Docket #: S17-211

Stretchable and Elastic Polymer Electrolyte for Lithium Ion Batteries

Engineers at the Zhenan Bao Lab have developed an elastic Li-ion conductor with dual covalent and dynamic hydrogen bonding crosslinks providing high mechanical resilience without sacrificing the room temperature ionic conductivity. A solid?state lithium?metal/$LiFePO_4$ cell with this resilient electrolyte can operate at room temperature with a high cathode capacity of 152 mAh $g^{?1}$ for 300 cycles and can maintain operation even after being subjected to intense mechanical impact testing. This new dual crosslinking design provides robust mechanical properties while maintaining ionic conductivity similar to state-of-the-art polymer-based electrolytes. This approach opens a route toward stable, high performance operation of solid state batteries even under extreme abuse.

Figure

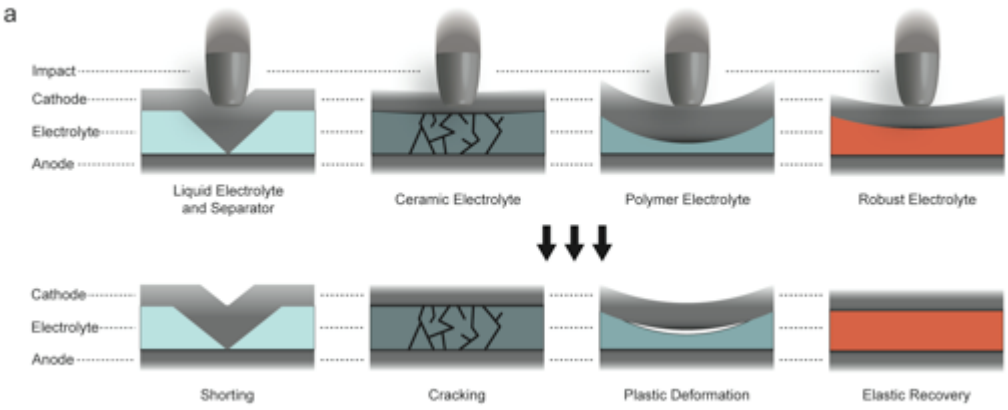


Figure description - a) Schematic of the response of different LIB electrolyte materials after being subjected to an impact. Liquid, ceramic, and polymer electrolytes short, crack, and deform respectively. Meanwhile, an elastic electrolyte material can reversibly recover and survive the impact event to continue operation.

Stage of Research

- Synthesized an elastomer capable of conducting Li-ions
- Tested in half and full coin cells

Applications

- **Stretchable/flexible batteries** - as binder to create freestanding stretchable electrodes
- **Solid state lithium metal batteries** – as solid-state electrolyte in combination with any existing or future anode and cathode materials

Advantages

- **This elastic conductor can:**
  - Demonstrate superior mechanical and thermal stability up to 350 °C
  - Can operate at room temperature with a high cathode capacity of 152 mAh $g^{?1}$ for 300 cycles
  - Function as a binder for both electrodes
  - Withstand high mechanical stress
  - Demonstrate low creep under sustained stress
  - Replace flammable organic liquid electrolytes, thus safer
  - Enable the stable cycling of all-solid-state batteries
- Solid-state electrolyte materials are **cheap and easy to process**
- Solid-state electrolyte materials can **advance development of solid-state batteries** which have higher stability

Publications

- J. Lopez, Y. Sun, D. G. Mackanic, M. Lee, A. M. Foudeh, M.S. Song, Y. Cui, Z. Bao, "A Dual Crosslinking Design for Resilient Lithium?Ion Conductors" *Adv. Mater.* 2018, 1804142.

Patents

- Published Application: 20190229371
- Issued: 10,978,735 (USA)

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