Improving Production of Lithium Based Perovskites (LLTO) for Solid-State Batteries

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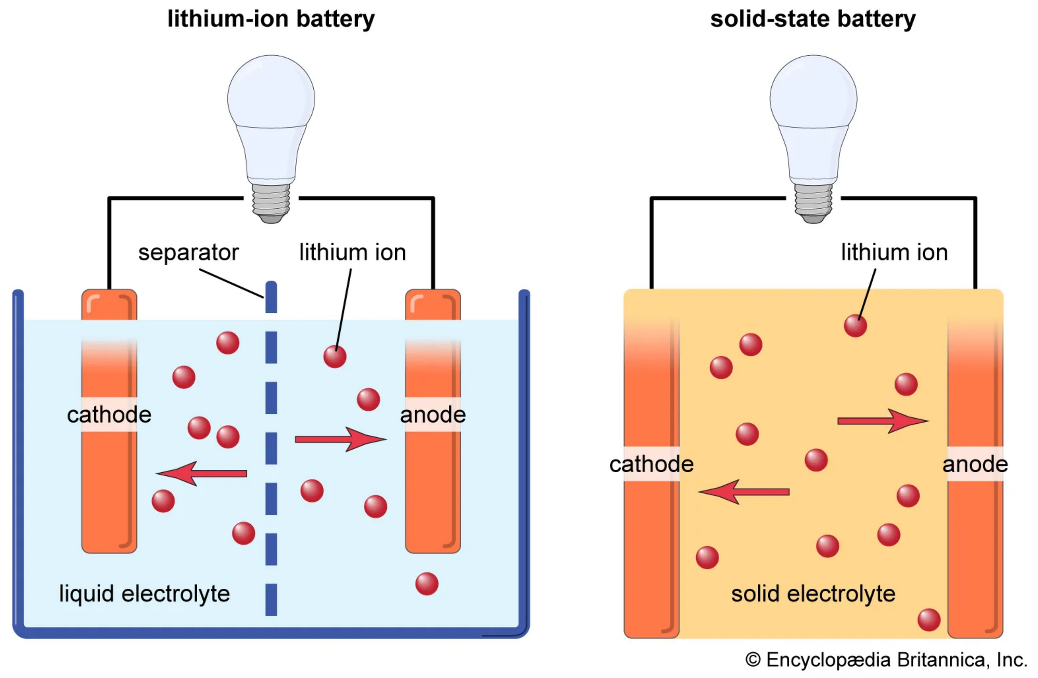
Background

With the growth of the sustainable energy sector, the demand for better batteries is rising. Recently, solid-state batteries have gained attention as a potential replacement for current liquid electrolyte batteries due to a variety of factors including:

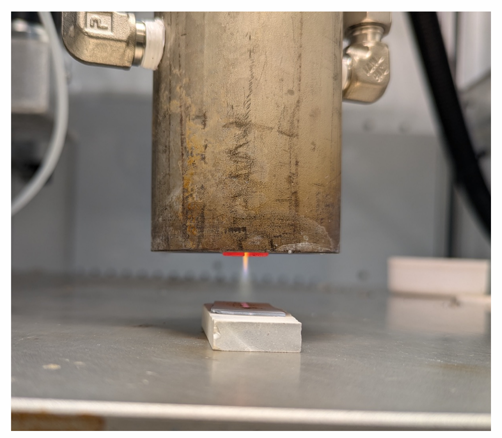
- Safety. Solid state batteries are much less volatile than modern lithium-ion batteries.
- Energy storage. Solid-state batteries may be able to store and transfer more energy than current lithium-ion batteries.



This research focuses on improving the production of lithium-based perovskites (LLTO), a potential electrolyte for solid-state batteries. Currently perovskite suffers from poor production time. Rapid thermal processing and plasma treatment are explored as methods for faster and better production.

Furnace (current standard)
>5 hours

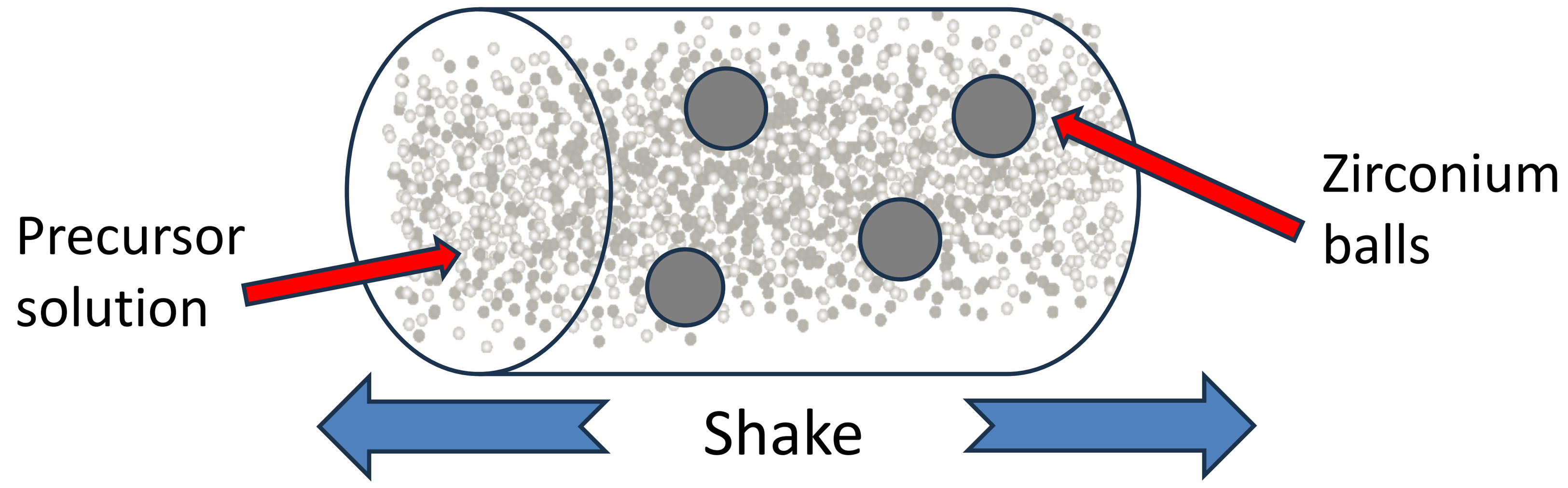
Rapid thermal processer
~30 minutes



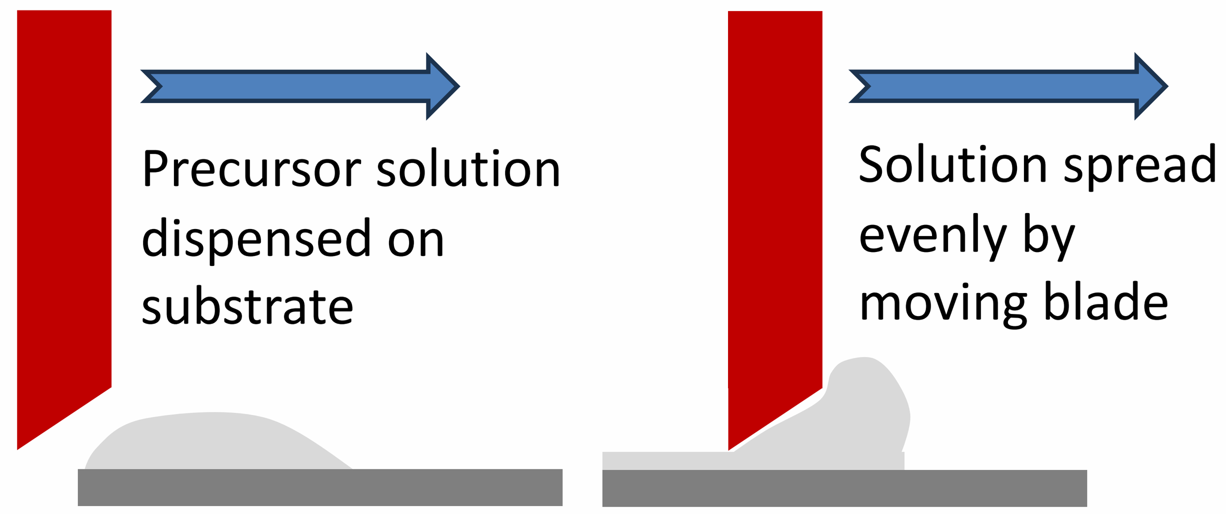
Plasma Treatment
<5 minutes

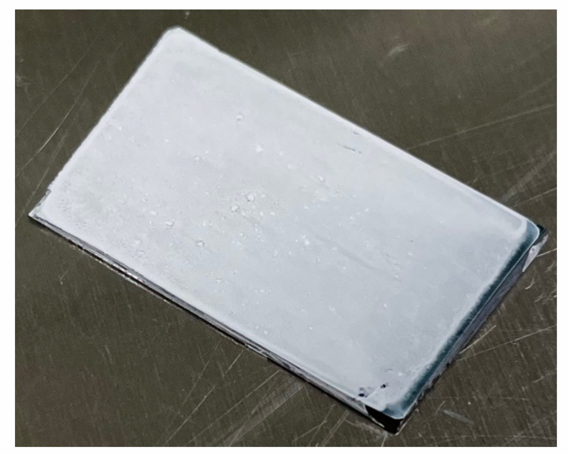
Process

Based on previous work, lanthanum oxide, titanium oxide, lithium compounds (i.e. lithium carbonate) were chosen as precursors.



Precursors dissolved in IPA and ball milled.





Example of resulting untreated film

Solution is then blade coated (above) and placed on a hot plate for around 5 minutes to dry. Various parameters of blade coating were adjusted in an attempt to produce optimal films.

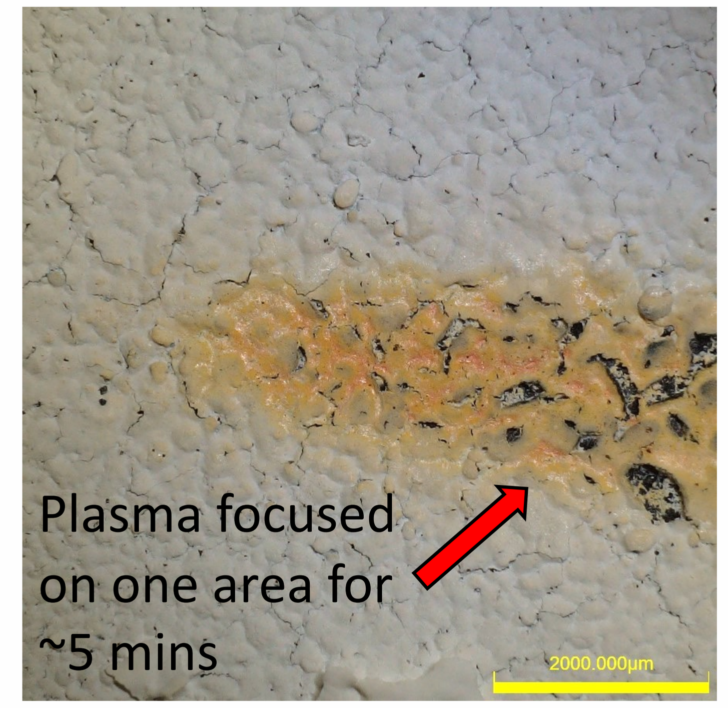
Films then underwent rapid thermal processing or plasma treatment for annealing and curing (as seen on bottom left).

Results

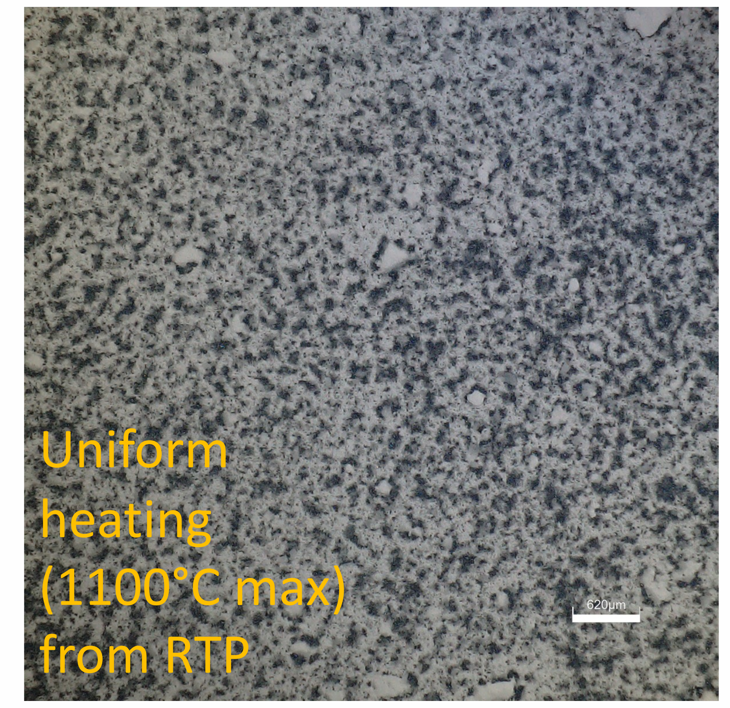
.Various films under a variety of conditions were produced. General findings include:

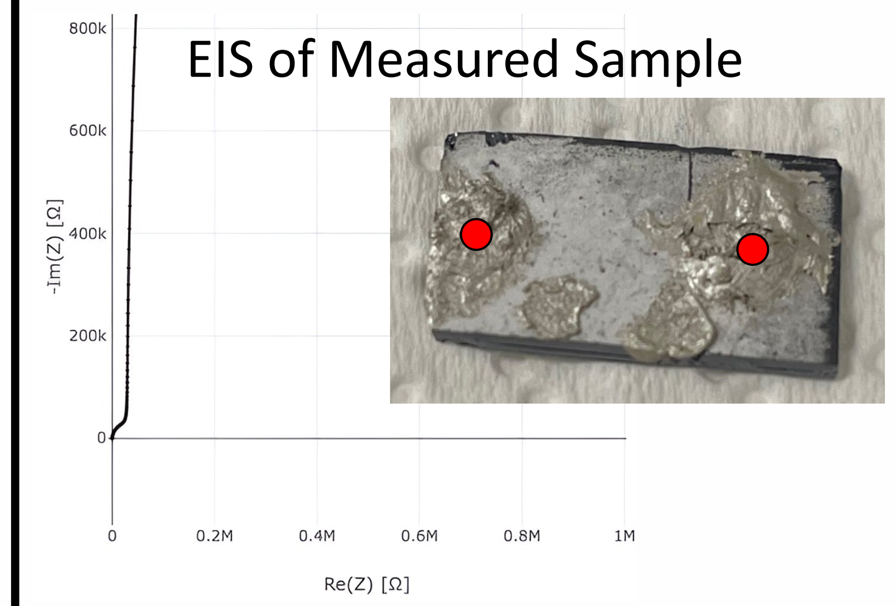
- Rapid thermal processing was easier than plasma treatment.
- Films annealed through rapid thermal processing produced a tough hard gray layer covered by a more fragile white layer.
- Relatively thinner films are better than thicker films.
- Films produced showed conductivity but are not perfect.

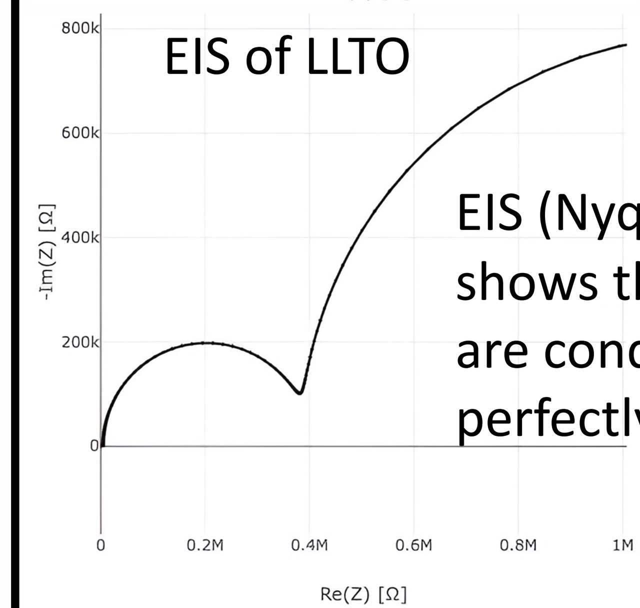
Plasma treatment of films



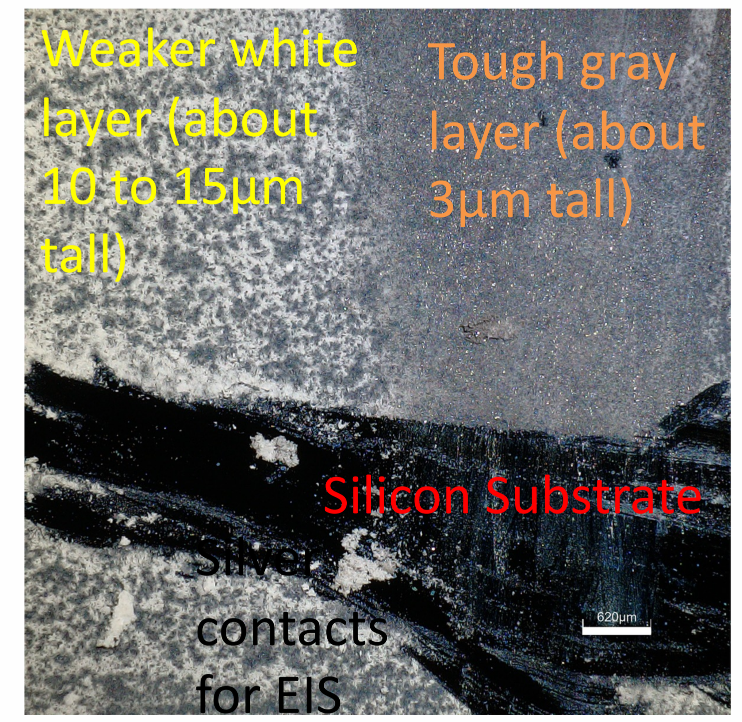
Rapid thermal processing of films







EIS (Nyquist plots) shows that RTP samples are conductive but don't perfectly match LLTO.



Silicon substrate and gray layer revealed by scratching film before RTP and after RTP, respectively.

Future Work

- Determine exact composition of the layers formed by rapid thermal processing.
- Find ideal conditions for films to form LLTO.
- Try different precursors for LLTO.
- Make adjustments to better form perovskite through plasma treatment.

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Sources: [1]"Seattle Pottery Supply - Series 28 - Model 284 Pottery Kiln," *Soul Ceramics*, 2023. https://www.soulceramics.com/products/seattle-pottery-supply-series-28-model-284-pottery-kiln (accessed Nov. 09, 2024).

[2]Company, "ALLWIN21 AccuThermo AW 810," *Caeonline.com*, 2024. https://caeonline.com/buy/rapid-thermal-processors/allwin21-accuthermo-aw-810/293619764 (accessed Nov. 09, 2024).

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Special thanks to the other students in the Rolston lab who helped mentor and teach me, including: Sahal, Vineeth, Marco, and Hanson. Thank you!

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