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## New lithium salts derived from naphthalene: toward carbonate-based single-ion polymer electrolytes

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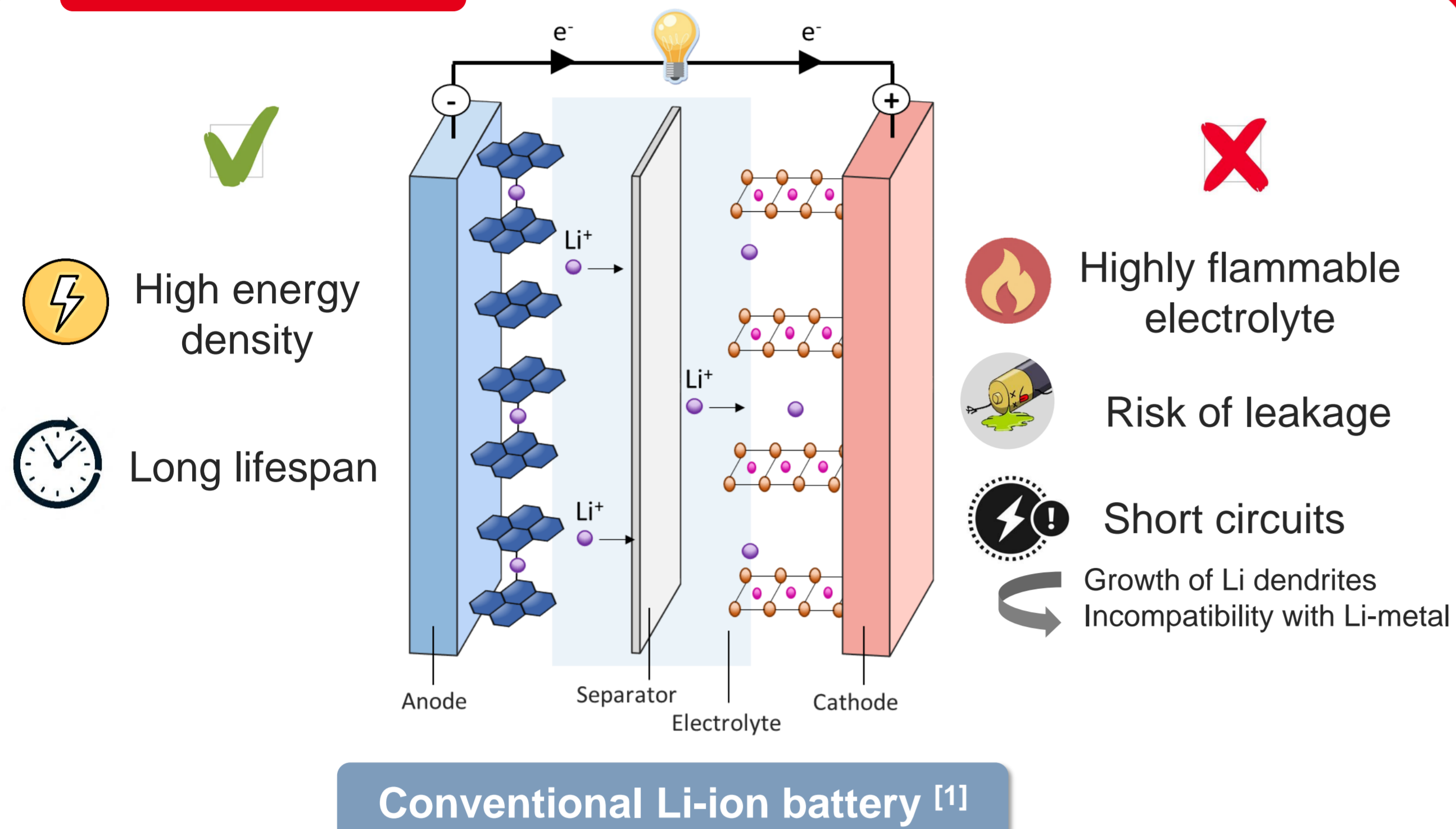
AGENCE  
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## Context



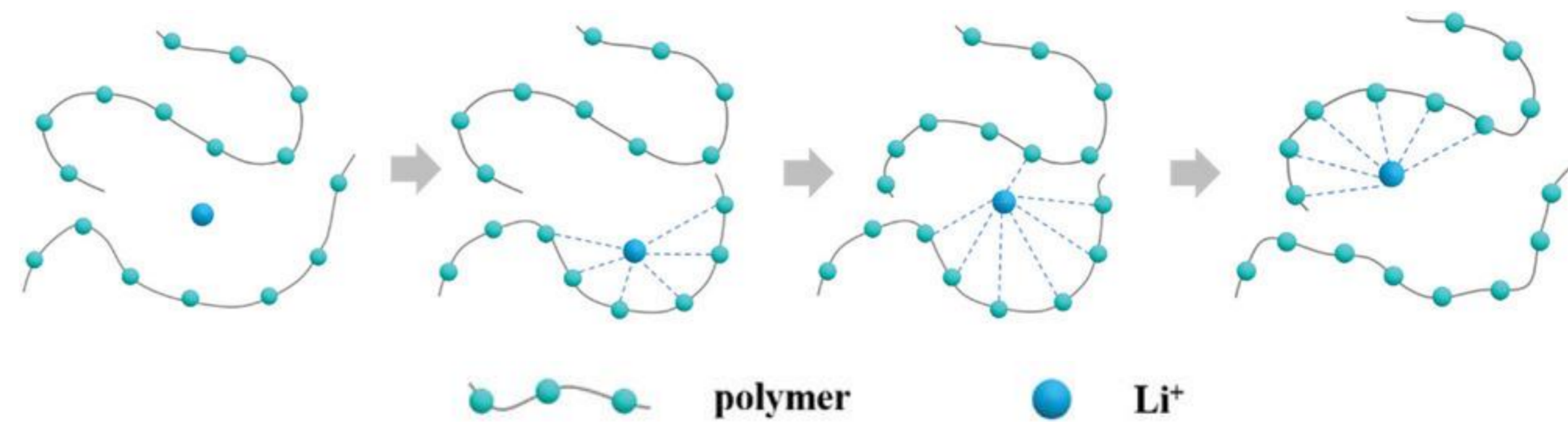
Strategy: substitution of liquid electrolytes with solid materials

3 different classes of solid electrolytes: oxides, sulfides, and **polymers**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>Lightweight</li> <li>Interface properties with active materials</li> <li>Adaptation to electrode volume changes</li> <li>Easy to process</li> </ul>	<ul style="list-style-type: none"> <li>Ionic conductivity at room temperature</li> <li>Mechanical properties</li> </ul>

## State-of-the art: PEO-like polymer electrolytes

- Dissolution of lithium salts in a polymer matrix
- Conductivity via the **segmental motion of polymer chains and diffusion** [2]



❖ PEO ELECTROLYTES [3,4]

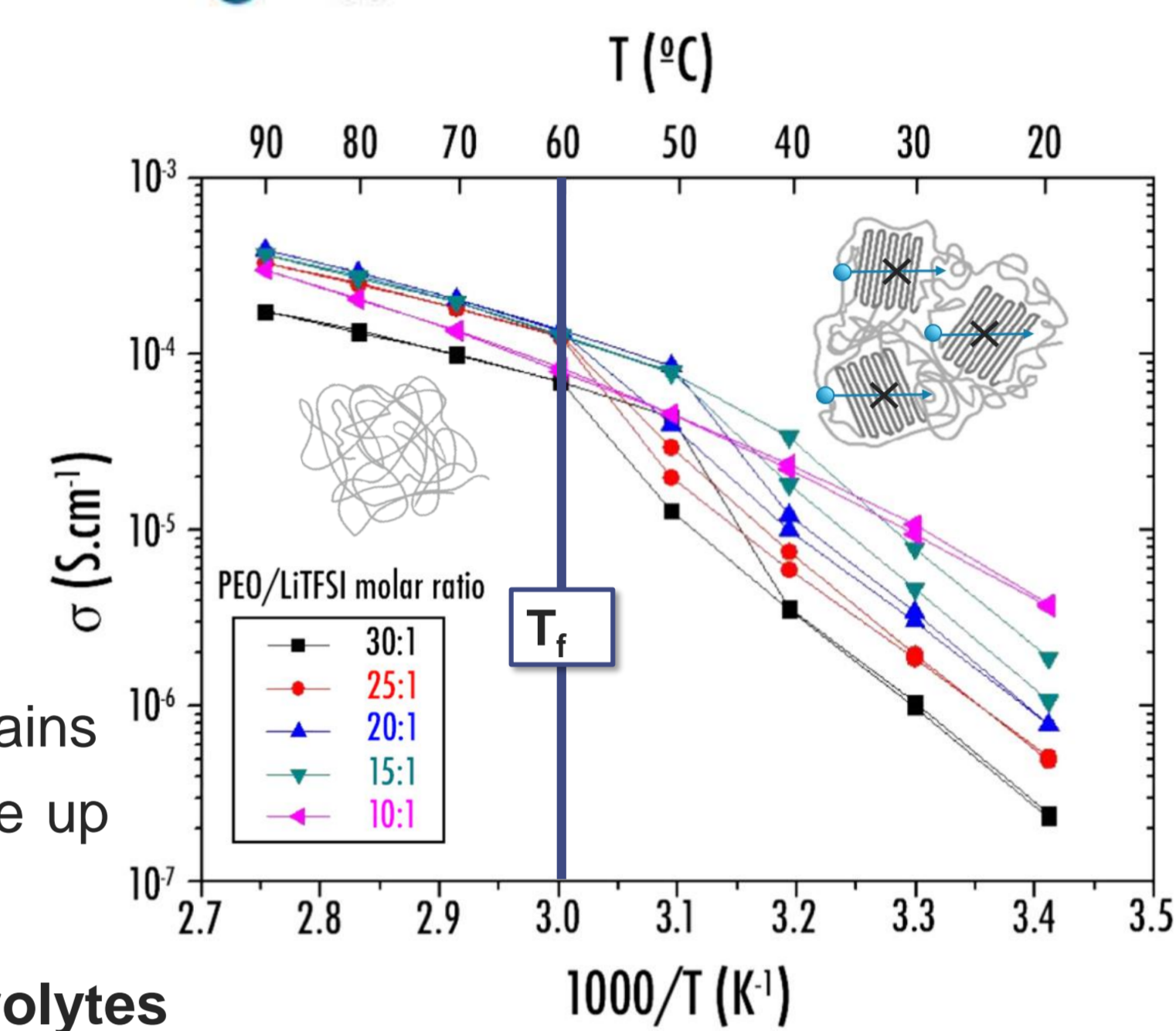
### Strengths

- Ionic conductivity about 1 mS.cm<sup>-1</sup> at 80°C
- Low glass-transition temperature ( $T_g = -60^\circ\text{C}$ )

### Weaknesses

- Non-conductive crystalline phases ( $T_f = 60^\circ\text{C}$ )
- Strong interactions between Li<sup>+</sup> and polymer chains
- Limited to low voltage cathode materials (stable up to 4V vs .Li<sup>+</sup>/Li<sub>0</sub>)

➔ Study of other families of polymer electrolytes



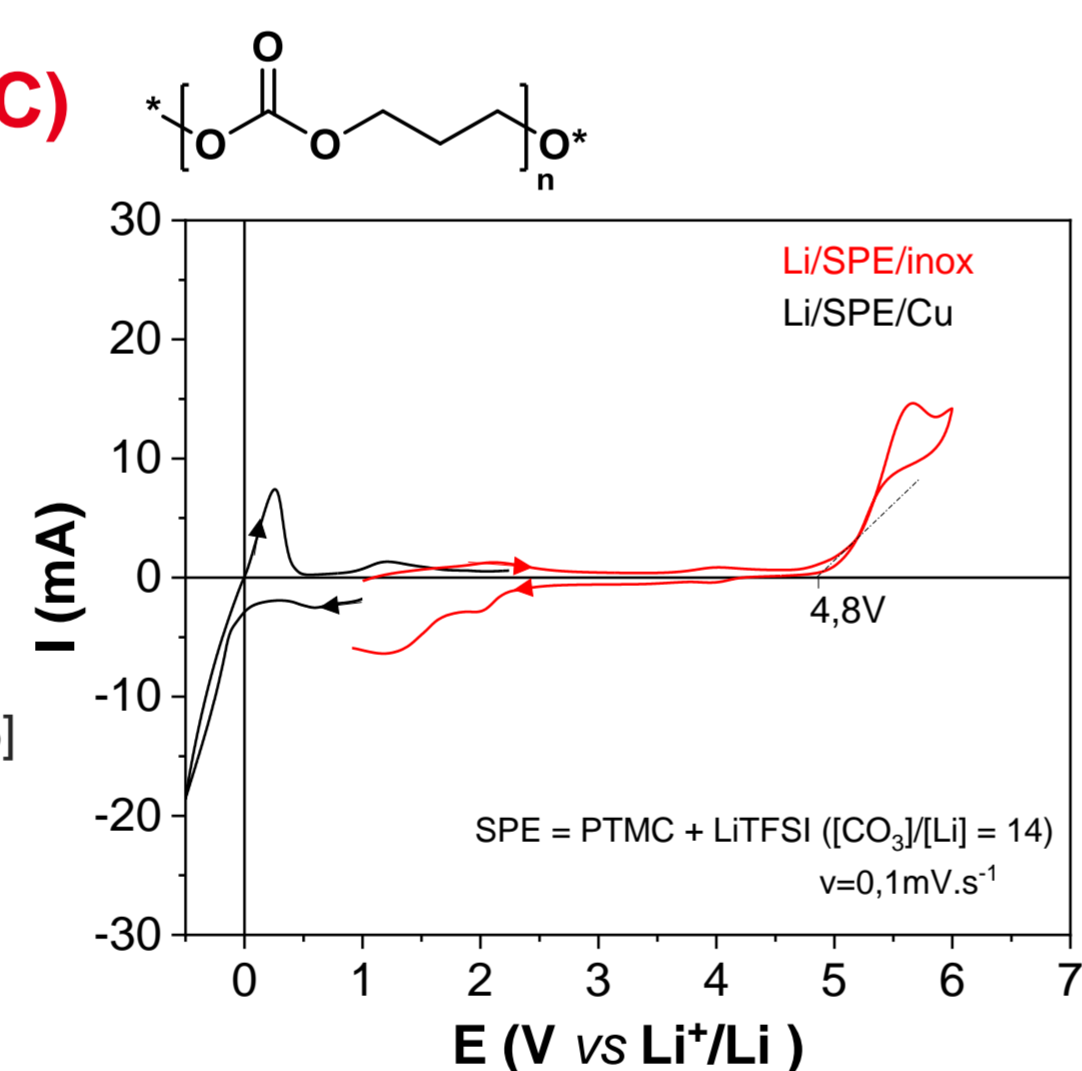
## Objectives

- Development of **stable high voltage polymer electrolytes** for high energy density batteries
- **Single-ion polycarbonate** synthesis (PTMC derivative) by covalently **grafting Li<sup>+</sup> counter-ions** on polymer chains
- Synthesis and electrochemical characterization of **new model salts**

## High voltage polymer electrolyte

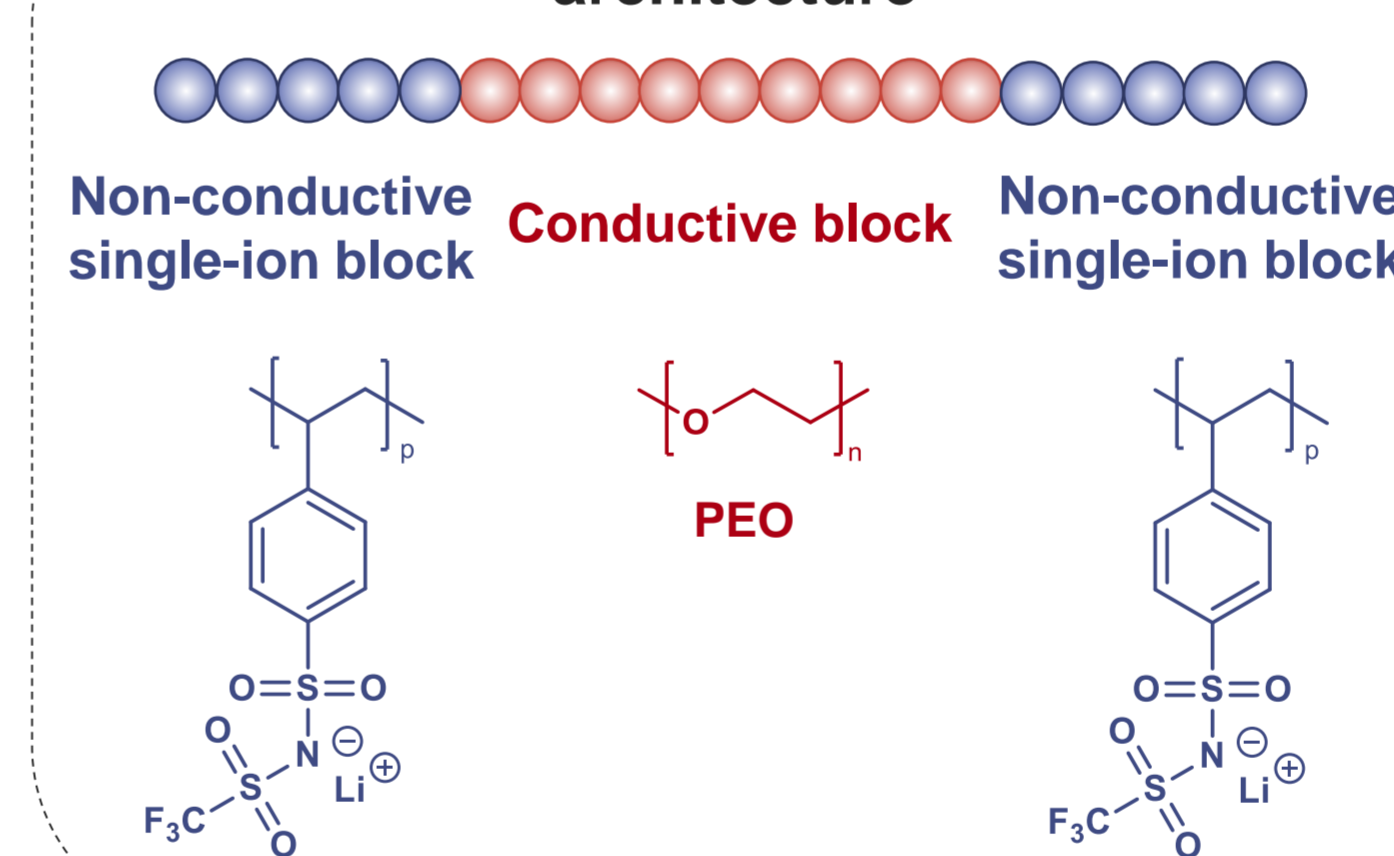
❖ POLY(TRIMETHYLENE CARBONATE) (PTMC)

- Amorphous polymer:  $T_g = -20^\circ\text{C}$  [5]
- Ionic conductivity is **mainly due to Li<sup>+</sup> mobility**  
→  $t_{\text{Li}^+} \approx 0,8$  [6]
- **Electrochemical stability up to 4.8V** vs. Li<sup>+</sup>/Li<sub>0</sub> [5]  
→ High voltage cathode compatibility

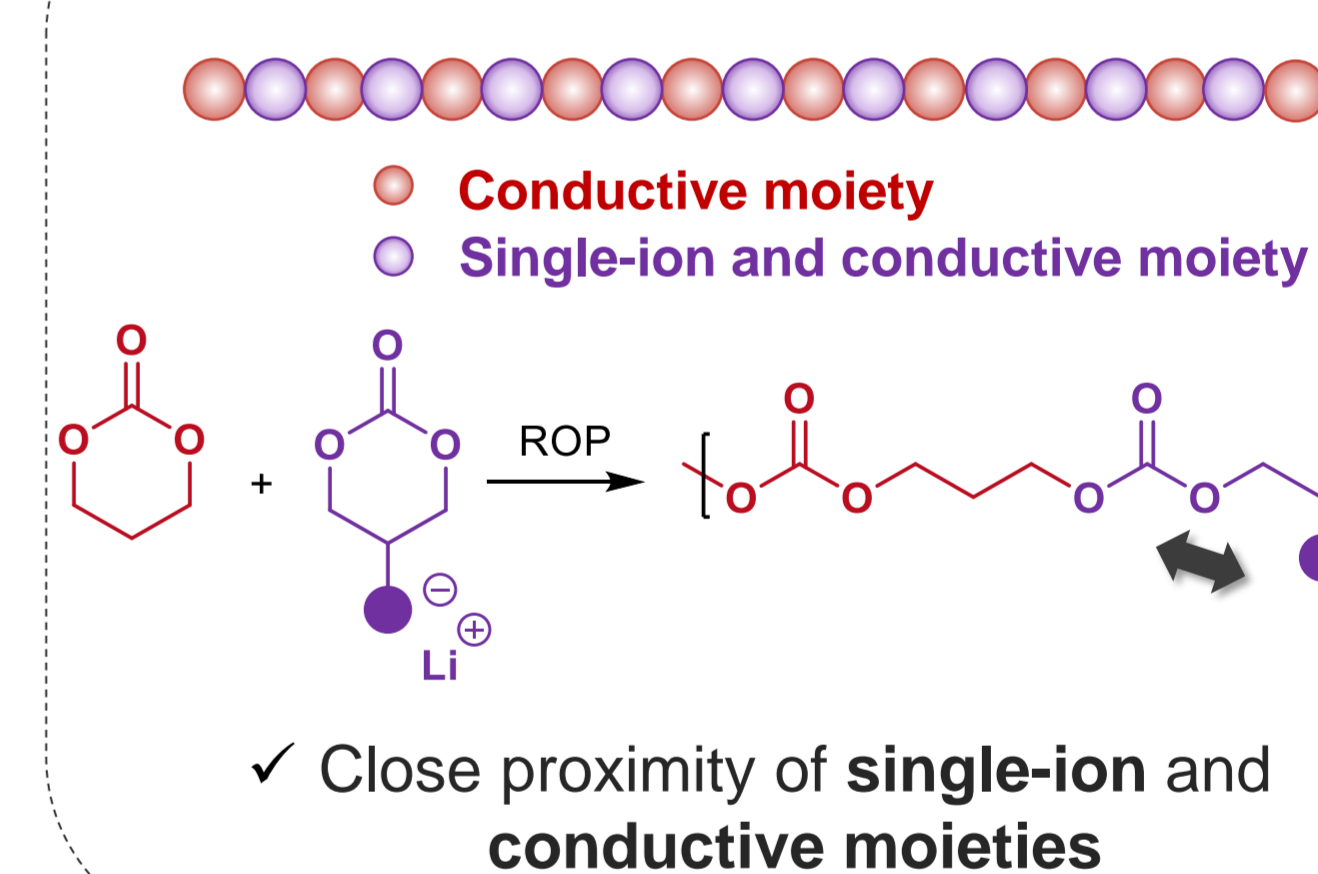


## Carbonate-based single-ion polymer electrolytes

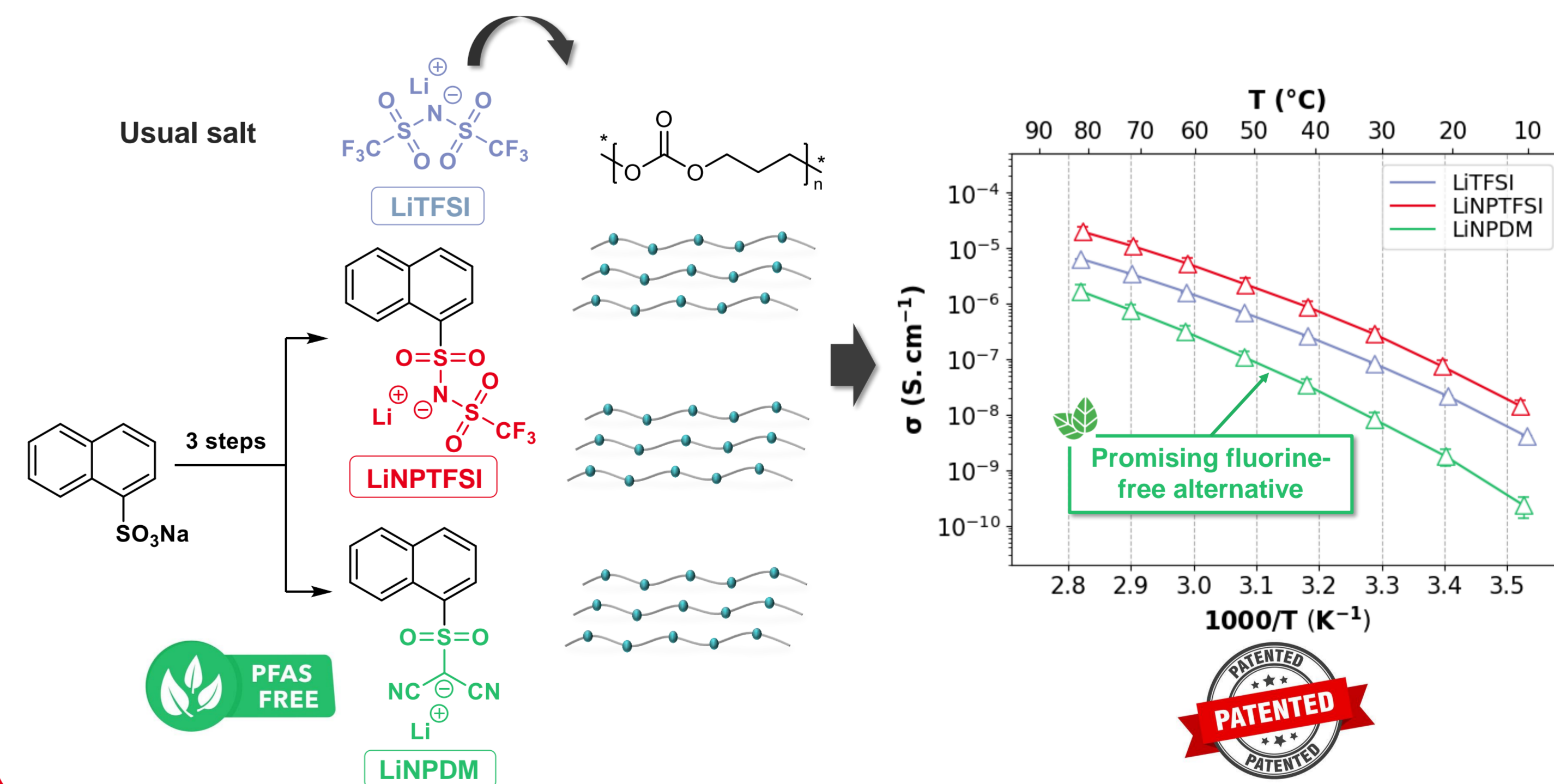
### Classic single-ion polymer architecture [7]



### This work

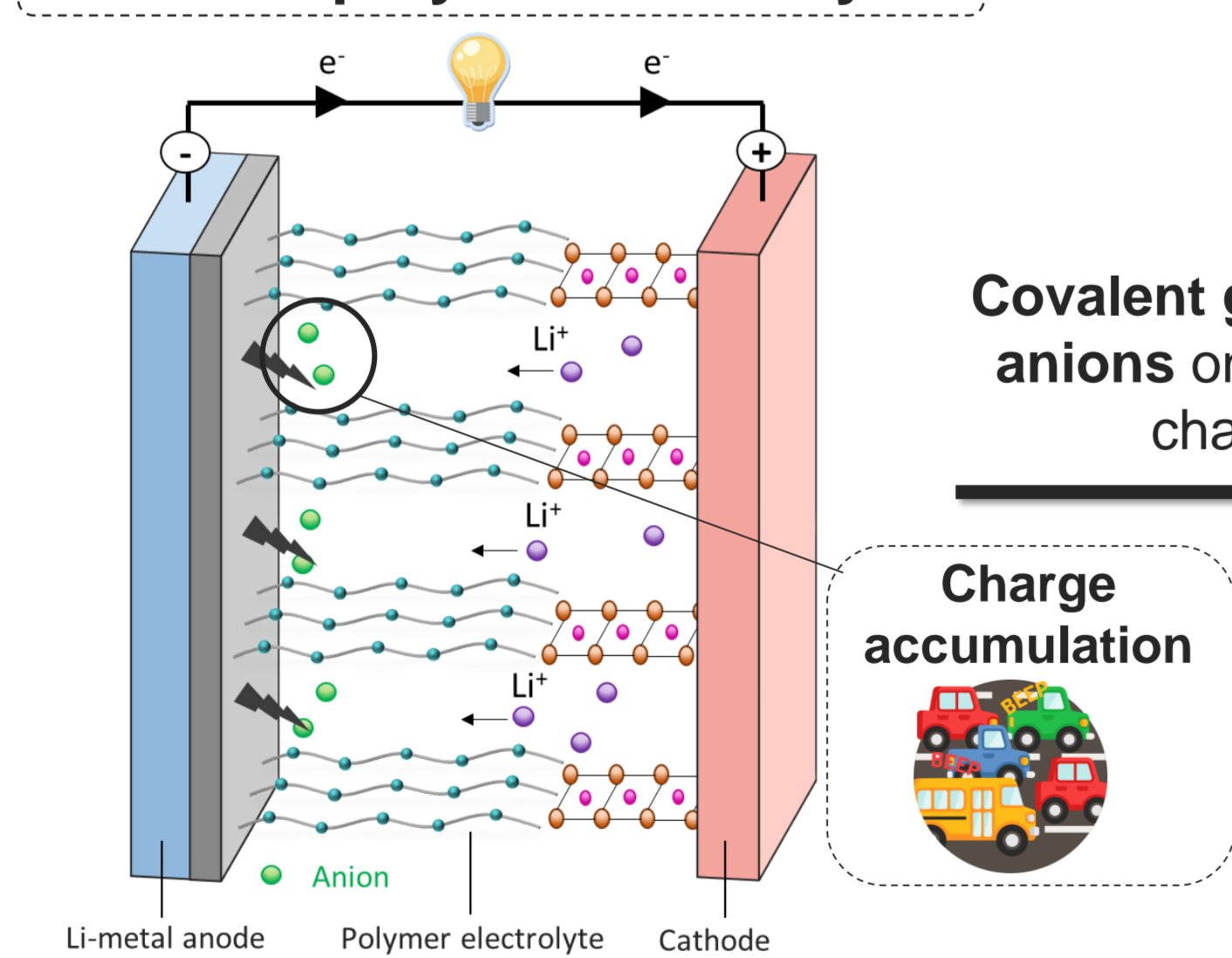


❖ ELECTROCHEMICAL CHARACTERIZATION OF NEW LITHIUM SALTS

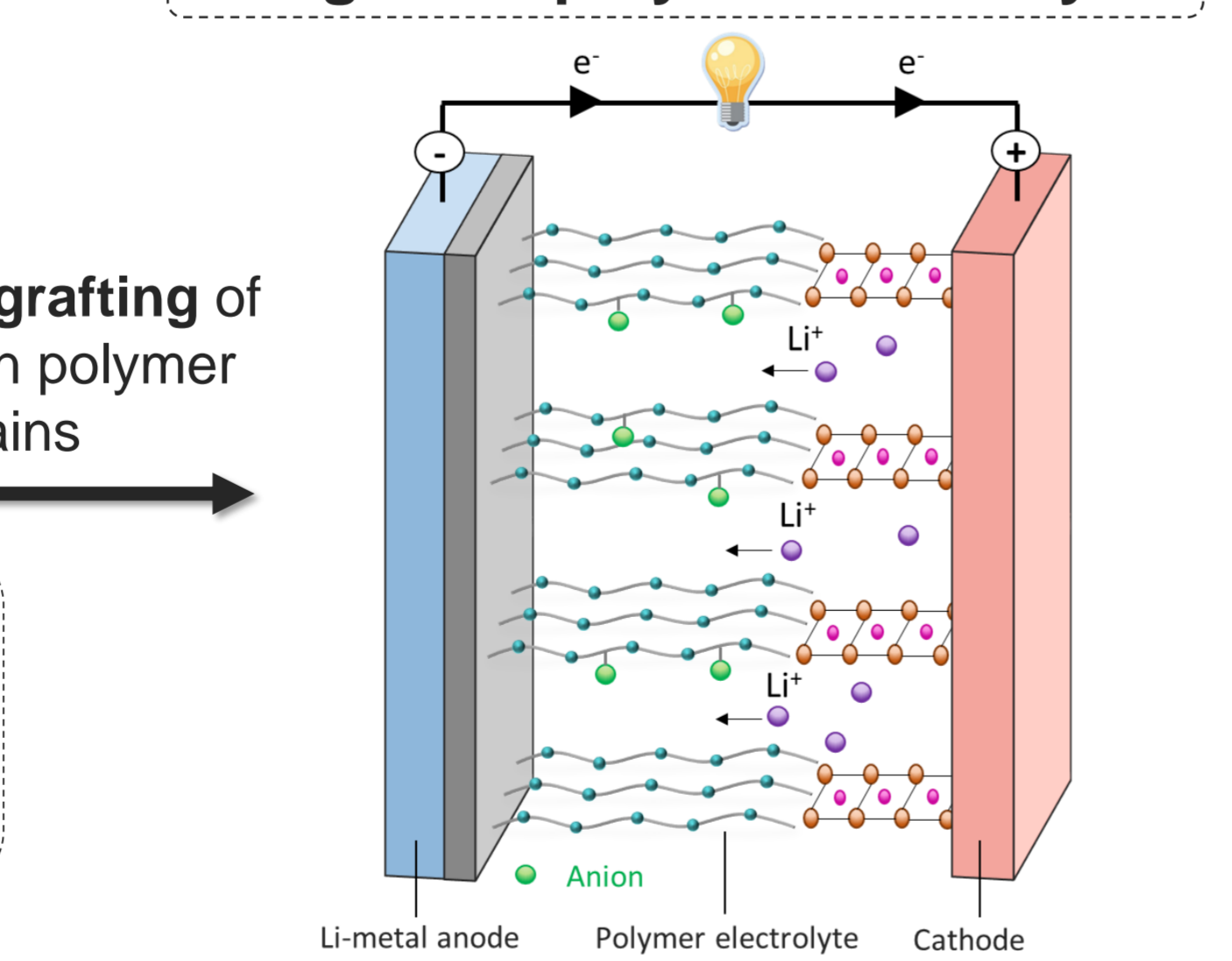


## Single-ion polymer strategy

### Classic polymer electrolyte



### Single-ion polymer electrolyte



Covalent grafting of anions on polymer chains

Charge accumulation

✓ Only Li<sup>+</sup> ions move via the segmental motion of polymer chains ( $t_{\text{Li}^+} \approx 1$ ) [6]

## Conclusions and perspectives

- Preparation of **new polymer electrolyte systems** with weakly coordinating lithium salts derived from naphthalene and electrochemical characterizations
- Development of a **versatile synthesis method** for **single-ion functionalized cyclic carbonate monomers**
- Study of the **copolymerization** of cyclic carbonate monomers and **single-ion functionalized cyclic carbonate monomers**

## References

[1] J. B. Goodenough, *Nat. Electron.*, **2018**, 1, 204–204.

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[5] T. Clement (2021). *Copolymères en peigne à greffons éthers et carbonates: du design macromoléculaire à leur utilisation comme électrolyte de batterie au lithium* [Doctoral thesis, Univ. Grenoble Alpes]

[6] M. Irfan, *et al. J. Power Sources* **2021**, 486, 229378.

[7] R. Bouchet, *et al. Nature Mater* **2013**, 12 (5), 452–457.