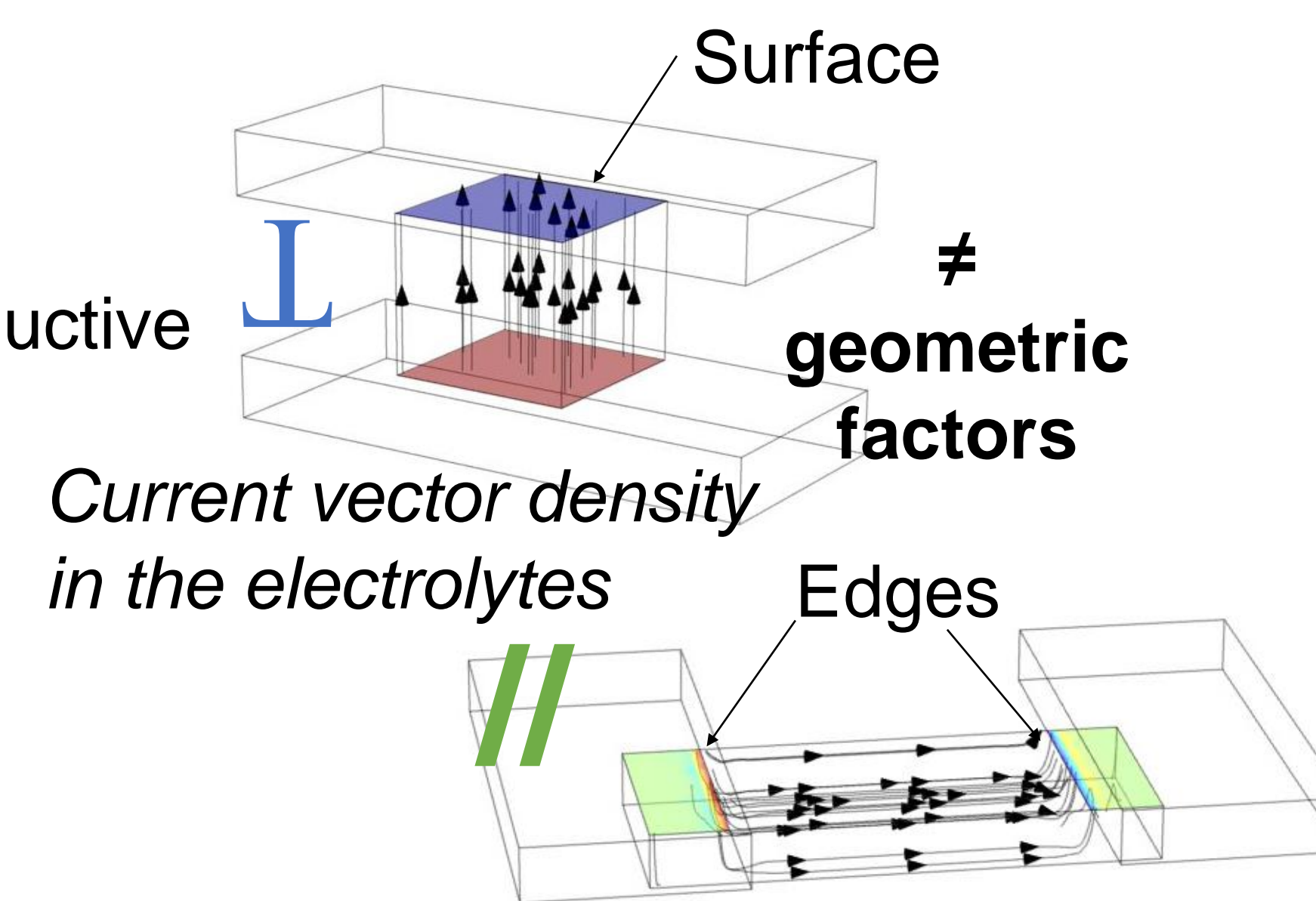


First design – in glove box at R.T. **Final design** – ongoing with versatile T

3 - Modeling

Stationary electric current in conductive medium

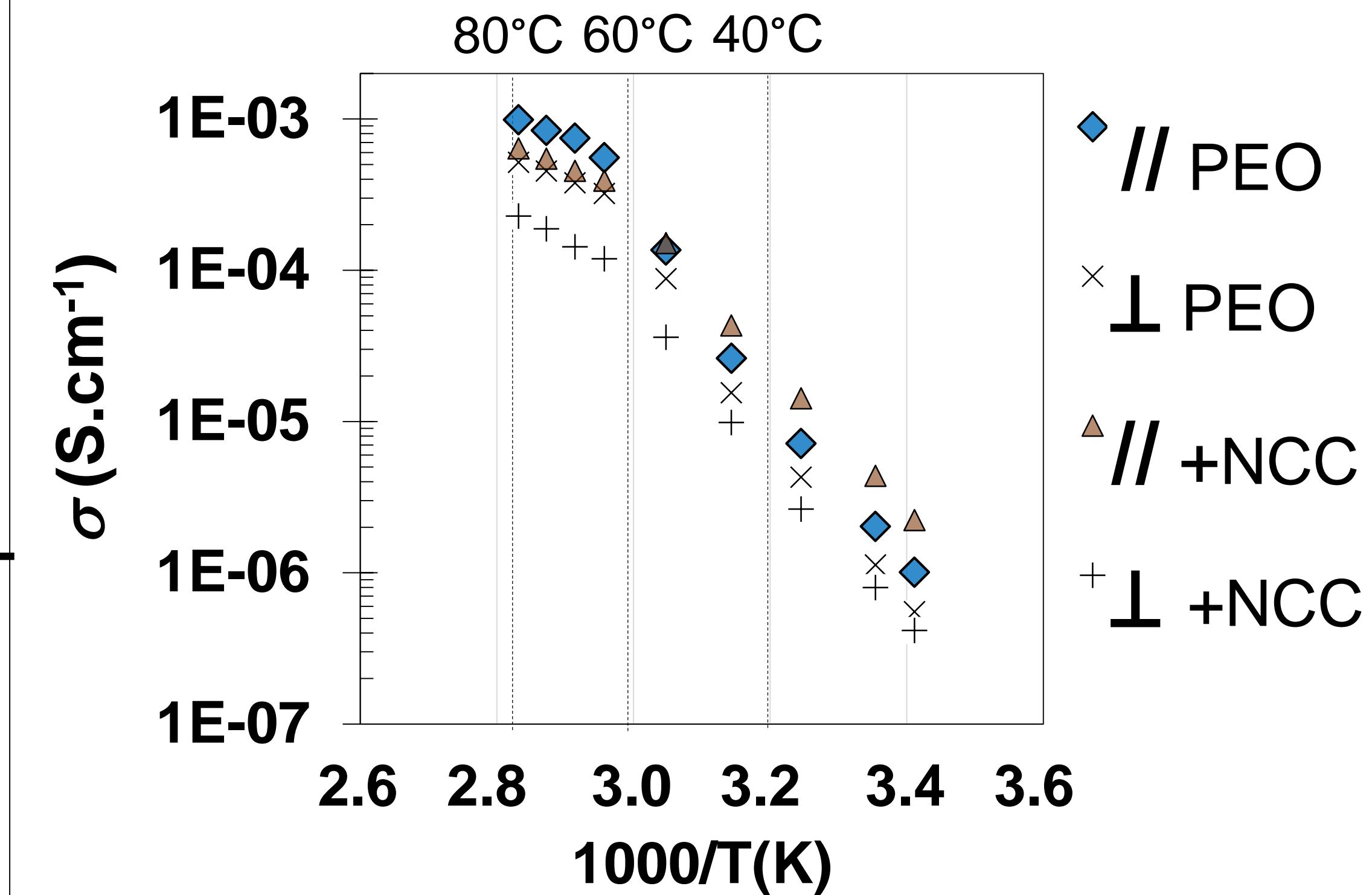
→ Ohm's law $J = \sigma E$ with J current density (A/m^2).



R_{el} in experiment ↔ R_{el} in modeling → σ_{Exp} vs. σ_{Model}

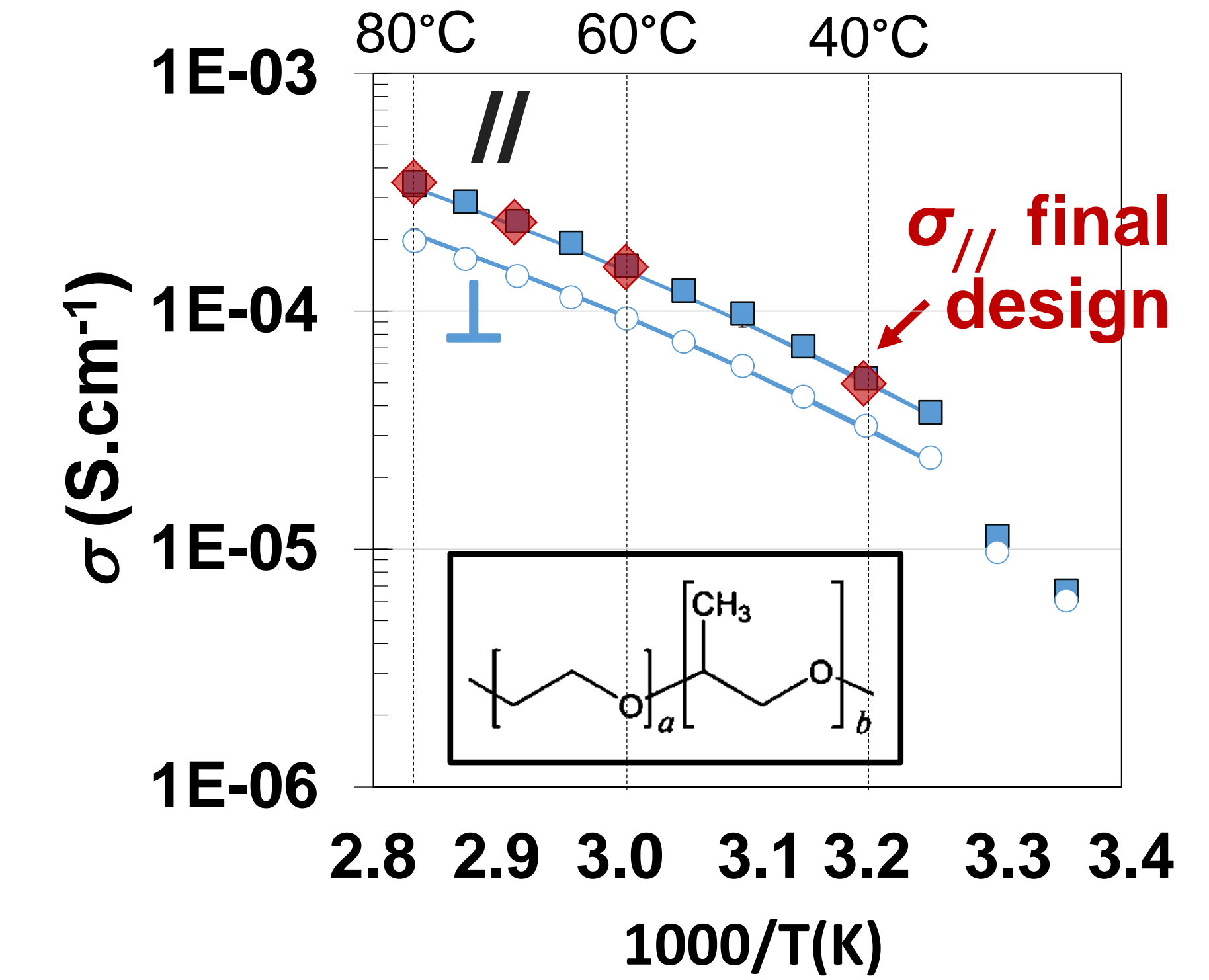
4-Results σ_{\parallel} vs σ_{\perp}

PEO/LiTFSI & PEO/LiTFSI + NCC (cellulose) [3]



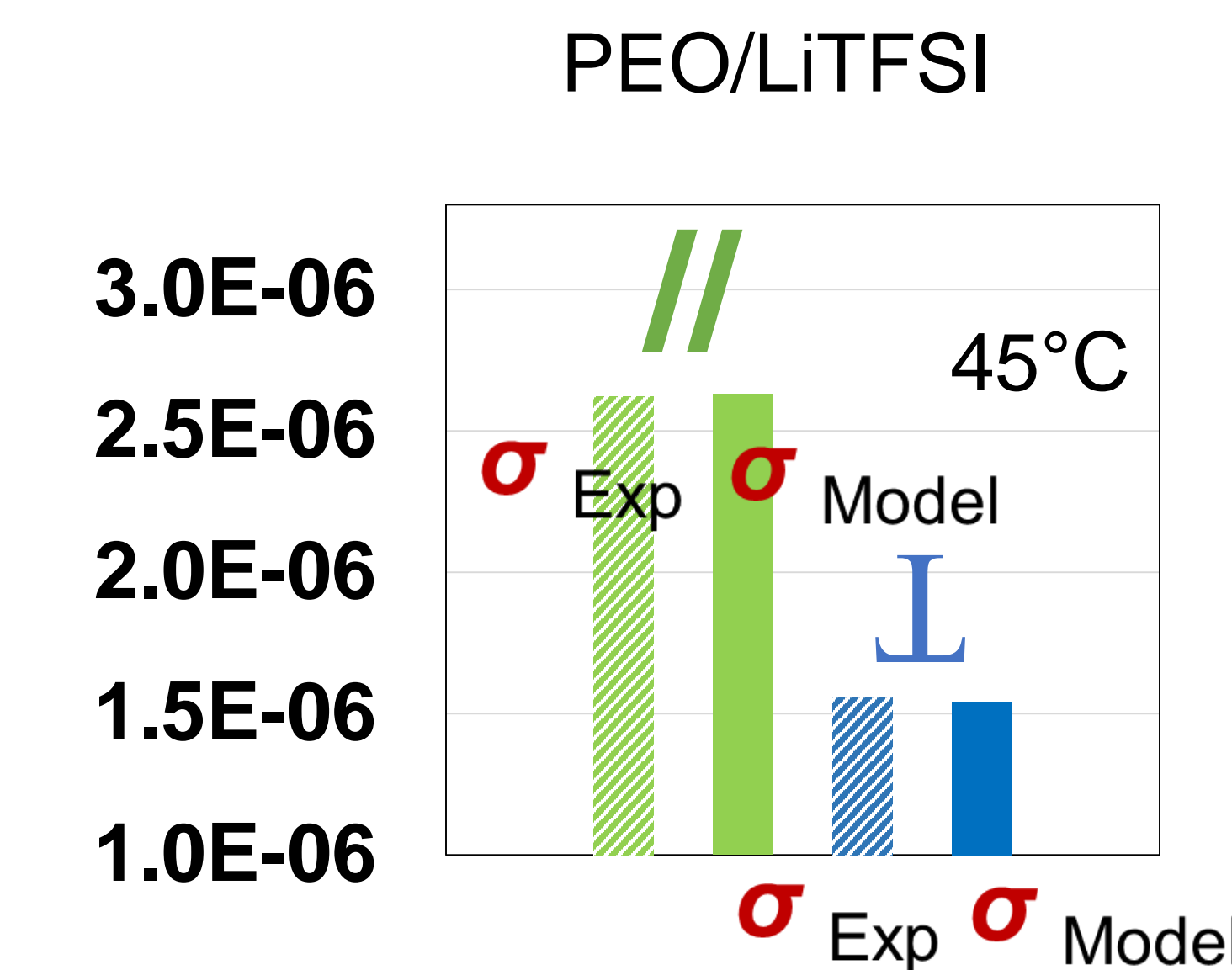
- PEO: $\sigma_{\parallel} = 1.9 \times \sigma_{\perp}$
- PEO+NCC: $\sigma_{\parallel} = 2.7 \times \sigma_{\perp}$ at 80°C

Statistical PEO based copolymer



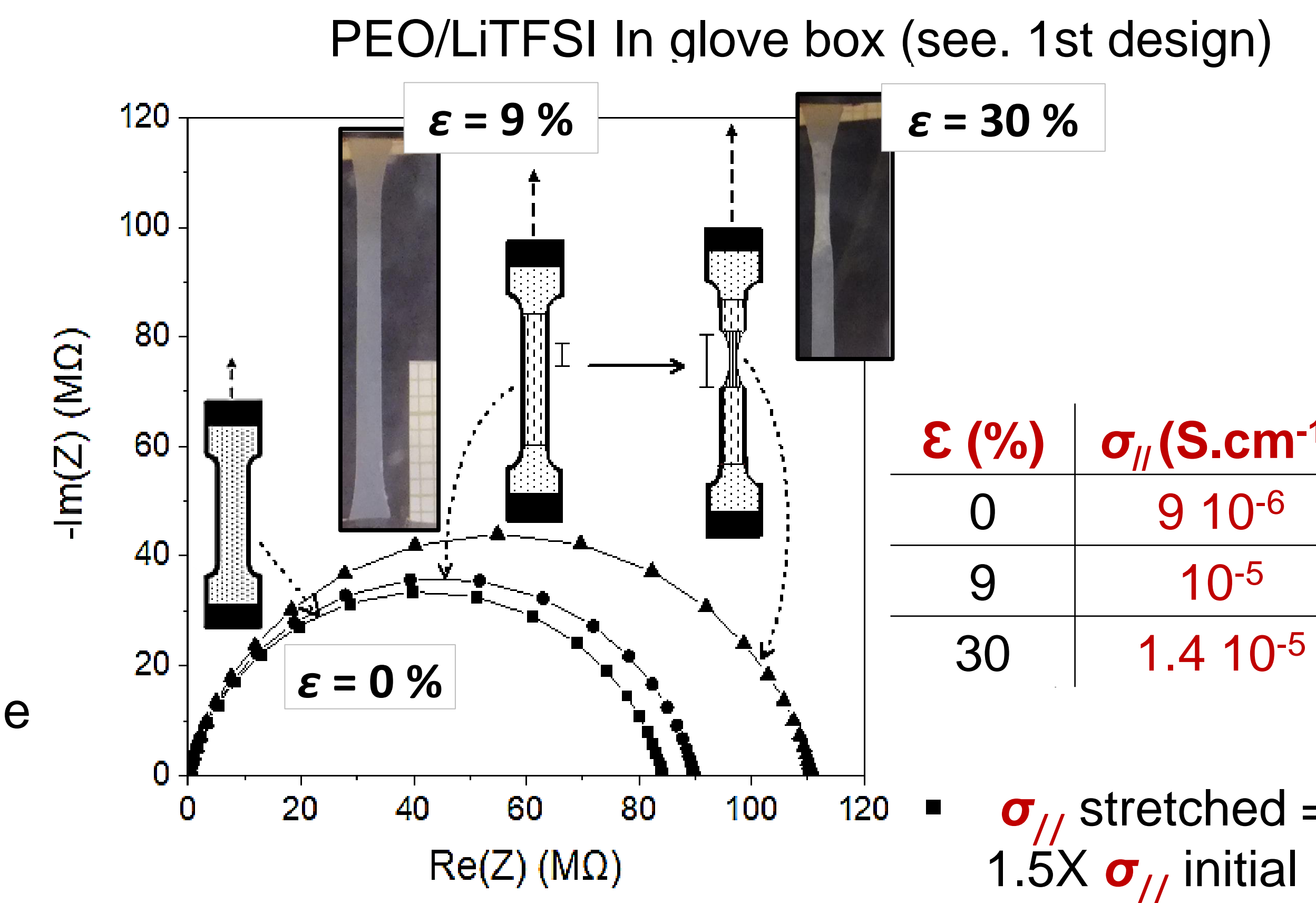
- $\sigma_{\parallel} = 2 \times \sigma_{\perp}$ at 80°C
- σ_{\parallel} final design = σ_{\parallel}

Modeling



- σ_{Exp} and σ_{Model} are identical
- Edge effect in the cells is negligible

σ_{\parallel} upon stretching



Conclusion & perspective

- $\sigma_{\parallel} > \sigma_{\perp}$ for all PEO based SPEs (homopolymer, composite, statistical)
- Modeling captures the experimental behavior
- Other transport properties to be characterized

References

- [1] D. Lisbona, T. Snee, Process Saf. Environ., 89 (2011) 434.
- [2] W. Xu et al., Energy Environ. Sci., 7 (2014) 513.
- [3] M.S. Azizi et al. J. Phys. Chem. B 2004, 108, 10845-10852.

Acknowledgement