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

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## Introduction

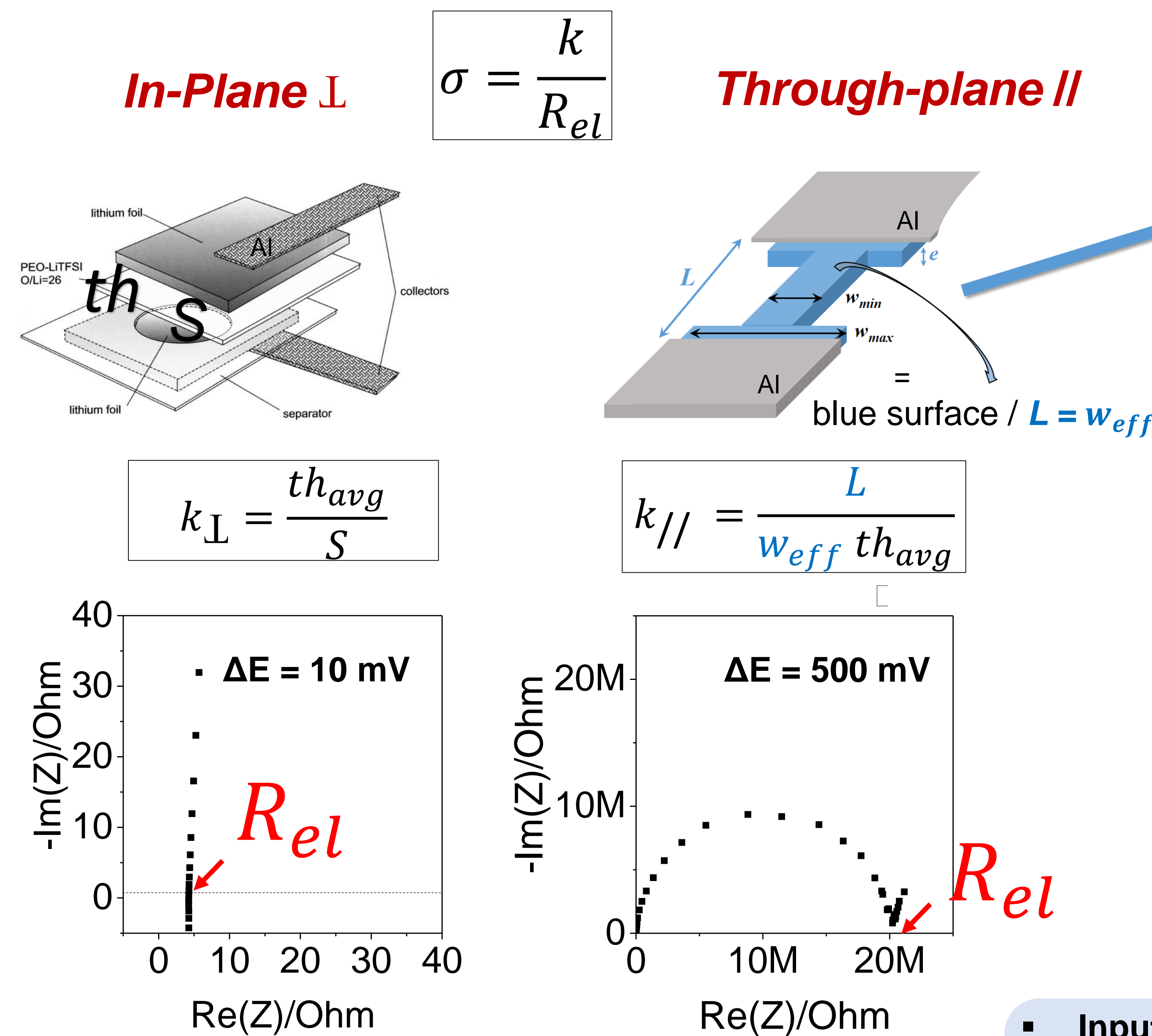
- Context:** Conventional Li-ion batteries can leak and react. [1]. *Solution?* Replace the liquid electrolyte by a non-flammable dry **Solid Polymer Electrolyte (SPE)**.
- Interest:** Flexibility, process easiness, lack of volatile compounds, and chemical and electrochemical stability toward Li metal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

## Objectives

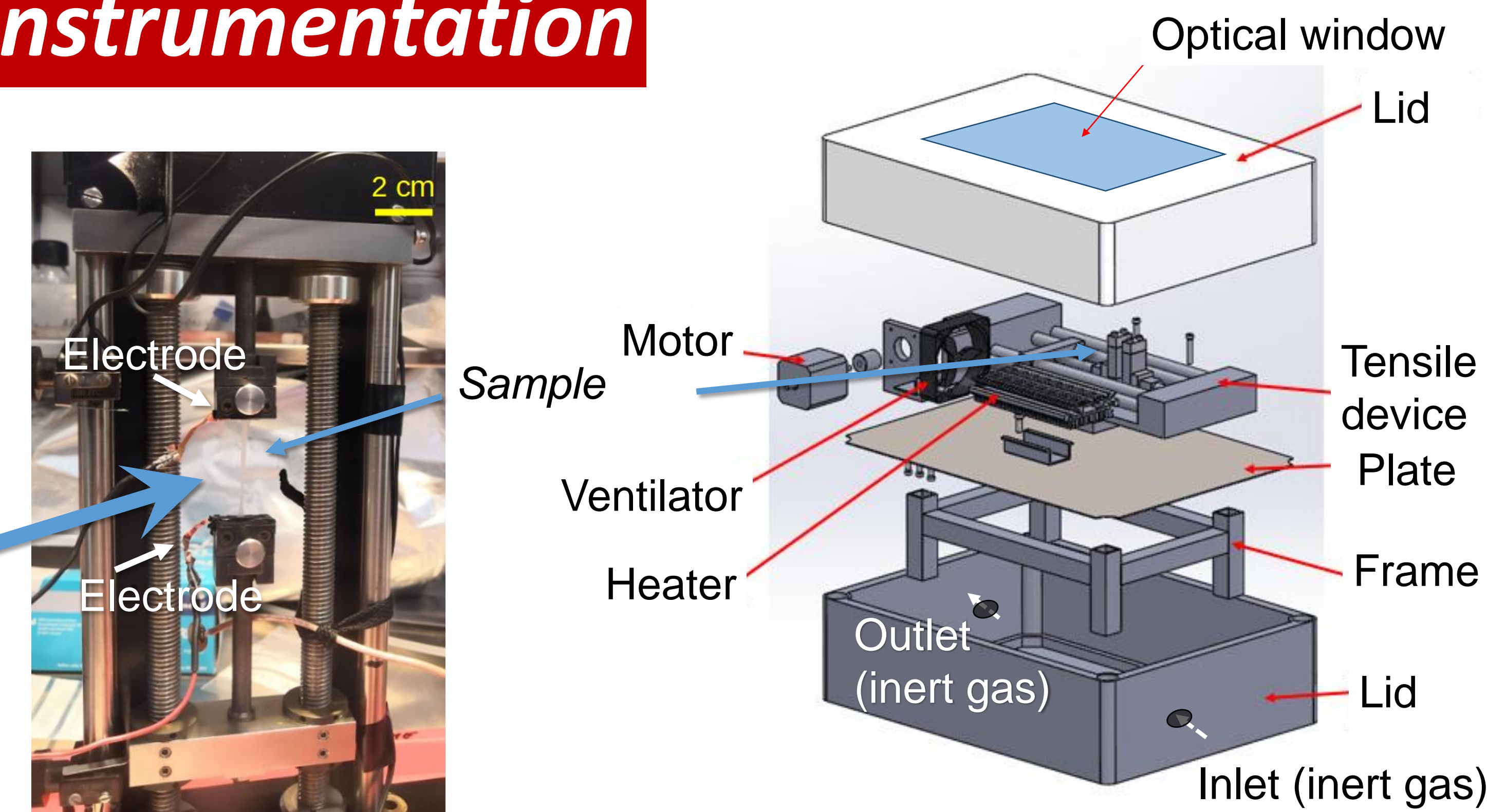
- 1 - Ionic transport:** Develop a solid methodology to determine ionic conductivity  $\sigma$  upon SPE stretching: *through-plane* ( $\sigma_{\perp}$ ) vs. *in-plane* ( $\sigma_{\parallel}$ ).
- 2 - Instrumentation:** Design of a setup to couple electric measurements and elongation as a function of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

## 1- Ionic transport

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



## 2- Instrumentation

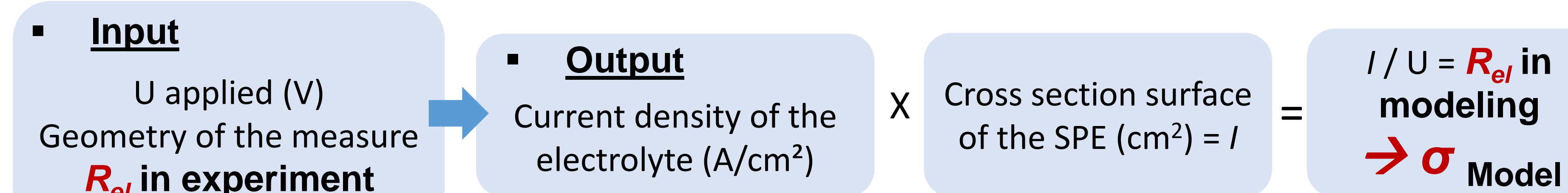
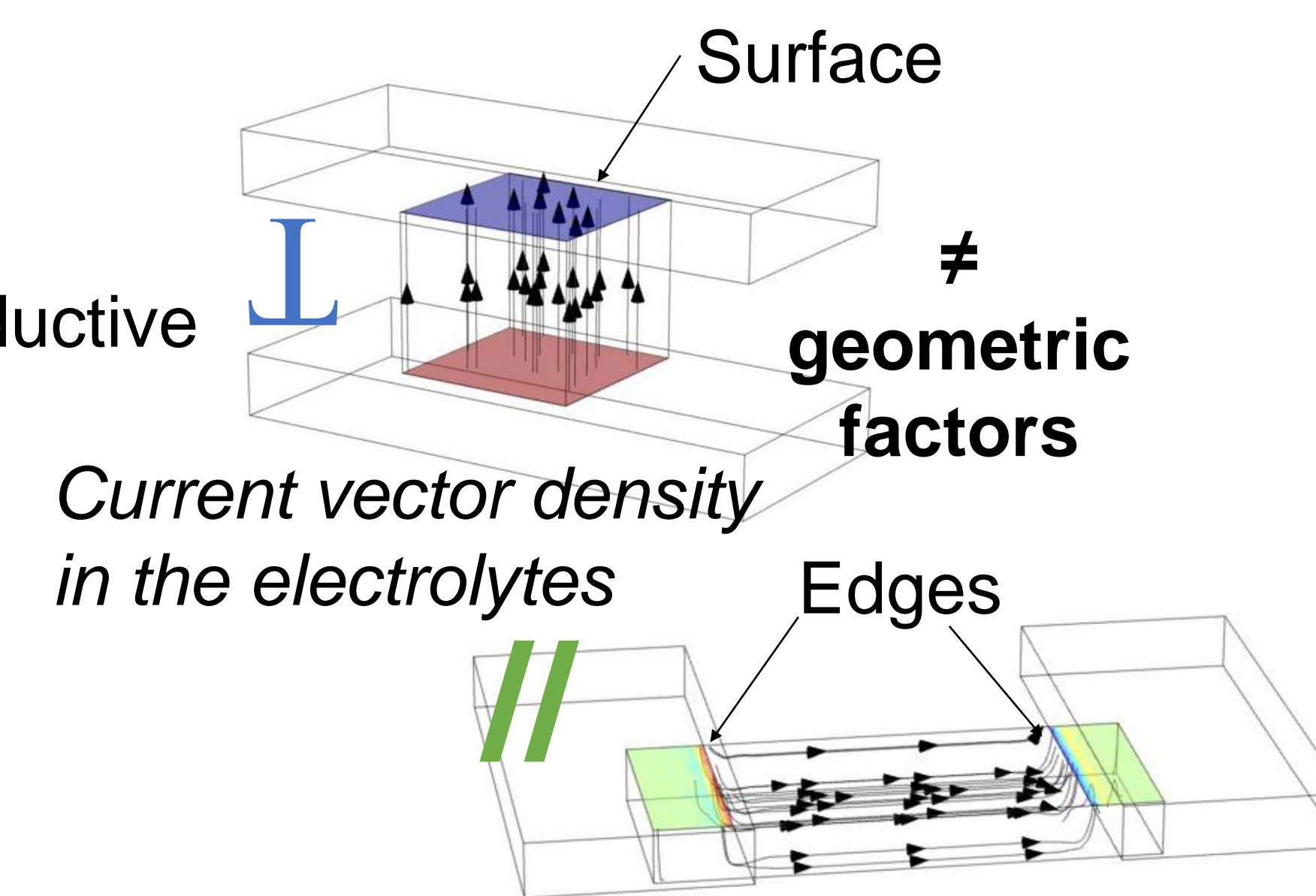


First design – in glove box at R.T. **Final design** – ongoing with versatile T

## 3 - Modeling

Stationary electric current in conductive medium

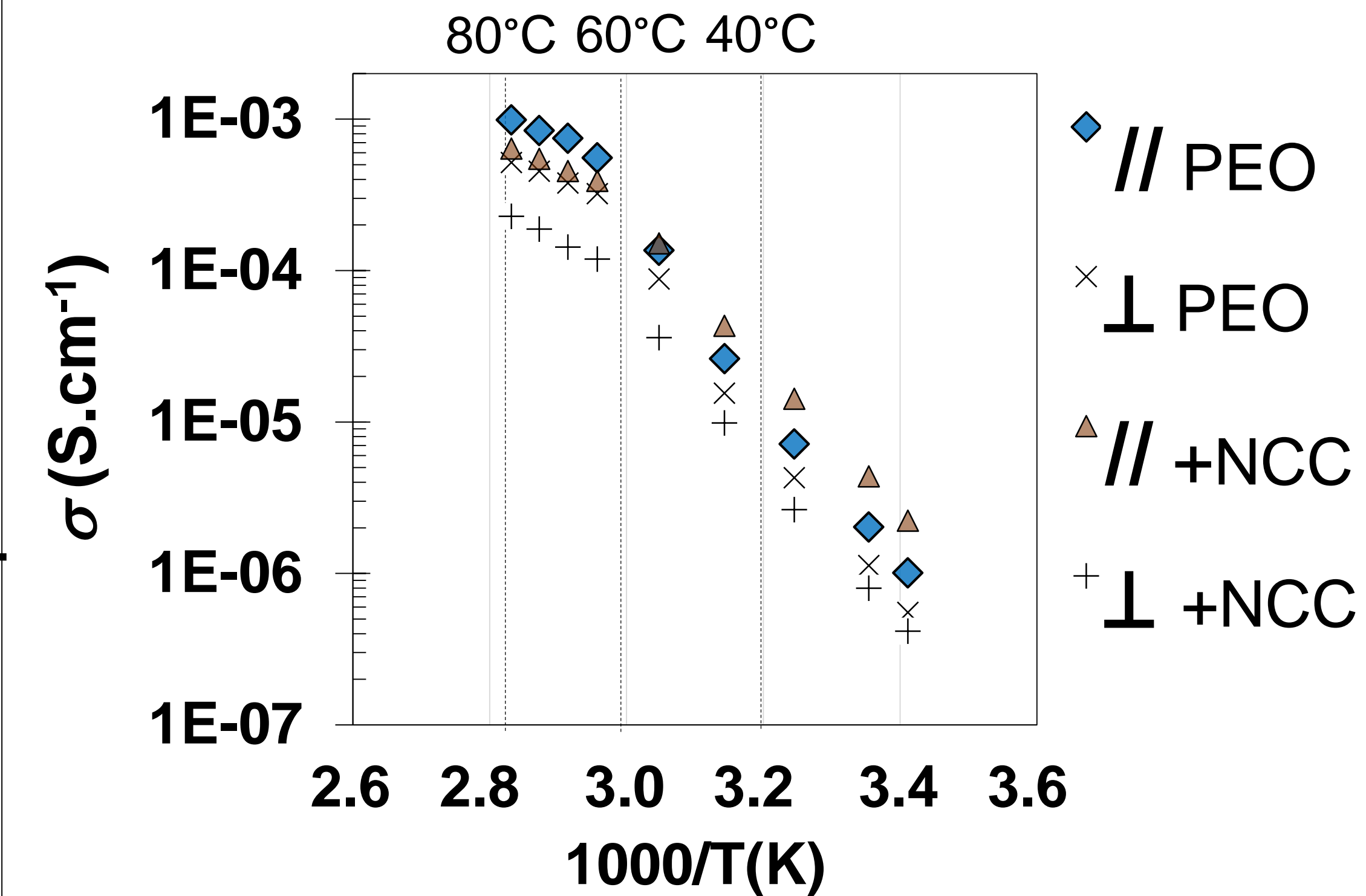
→ Ohm's law  $J = \sigma E$  with  $J$  current density (A/m<sup>2</sup>).



$R_{el}$  in experiment ↔  $R_{el}$  in modeling →  $\sigma_{Exp}$  vs.  $\sigma_{Model}$

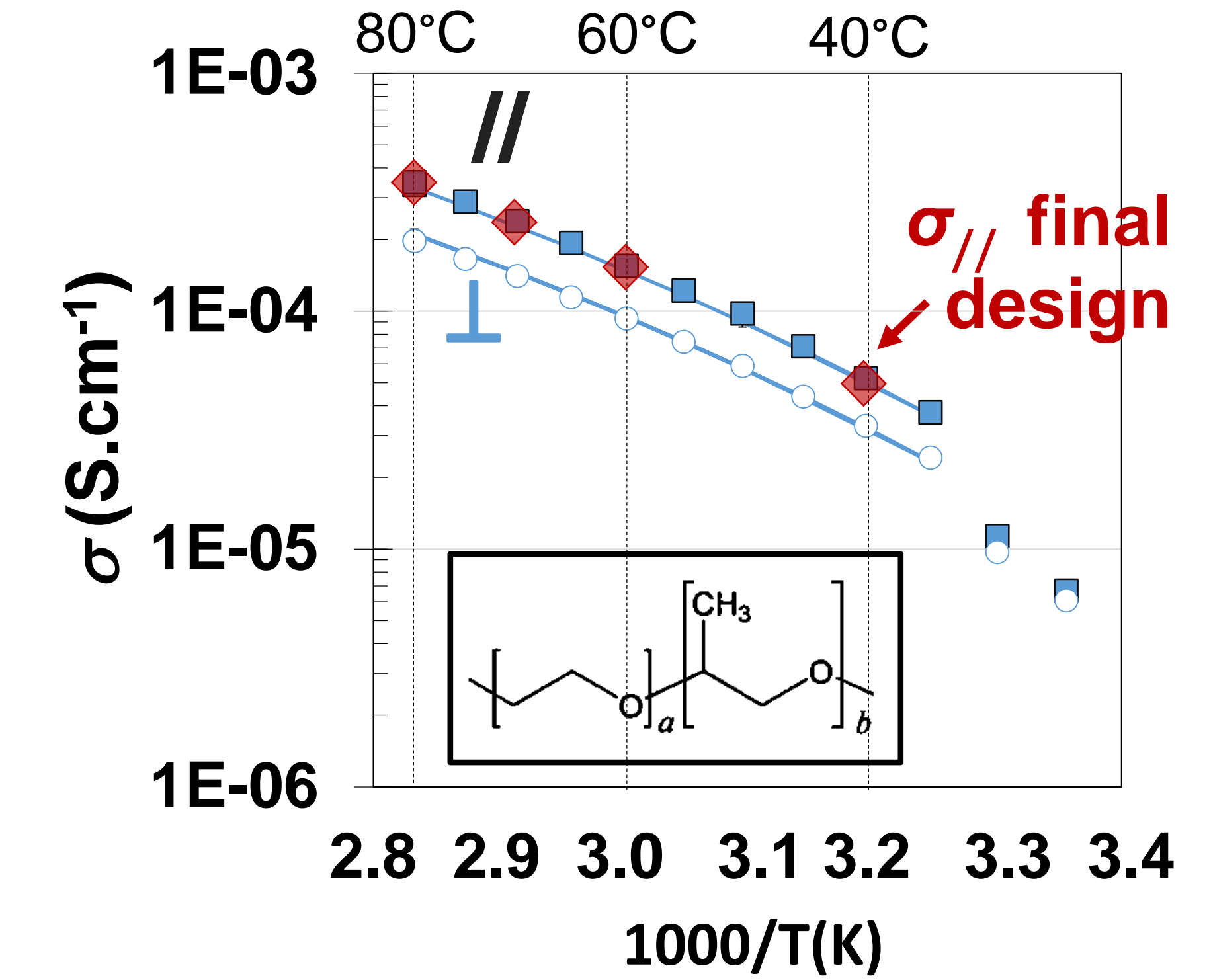
## 4-Results $\sigma_{\parallel}$ vs $\sigma_{\perp}$

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



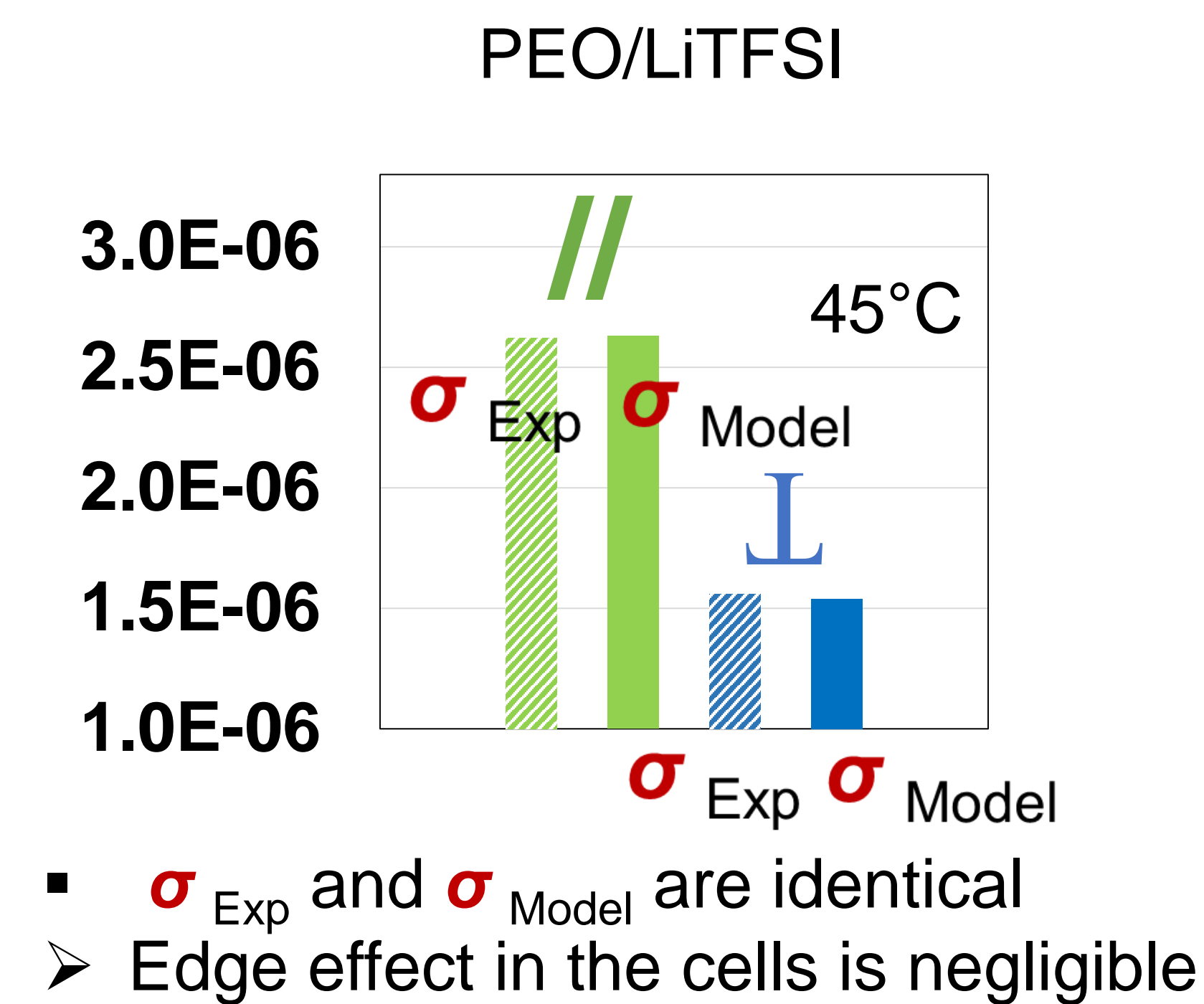
- PEO:  $\sigma_{\parallel} = 1.9 \times \sigma_{\perp}$
- PEO+NCC:  $\sigma_{\parallel} = 2.7 \times \sigma_{\perp}$  at 80°C

Statistical PEO based copolymer



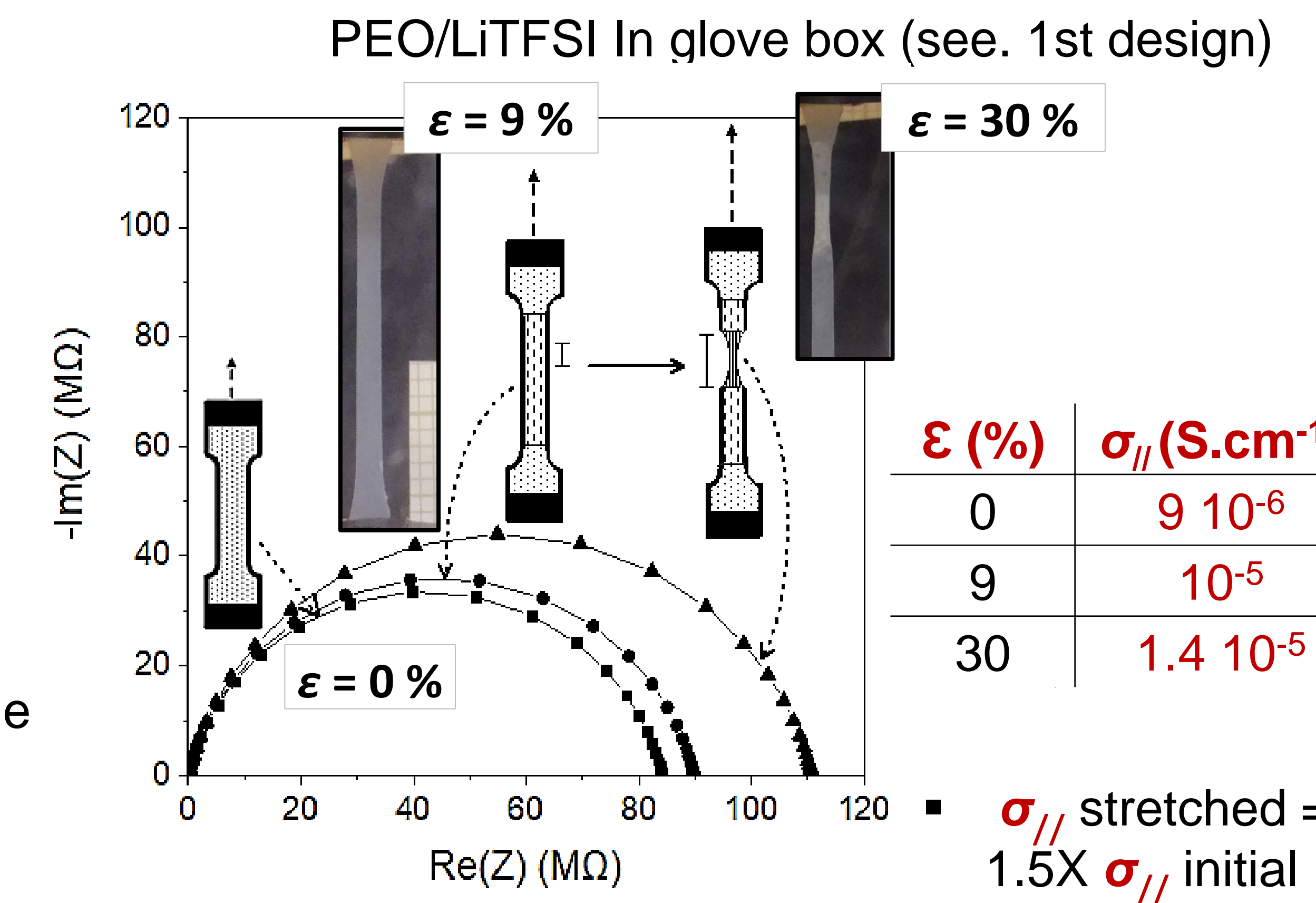
- $\sigma_{\parallel} = 2 \times \sigma_{\perp}$  at 80°C
- $\sigma_{\parallel}$  final design =  $\sigma_{\parallel}$

## Modeling



- $\sigma_{Exp}$  and  $\sigma_{Model}$  are identical
- Edge effect in the cells is negligible

## $\sigma_{\parallel}$ 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