

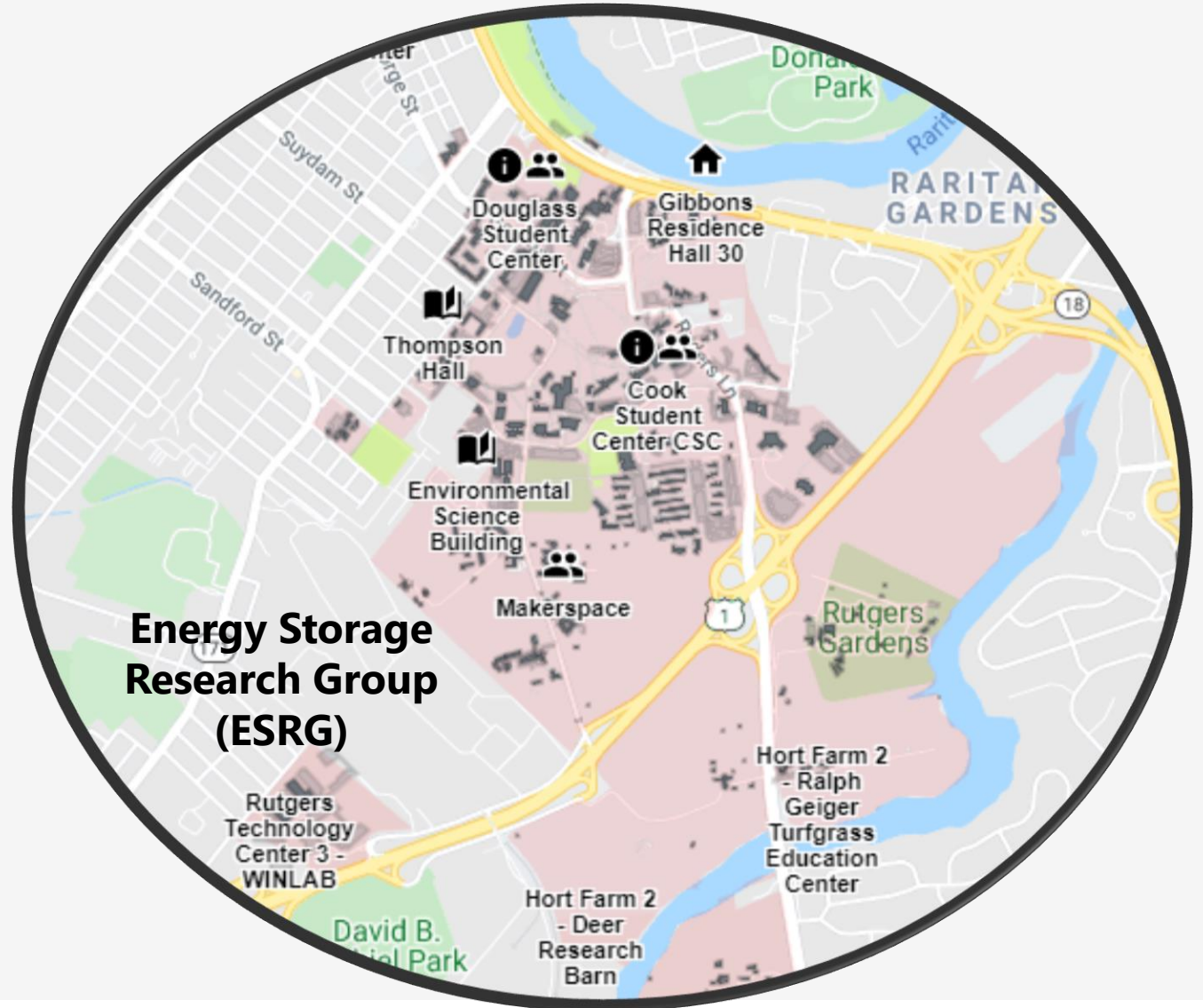
Li-Ion Batteries

By Gustavo Ramirez



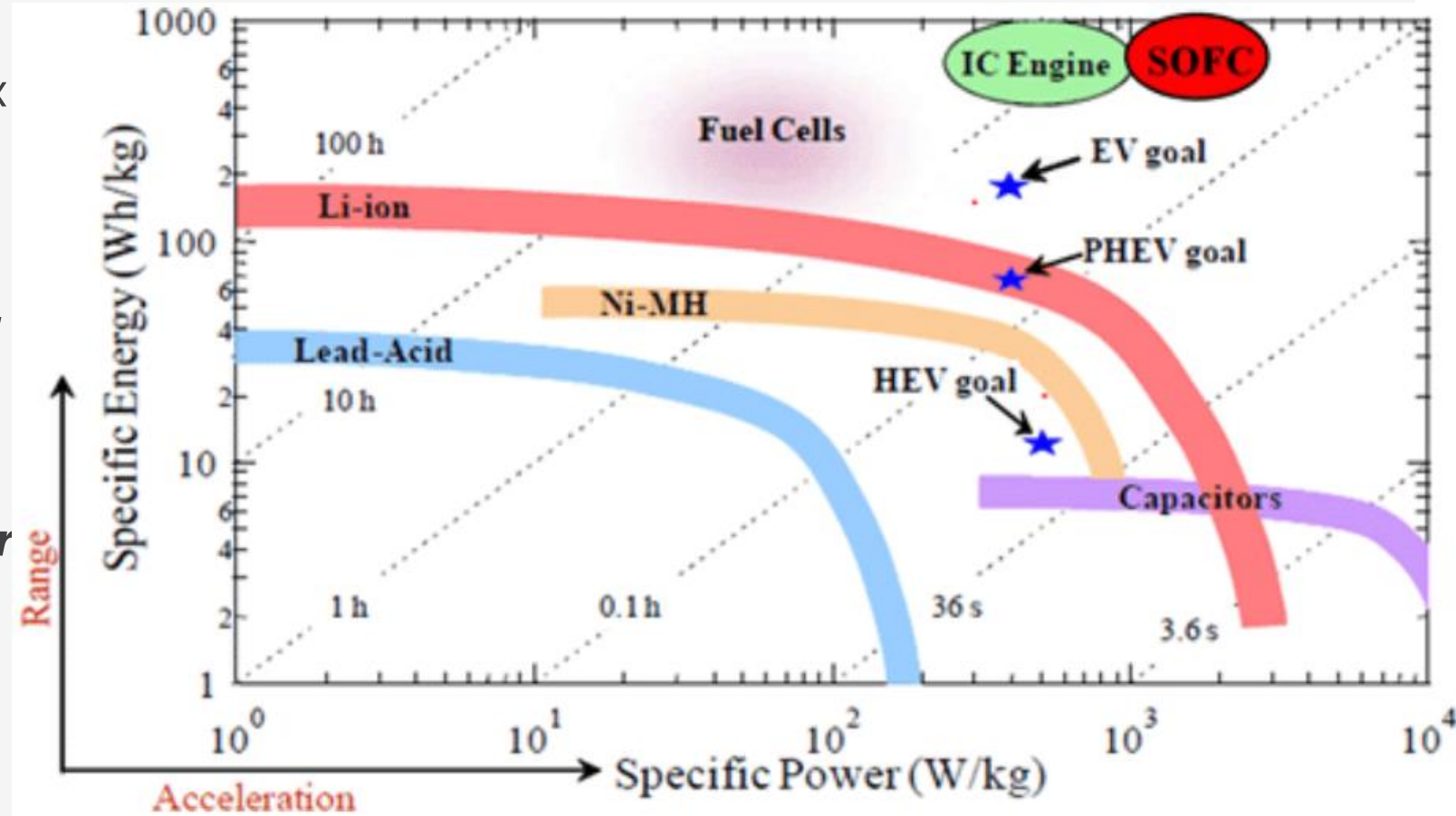
OVERVIEW

- Introduction to battery as a technology
- Current Li-ion batteries
- Next Generation?



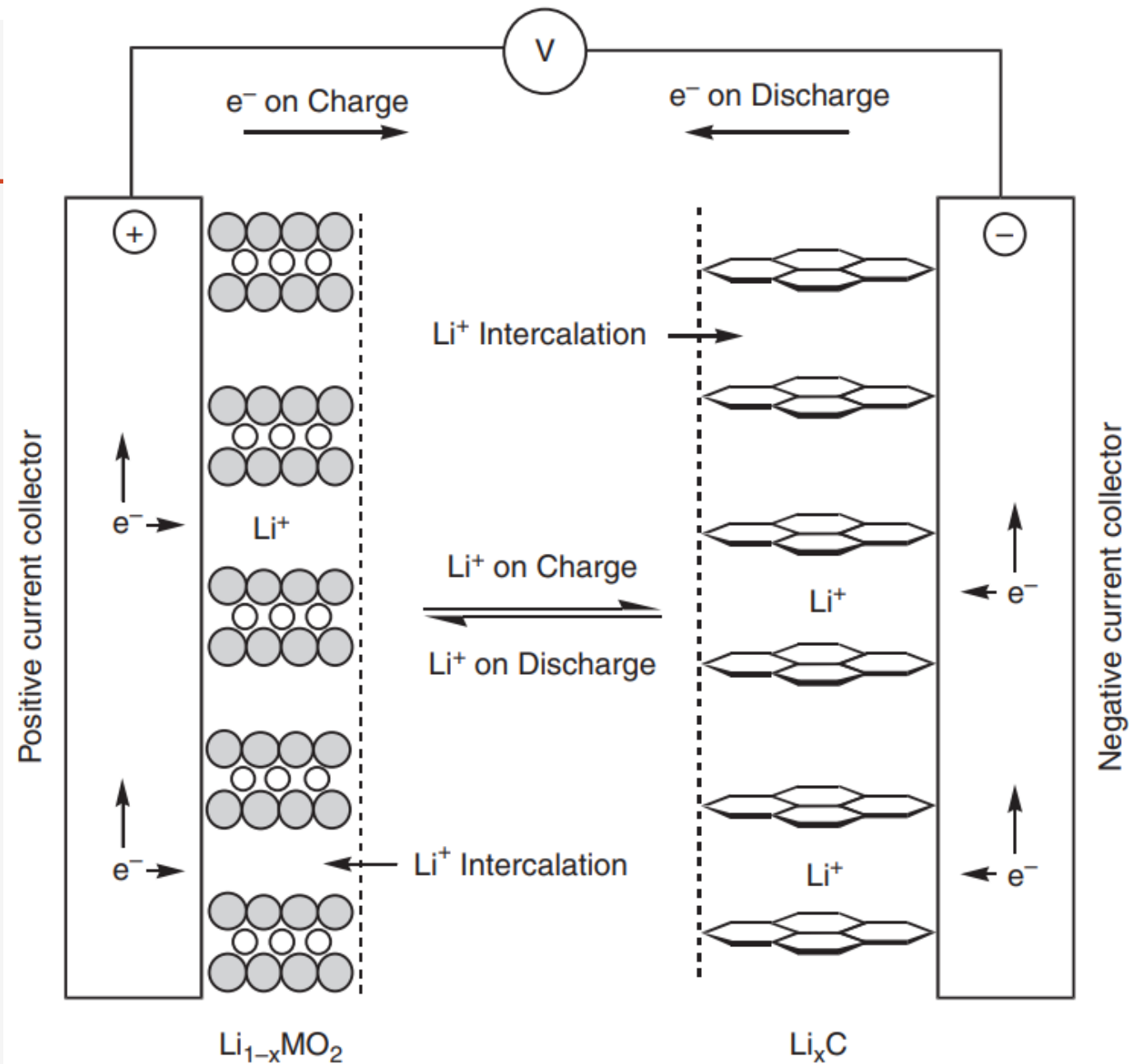
Introduction to the Battery

- **Cell** is the fundamental unit of a battery; converts chemical energy **directly** into electrochemical energy via redox reaction
- Technology is the **ability to store energy into the future in the form of an electrochemical reaction**
- **Current Li-ion battery technology is on par with other mature battery technologies, and there's still significant room for improvement!**



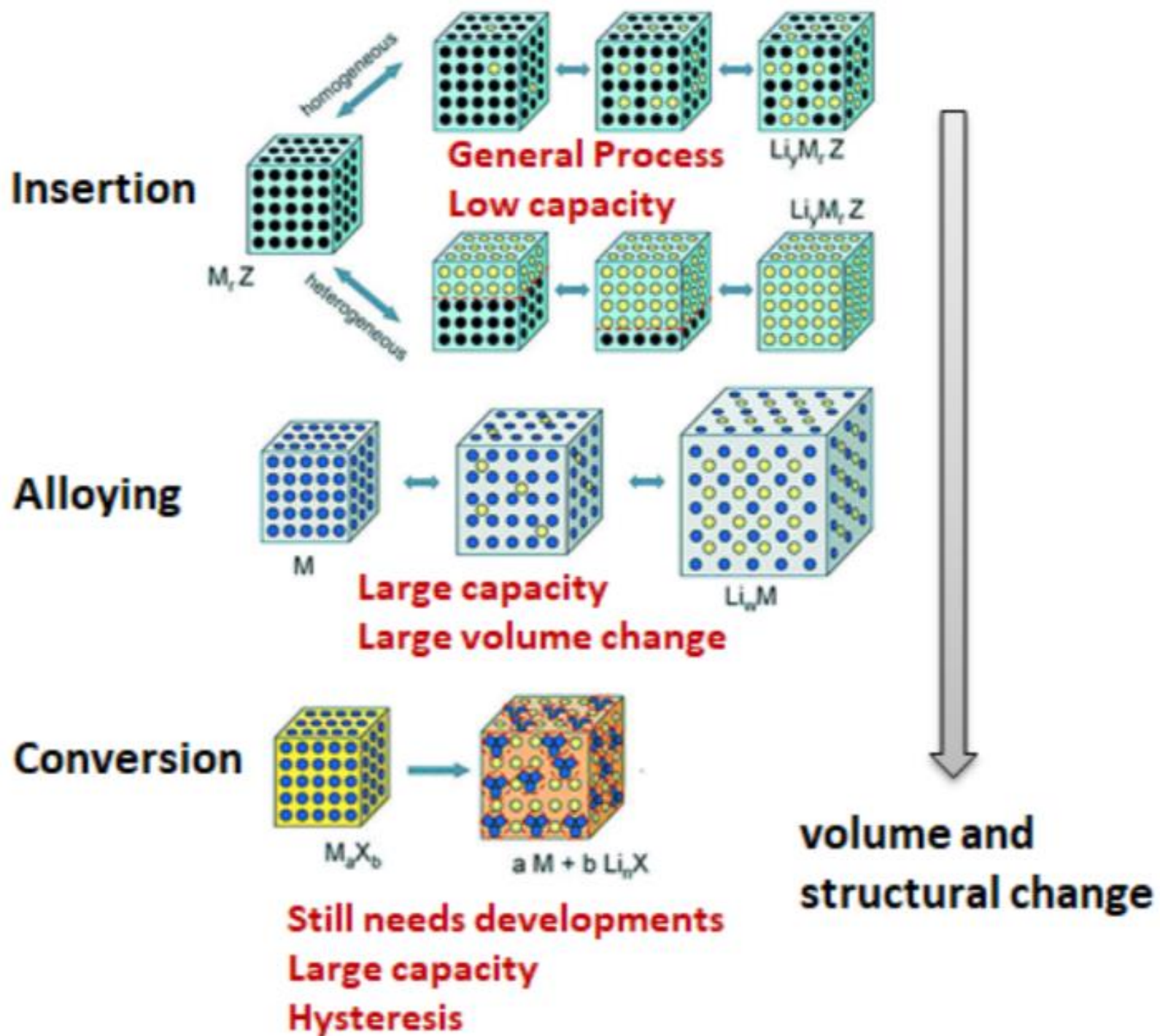
Lithium-Ion Battery

- **Li-ion battery conducts Li-ions between its 3 main components:** cathode, anode, and electrolyte
- **Cathode (+)** uses a **transition metal oxide:**
$$x\text{Li}^+ + xe^- + \text{Li}_{1-x}\text{MeO}_2 \leftrightarrow \text{LiMeO}_2$$
- **Anode (-)** uses a **carbon:**
$$\text{Li}_x\text{C}_6 \leftrightarrow x\text{Li}^+ + xe^- + \text{C}_6$$
- **Electrolyte** is LiPF_6 salt dissolved in ethylene carbonate (EC) & another carbonate solvent, **providing Li ions**



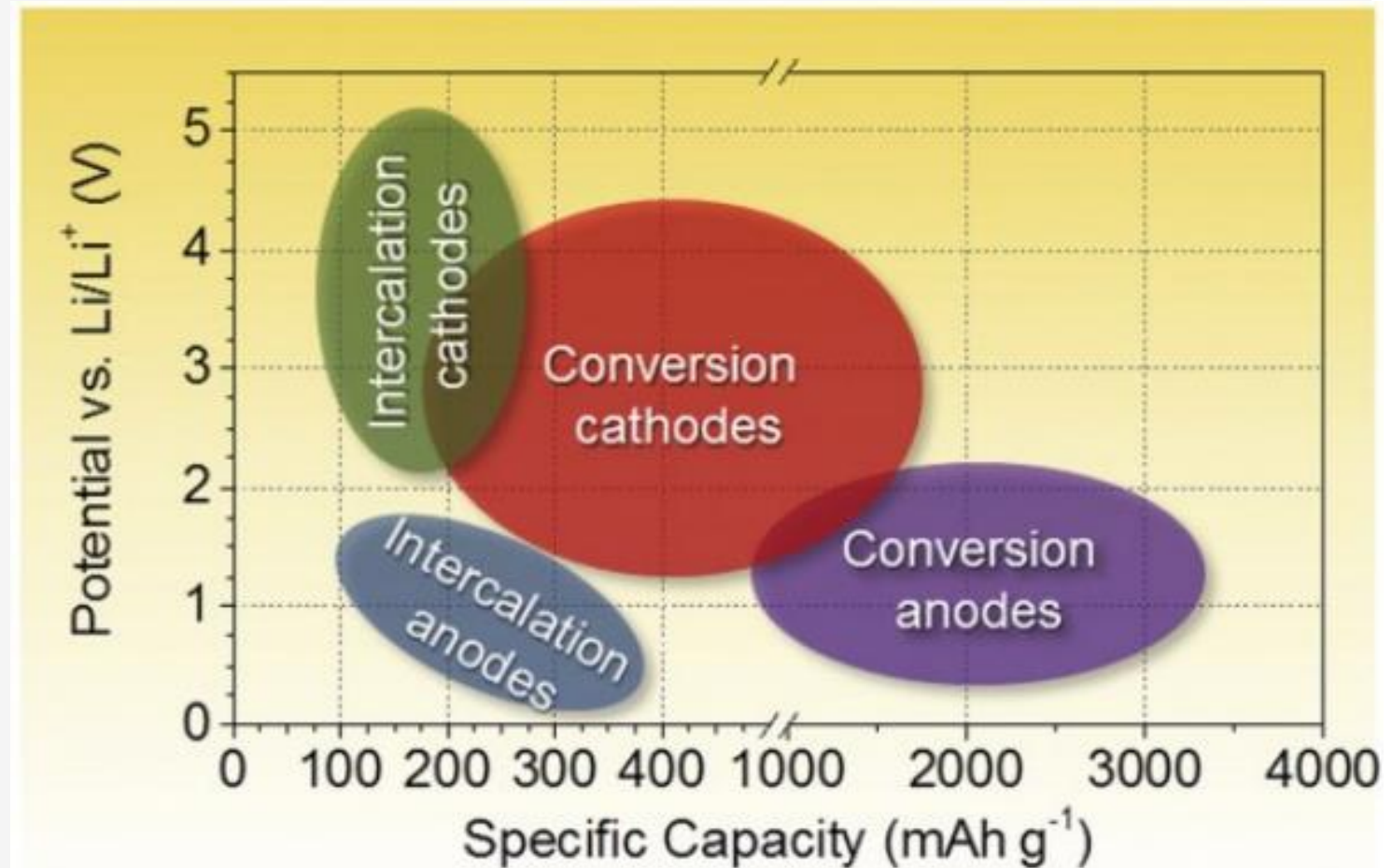
Next Generation?

- Current cathode and anode materials are **intercalation materials**, crystal structure maintained during charge/discharge
- **Alloying materials (-)** alloy with lithium, causing massive volume expansions
- **Conversion materials (+)** experience complete dissolution of the crystal structure:
$$x\text{Li}^+ + x\text{e}^- + \text{MeF}_x \leftrightarrow \text{Me}^0 + x\text{LiF}$$



Advantage Over Intercalation

- Conversion and alloying materials **allow more lithium per amount of metal than intercalation** (≤ 1)
- **Remarkable increases in gravimetric and volumetric capacities are possible for both cathode and anode materials**
- There are many challenges awaiting regarding structure integrity during prolonged cycling



Thank You!

