ENVIROMENTALLY FRIENDLY ALL SOLID-STATE BATTERIES

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Current Li-ion?

Li-ion batteries are leading current battery technology however:

Toxic NMP solvent is used for the fabrication of toxic active material.

Uses flammable liquid electrolyte, combined with oxygen based electrode materials, they risk combustion!

Li-ion is also harder to manufacture due to air sensitive liquid electrolyte.

All Solid State

All solid state batteries avoid the use of dangerous liquid electrolyte by replacing it with a solid one.

Solid electrolyte is:
Safe and stable, allows for faster charging and lightweight batteries that are easier to manufacture.

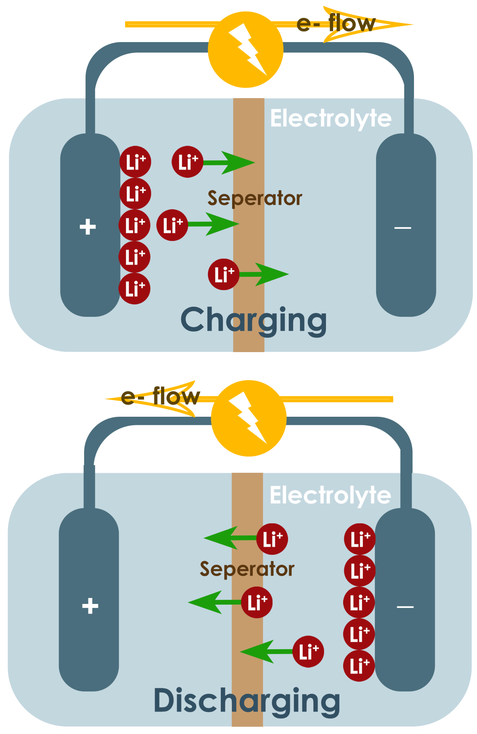
Carboxymethyl-cellulose (CMC) electrolyte is water processable, non-toxic, biodegradable, thereby increasing battery life, safety and making a push towards friendly batteries!

How Do They Work?

Li-ion batteries are usually made from Lithium Cobalt Oxide($LiCoO_2$) for (+) electrode and graphite for the (-) electrode and a liquid electrolyte.

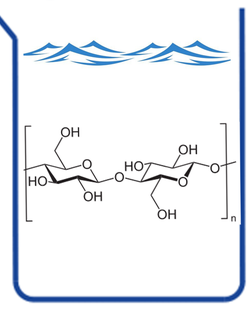
When discharging the cathode (+) is reduced and the anode (-) is oxidized. The opposite happens when charging.

Solid state batteries operate on a similar principle but we use a solid electrolyte instead of a liquid one! Our electrolyte aims to increase cell safety all while pushing towards an enviromentally friendly future!

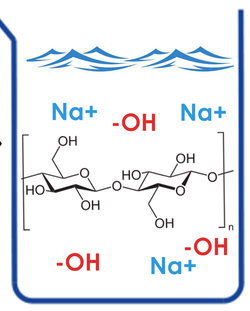


Methodology

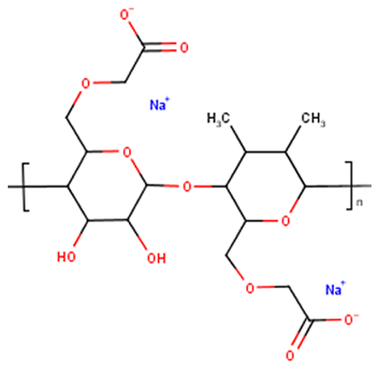
1) Isopropanol
2) CMC



1) NaOH



1) Purification



1) Mix with salt ($LiClO_4$)
2) Ball Mill
3) Cast on Polyimide tape and dry

Data and Results

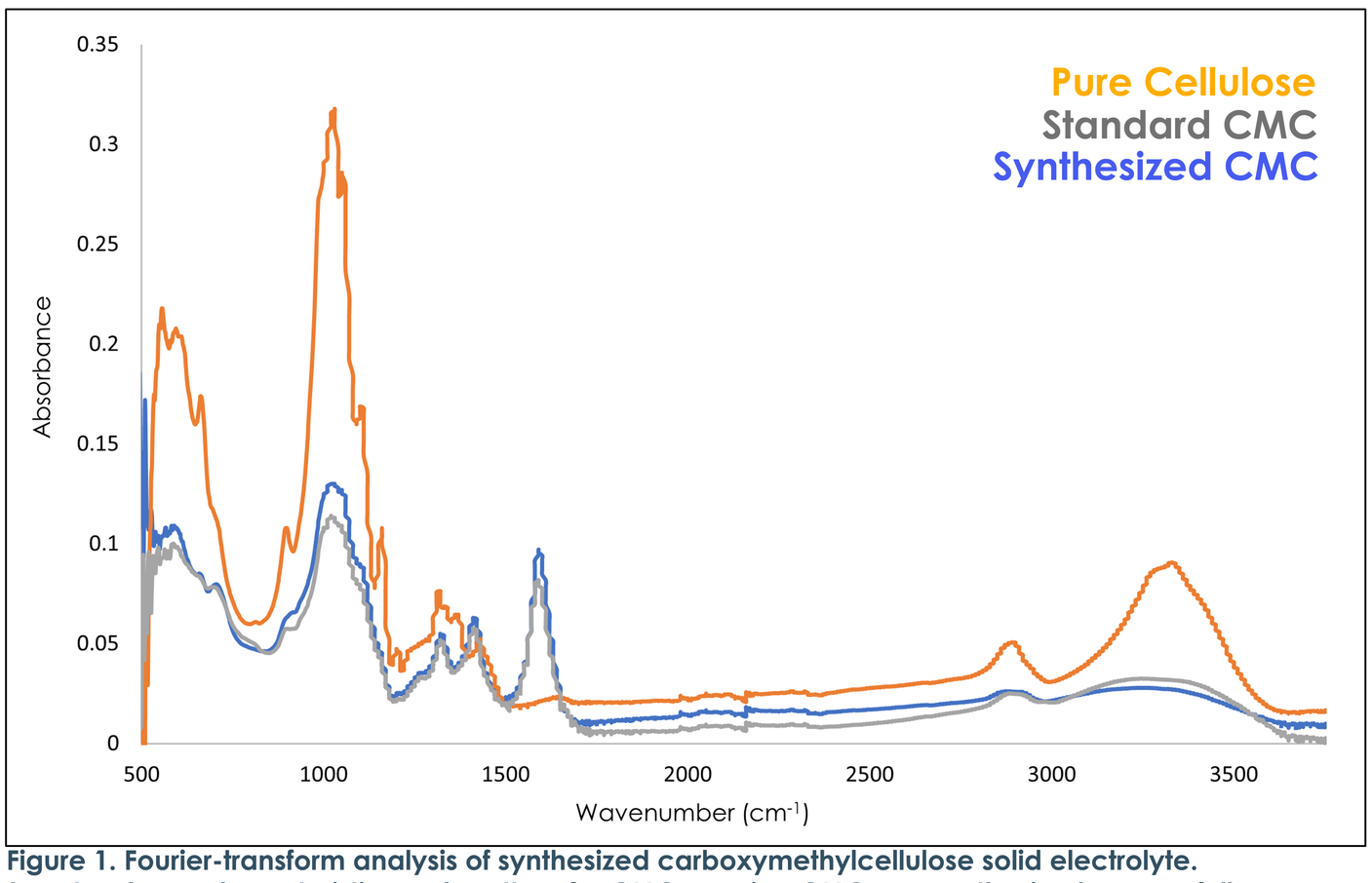


Figure 1. Fourier-transform analysis of synthesized carboxymethylcellulose solid electrolyte. Spectra shows characteristic peak pattern for CMC, proving CMC was synthesized successfully.

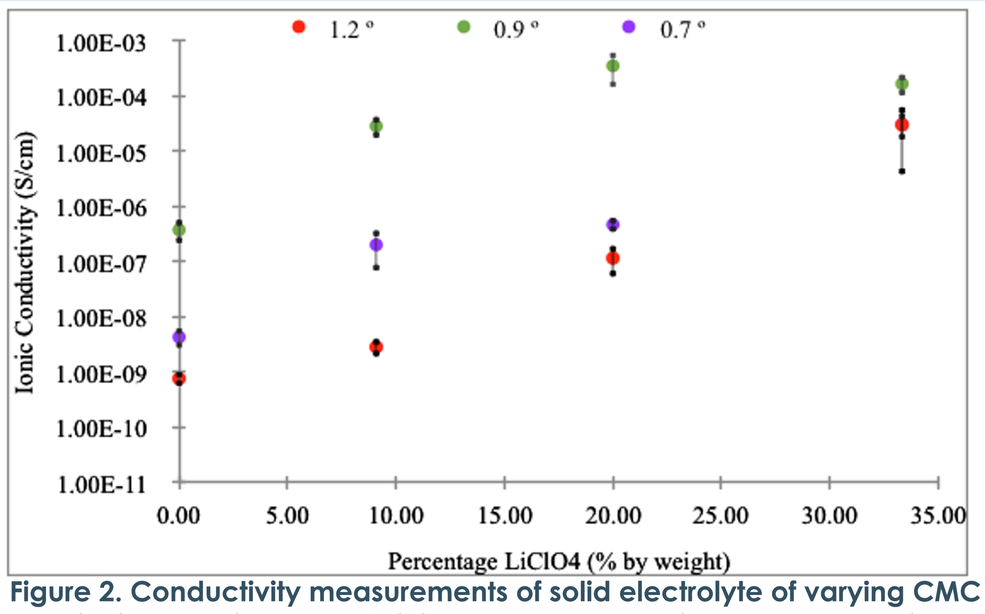


Figure 2. Conductivity measurements of solid electrolyte of varying CMC substitutions against added Lihium salt concentration. As more salt is added, conductivity increases.

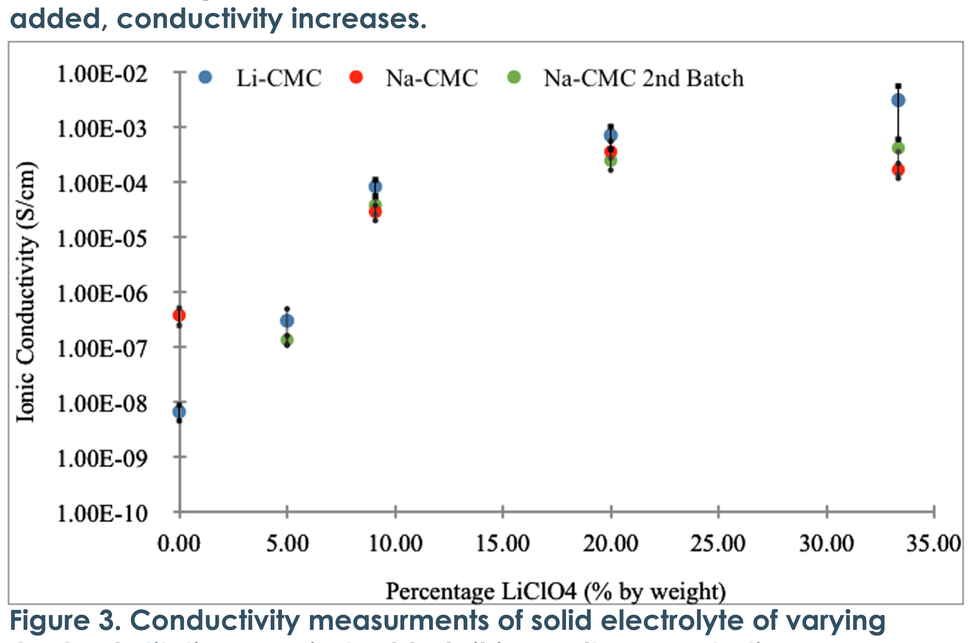


Figure 3. Conductivity measurments of solid electrolyte of varying CMC substitutions against added Lihium salt concentration. As more salt is added, conductivity increases.

What we found:

- Our solid state electrolyte can be isolated with relative ease and is conductive to a reasonable degree.
- Our electrolyte exhibits differing levels of conductivity at varying degrees of susbtitution for CMC.
- When impregnated by lithium ions in place for sodium, conductivity is similar for both Na and Li. A favorable result as we are moving Li-ions in batteries.

Conclusion

- Our electrolyte was found to be conducting at varying levels of substitution for CMC and when replacing Sodium ions for Lithium ions.
- This property will help maintain a conductive network through the electrolyte while cycling the battery.
- We can expect increased perfomance and battery cycle life when our electrolyte is combined with a conductive polymer.

In the Future:

- Incorporate conductive polymer into the electrolyte and observe its effect.
- We would like to apply our findings and see how it truly affects battery performance and use them with a variety of cathode materials and battery designs.

Acknowledgments

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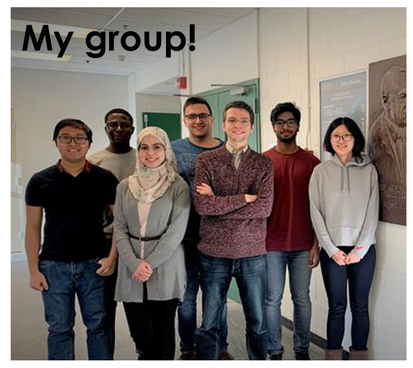
University of Manitoba | Manitoba Institute for Materials
faculty of SCIENCE
discover the unknown + invent the future



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