

Student: Alexandra Martin (Briarcrest Christian High School)

Mentors: Dr. Gary Bohannon (Instructor of Physics and Materials Science at the University of Memphis)
Adriauna Sanders (Undergraduate Biomedical Engineering Student at the University of Memphis)

Introduction

- * **Fractor Devices** are new elements used in electronic circuits that hold constant phase angles over several decades of frequencies of alternating currents in order to provide a control system with sufficient "memory" to adjust the operating conditions.
- * **Phase Angle** is the phase difference between the voltage applied to the impedance and the current driven through it.
- * **Impedance** is the measure of the opposition that a circuit presents to a current when a voltage is applied.
- * **The gradual "forgetfulness" of a fractor** makes it more comparable to biological and chemical concepts, making it an ideal solution to be used in prosthetic arms and other machinery mimicking human movements.
- * **The short term goal of this study** is to build upon previous successful recipes to find the most efficient, accessible, and degradation-proofed form of an ionic compound.
- * **The long term goal of this study** is to create a set of fractors with various fractional orders that can then be given to the department of biomedical engineering to be used in control-powered joints.

Objectives

Can we reproduce previously successful fractors with a **Lithium Nitrate** solution?



Can we exchange **sodium** for lithium?



Does **polyaniline** change mechanical or electrical properties of lithium fractors?

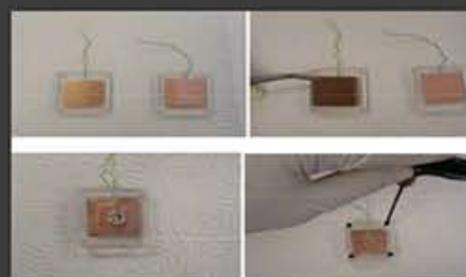
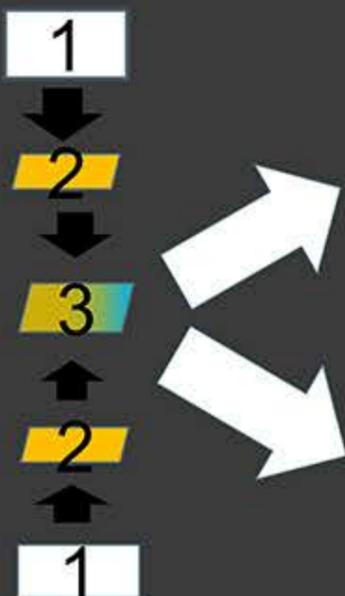
Future Work

Future work will include progressing toward a more compactible, practical fractor for possible commercial use and eventually passing these fractors on to biomedical engineering to be used in control-powered joints.

Acknowledgements

Thanks to Dr. Gary Bohannon for his immense supervision and great wisdom, Adriauna for the smiles and knowledge, Dr. Sabri for this great opportunity, and Sarah, Kathy, Lily, Sneha, and Alisha for always making me smile.

Deconstructed View of Fractor



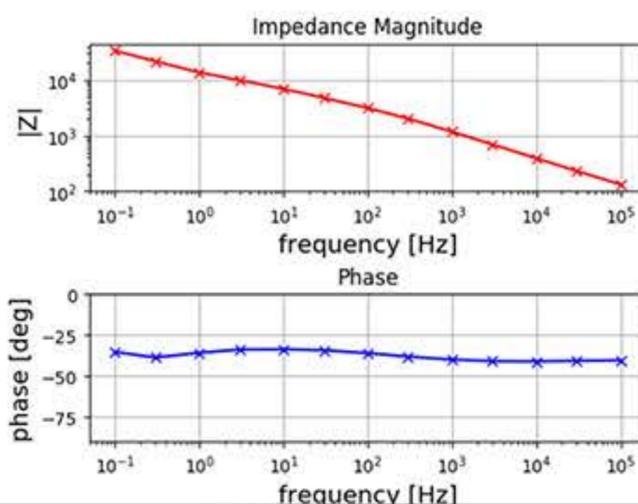
1. Plastic Plate
2. Clean Copper Plate (Electrode)
3. Copper plate covered with ionic solution

Conclusion

We were able to reproduce the lithium fractor with a 20% yield. The sodium fractor was rather unsuccessful as the phase begins to drop among higher frequencies. The same can be said for the lithium fractor contaminated with the polyaniline. Therefore, our attempts at finding a lower-cost solution to the lithium fractor were unsuccessful. However, we discovered that using the oven at a lower temperature to dry the copper plates decreases the fractional order. This discovery could lead to further investigations on other variants that control the electrical properties of a fractor.

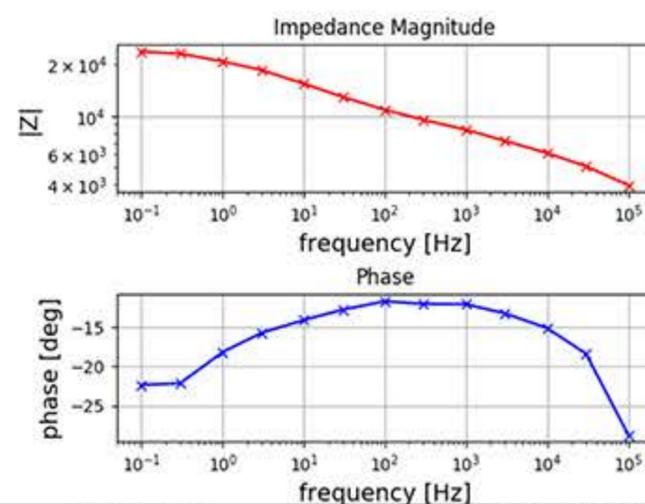
Results

Li Sample#3b (7/7/2017)



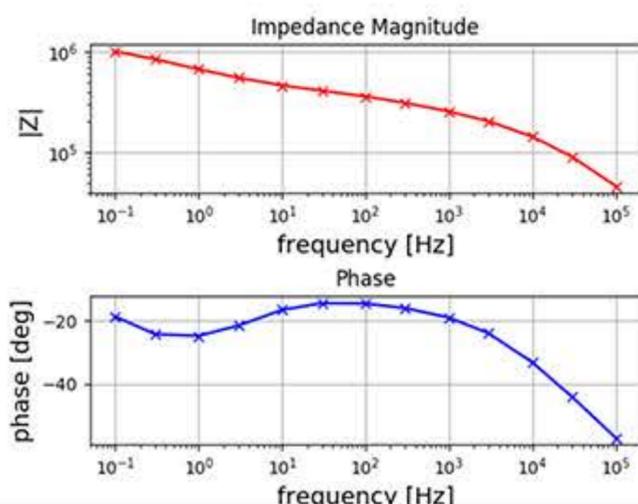
Lithium

Li with PANI #1 (7/10/2017)



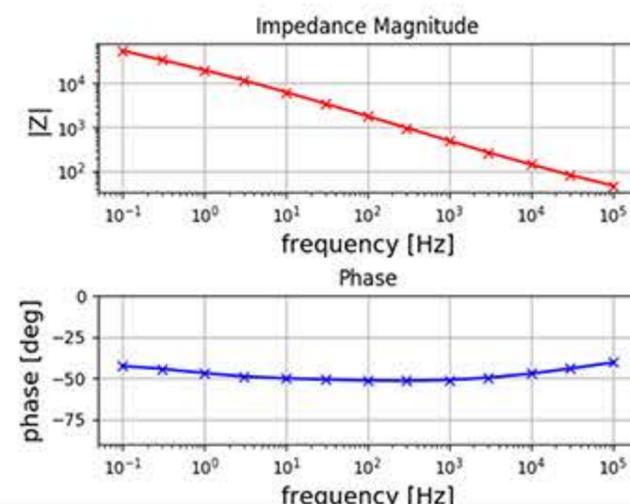
Lithium (with PANI)

Na Sample #2 (7/6/2017)



Sodium

Skytland #3 (7/11/2017)



Ideal Solution

Recipe: 95% ethyl alcohol, tetraethyl-orthosilicate, distilled water, nitric acid