BEA Zeolite Membranes for Li-Ion Batteries

Yaris Eidenbenz, Material Science Engineering
Mentor: Regents Professor, Jerry Lin
School for Engineering of Matter, Transport and Energy

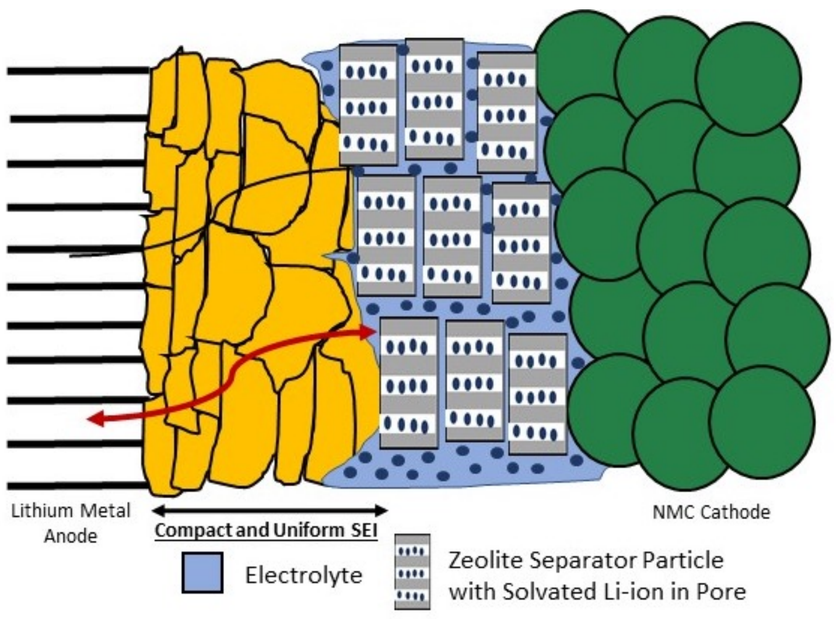
Introduction

Lithium-ion batteries are critical for renewable energy storage but are limited by the safety and performance of conventional polymer separators. BEA-type zeolites offer a promising alternative due to their high thermal stability and well-defined microporous structures that support lithium-ion transport. In this project, BEA zeolite materials are synthesized and processed into battery separators, then evaluated in coin cells to assess electrochemical performance and separator functionality.

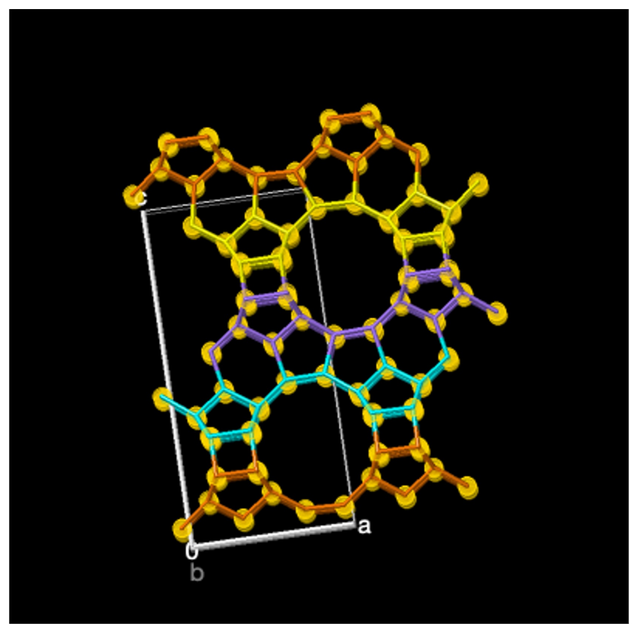
Hypothesis

The objective of this research is to evaluate BEA nanostructured zeolite membranes as ion-selective lithium-ion battery separators and compare their performance to conventional polypropylene (PP) separators . BEA zeolites with high intraparticle porosity, low interparticle porosity, and high tortuosity will enable more uniform lithium-ion flux and improved electrochemical performance.

Depicts Li-ion Separator Mechanism

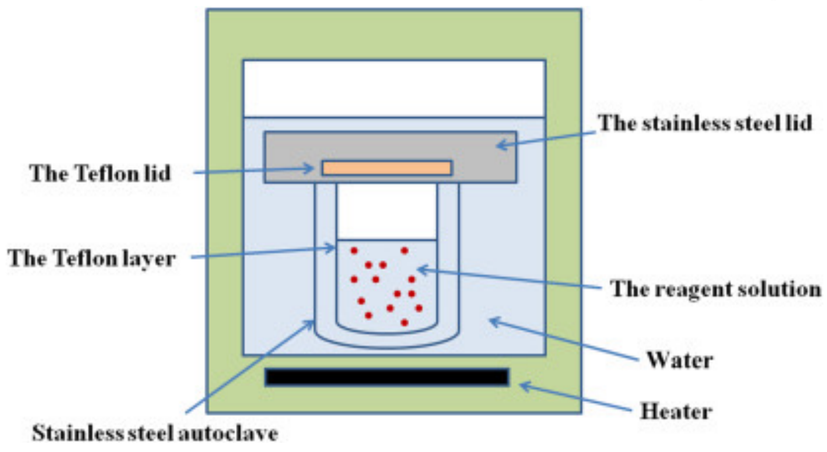


BEA crystal structure viewed along the a-axis[1]

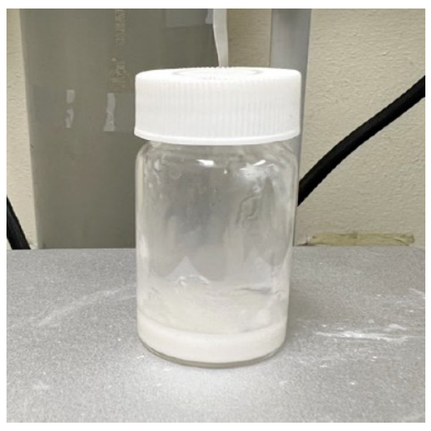


Methods

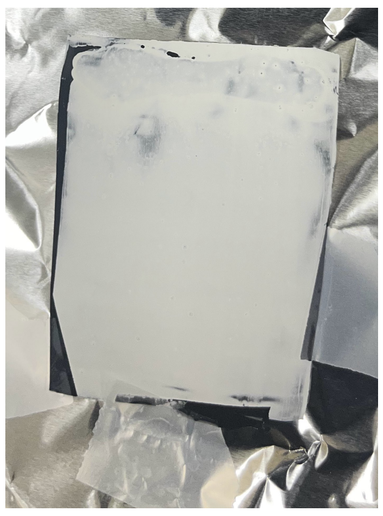
1. BEA Zeolite is synthesized via hydrothermal synthesis [2]



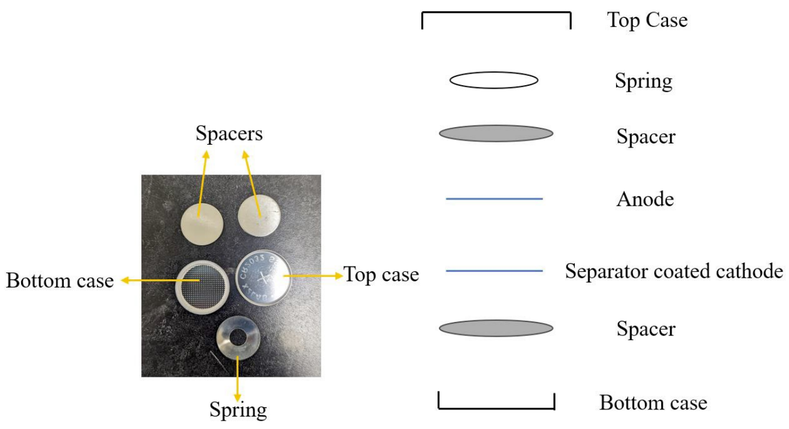
2. Synthesized BEA powder is dispersed in water and poly (vinyl alcohol)to make slurry [3]



3. Slurry is coated on NMC Cathode using blade coating then cut into 16 mm disks



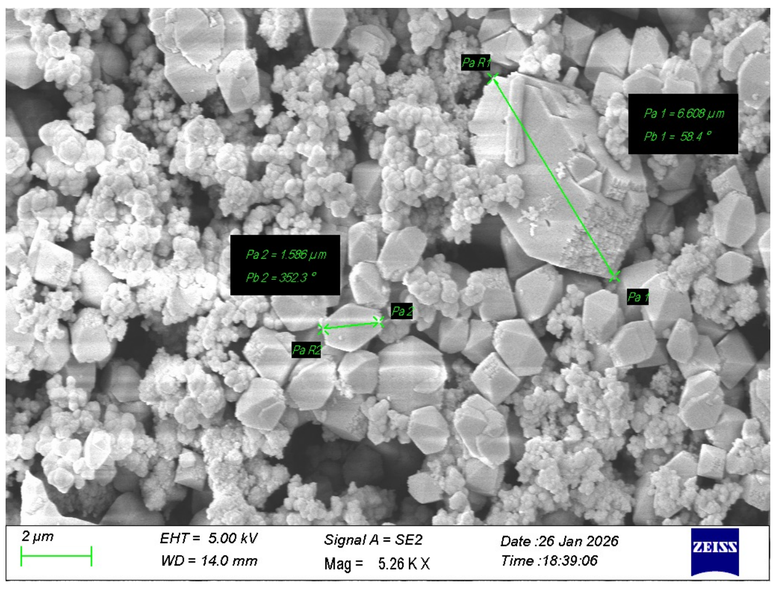
4. Coated cathode coin cell was assembled in glove box [4]



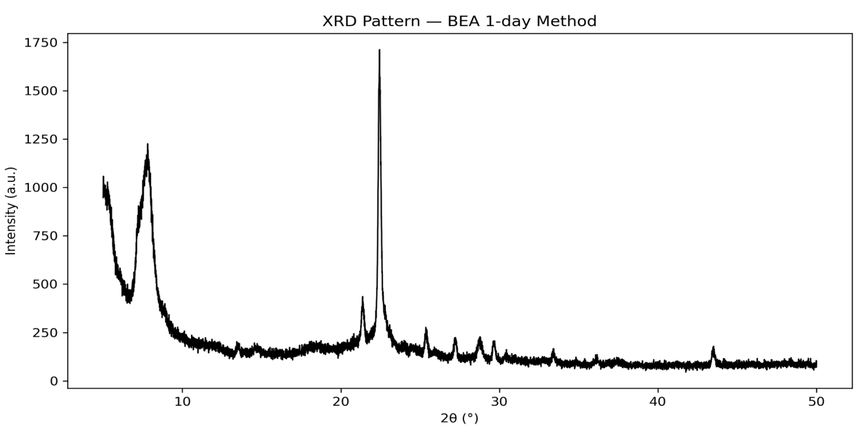
Results

- BEA zeolite was successfully synthesized and validated by scanning electron microscopy (SEM) and X-ray diffraction (XRD)
- Coin cells were successfully assembled with conventional PP separators
- PP separators were tested and exhibited stable constant- current, constant-voltage cycling behavior

SEM Image of BEA Crystals



XRD Pattern of BEA Crystals



Future Direction

- Further optimize BEA synthesis, slurry preparation, and membrane coating
- Assemble coin cells with BEA-coated cathodes for electrochemical evaluation
- Scale up BEA zeolite synthesis

References

[1] International Zeolite Association Structure Commission (IZA-SC). Database of Zeolite Structures: BEA Framework. Accessed February 2026.
[2] “Hydrothermal Synthesis.” ScienceDirect, Elsevier
[3] Liu, Chia-Ling. Zeolite Membrane Coating on Anode as Separator in Li-ion Batteries. Arizona State University, 11 Dec. 2025. Applied Project Report.
[4] Nalam, Ramasai Dharani Harika. Zeolite Synthesis and Its Application as a Separator for Safe Li-ion and Li-metal Batteries. Arizona State University, 2023.

FURI

Ira A. Fulton Schools of Engineering
Arizona State University