Group: Advanced Materials for Chemical Sensitivity (AMCS)
Project: **Selectively Separating Li^+ Ions from Aqueous Solutions**
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Introduction

Lithium is a critical resource in battery technology, alloys for aircraft materials, fuel for nuclear fusion, etc. and the global demand for lithium is increasing rapidly. Majority of lithium exists as salt lake brine. Thus, separating lithium from magnesium has been of great interest. While there exist methods of extracting lithium, current methods are expensive, consumes other chemicals, and not eco-friendly. (Membrane) Capacitive Deionization ((M)CDI) is an emerging technology that is energy efficient and more sustainable owing to its intrinsic characteristics. Although the primary purpose of MCDI is to desalinate water, it can also be employed to selectively separate ions of interest.

In the present, the use of MCDI to recover lithium relies on utilizing commercially available ion-exchange membranes or electrodes coated with lithium selective adsorbents ($LiMn_2O_4$). We aim to modify porous carbon electrodes with polymer coatings to selectively and reversibly capture lithium ions, using size exclusion, in an MCDI setup (Figure 1). These polymer coatings will be in at nanometer scale in terms of their thickness, reducing the electrical resistance, which in turn is expected to increase the recovery efficiency.

Goal

To selectively separate Li^+ ions from an aqueous mixture containing both monovalent and divalent ion using MCDI.

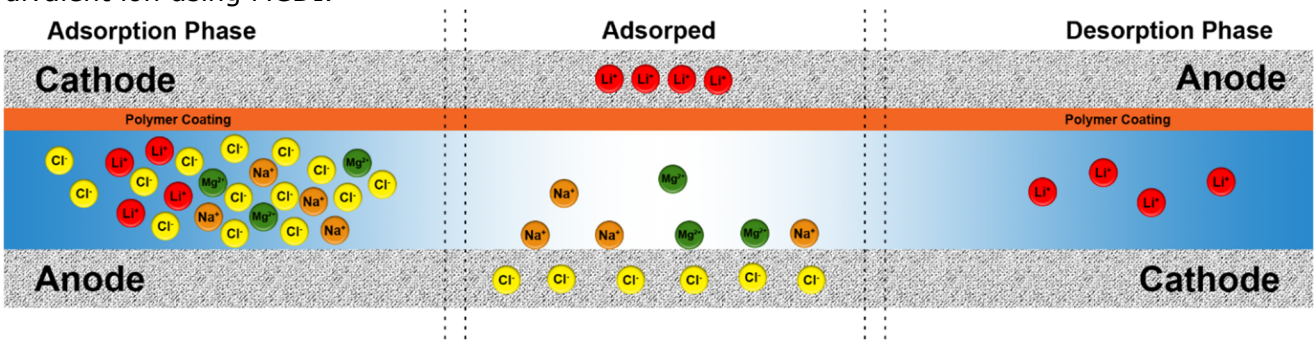

Figure 2. Conceptual representation of the proposed MCDI setup. The cathode is coated with a polymer layer that selectively adsorbs Li^+ ions. Once the electrode is saturated with Li^+, the rest of the ions are flushed out of the stream, followed by desorption of Li^+ ions by reversing the electrical field, ideally generating a Li^+ rich stream.

Several research questions can be addressed during this project. What type of polymer coating(s) would allow the separation between Li^+ and other ions? What is the optimal thickness of the coating? What are the optimal operating conditions of the MCDI setup (cell voltage, flow rate, pH, ionic strength)? Using these questions as a guide, the aim is to tune the polymer coating and the operational conditions to achieve selective separation of Li^+ ions.

Techniques to be used

- Synthesis (+ NMR, UV-Vis, IR)
- Surface modification and characterization (XPS, AFM)
- Various analytical and electrochemical techniques

For more information

1) *Sep. Purif. Technol.* **2019**, *210*, 885-890 [link], 2) *Desalination* **2019**, *449*, 118-130 [link], 3) *Prog. Mater. Sci.* **2013**, *58*, 1388-1442 [link], 4) *J. Membr. Sci.* **2010**, *346*, 256-262 [link]

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