Docket #: S18-311

Coating Design based on Ion-conductive Organic Networks (IONs) to improve safety and stability of Lithium Metal Batteries

Researchers at Stanford University and SLAC National Accelerator Laboratory have developed a new coating design which makes lithium metal batteries stable and promising for further development. This new coating forms an artificial solid electrolyte interface (SEI) to prevent cracking and formation of dendrites, preventing fires and explosions.

The team integrated dynamic flowability, fast single-ion conduction, and electrolyte-blocking property into a single matrix, the dynamic single-ion-conductive network (DSN), to obtain a multifunctional coating material. The DSN helps to form a stable protection layer on Li surface, to lower the interfacial impedance and make the cycle life longer for Li metal anodes. This is believed to be the first example of a multifunctional coating layer in a single chemical structure/polymer. With the DSN, the team achieved long cycle life for lithium-metal full cells in commercial carbonate electrolyte. In addition. the solution processability of DSN enables large-scale fabrication.

This invention has the potential to provide a new path for developing practical lithium-metal batteries.

Related Technologies:

Stanford docket S15-458 - "Thermoresponsive Material to Prevent Battery Fire"

This invention is a high-performance, ultrafast, thermoresponsive polymer that can act as a circuit breaker to prevent fires in next-generation high-energy-density batteries by rapidly and reversibly turning off when overheated.

Figure:

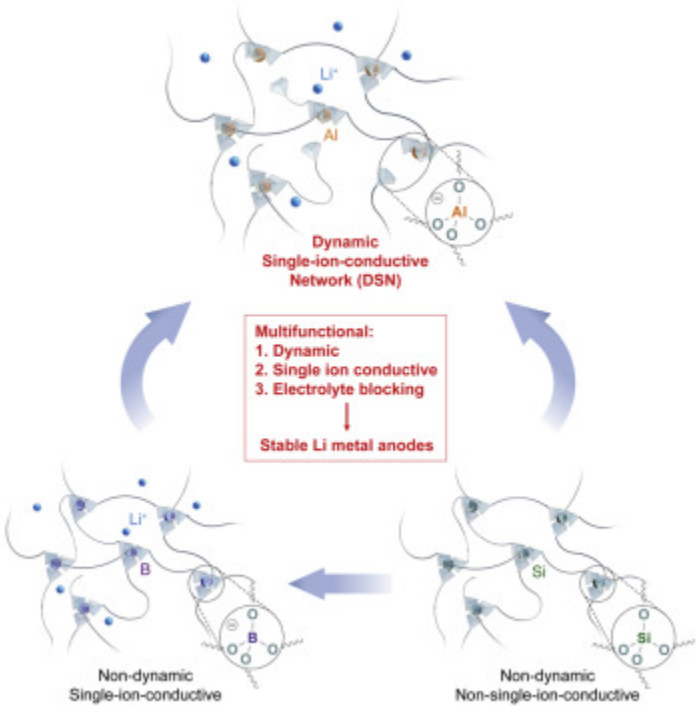

Figure Description - Graphical Abstract-multifunctional material to improve the stability of lithium-metal anodes

Stage of Development:

- **Refining coating design** to increase capacity retention and testing cells over more cycles
- After 160 cycles, these Li metal cells still delivered **85 percent of the power** as in their first cycle, as compared to 35% in current Li metal cells.

Applications

- **Consumer electronics**
- **Ultimately, electric vehicles**

Advantages

- **Safer and more stable** - coating is an Artificial Solid Electrolyte Interface (SEI) which limits formation of dendrites which a key limitation to lithium metal

battery development
- **Can be a new approach to developing practical lithium metal batteries** which are more powerful and lightweight
- **Scalable production**
- **Can be applied to Li-S and Li-air batteries**
- **Key features:**
    - Solution processable
    - Low cost
    - Easy to process
    - Tunable
    - Simple and atom-economic
    - Novel structures
    - Clean and easy reaction to procure
    - Li-ion conductive
    - single ion conductive
    - NO side reaction with Li metal

Publications

- Z. Yu, D.G. Mackanic, W. Michaels, J. Qin, Y. Cui and Z. Bao A Dynamic, Electyrolyte-Blocking, and Single-Ion-Conductive Network for Stable Lithium-Metal Anodes *Joule* August 26, 2019.

Patents

- Published Application: WO2020072650
- Published Application: 20220045332
- Issued: 11,909,050 (USA)

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