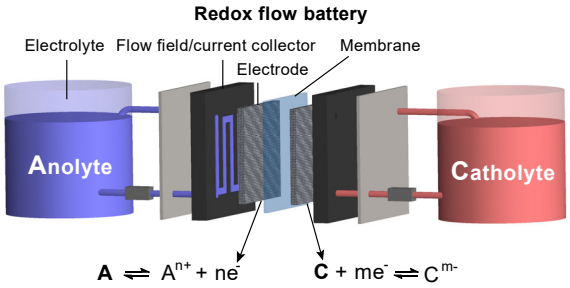
MSc Internship redox flow battery

Background



Large-scale energy storage is becoming increasingly critical to balance the intermittency between renewable energy production and consumption. Redox Flow Batteries (RFBs), based on inexpensive and sustainable redox-active materials, are promising storage technologies. An RFB consists of two tanks of redox-active electrolytes, one catholyte and one anolyte, and its capacity can be scaled up just by increasing the volume of the tanks. The electrolytes flow through an electrochemical cell where redox reactions happen. Due to this design, one of the distinct features of RFBs is the decoupling of their energy storage and power generation. Thus, they are suited for grid-scale energy storage up to MWh.

RFBs come with their own set of challenges. During battery operation, side reactions and cross-over of the electrolytes (the catholyte moving to the anolyte side and *vice versa*) in an RFB can occur and cause an imbalance in the oxidation states of the catholyte and anolyte, which inevitably results in capacity loss. Depending on the mechanisms, the electrolytes can be re-balanced, and the capacity can be restored allowing the RFBs to continue to operate at full capacity. In order to achieve this re-balancing, the state-of-charge, defined by the average oxidation state of the redox-active electrolytes in RFBs, needs to be accurately measured. This can be done via NMR spectroscopy or magnetic susceptibility measurements [1].

Goals of the internship

This internship project aims at:

- Developing new and inexpensive methods for measuring the state-of-charge of an RFB.
  Two potential approaches will be explored. The first one is based on UV-Vis spectroscopy and the second one is based on simple RGB colour code analysis.
- Establishing a protocol, suitable for an undergraduate laboratory class, for carrying out charge-discharge cycles of an RFB and measuring the state-of-charge during battery operation.

Learning goals

During this internship, you will learn electrochemistry, battery chemistry and applied UV-vis spectroscopy.

Supervision

This is a joint project between the Magnetic Resonance Research Center and the Molecular Sciences Education Labs. You will be supervised by Evan Wenbo Zhao and Tom Bloemberg.

References

[1] Jing, Y., Zhao, E. W., *et al.*, In situ electrochemical recomposition of decomposed redox-active species in aqueous organic flow batteries, *Nature Chemistry*, 2022, *in press*.