Group: Advanced Materials for Chemical Selectivity
Project: Catching Lithium Ions from Aqueous Solutions
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The global consumption of lithium to fabricate batteries is ever increasing. Lithium is harvested from natural resources, mainly from lithium-containing brines, which is extracted from underground pools and then concentrated by the solar-driven evaporation of water. This works well, but it is time-consuming and costly process.

This project aims removing lithium ions from aqueous solutions instead of removing the water from lithium salts. Catching alkali metal ions rather specifically can be achieved by size-tuneable macrocyclic compounds, more generally known are ionophores. For example, crown ethers. Several derivatives of these compounds are commercially available and some of these have a handle (functional group) that can be used to immobilize them on a surface. Figure 1 *(left)* shows a Li^+ ionophore, but it lacks such a handle. In this project, we wish to introduce a functional group at the benzene ring, enabling attachment to surface of e.g. a membrane or an adsorption material. Furthermore, the affinity strength of the ionophore can be tuned via electron-withdrawing and electron-donating groups at the benzene ring. Next to selectivity also the reversibility of the Li-coordination is important as we aim to release and harvest lithium ions afterwards.

These novel ionophores will be attached to magnetic beads and they will be tested for lithium recovery and recycling purposes.

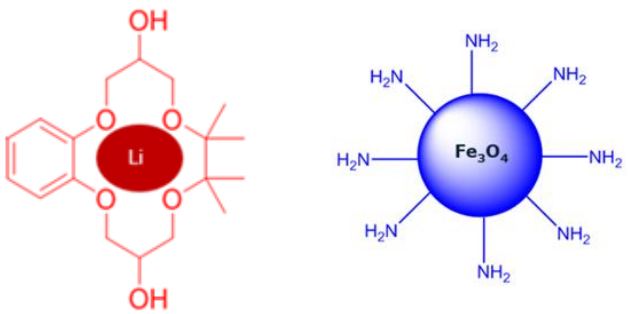

Figure 1: *(left) Lithium ionophore and (right) amino-terminated magnetic beads.*

We explore the use of electro-driven separations to achieve targeted (ion-selective) removal. Our current focus is on the preparation of ultrathin coatings of alternating layers of oppositely charged polymers (polyelectrolytes). The integration of ion-selective materials, like the one shown in Figure 1 (left), may further tune the selectivity.

Opportunities for BSc and MSc students

- Synthesis of Li^+ ionophores: tuning selectivity and reversibility via ring-substituents.
- Decorating magnetic beads with Li^+ ionophores: coupling lithium ionophores to beads
- Decorating nanoparticles with Li^+ ionophores: going nano to boost the loading capacity

Techniques to be used

Organic synthesis (+ NMR, UV-Vis, FTIR) and surface modification & analysis (FTIR, XPS, AFM).

Electrochemical and analytical techniques to study the salt composition of aqueous solutions (*e.g.*, ion chromatography and ion-coupled plasma, in collaboration with the Chair of Environmental Technology). Modelling of electrical double layers can also be performed in strong collaboration with Wetsus (Dr. Maarten Biesheuvel).

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