MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, June 21st, 2023 at 13:30, D. Dan and Betty Kahn Building, Room 217.
Online: https://technion.zoom.us/j/92071331741

Ion-Ion Selectivity Mechanisms in Capacitive Deionization

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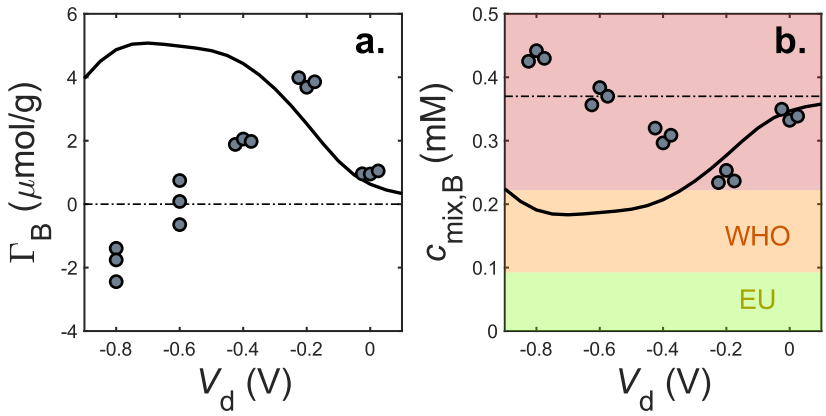
Water stress is a growing challenge due to overextraction and climate change. Many emerging applications require ion-ion selective separations, namely, the selective removal of a specific species over others. Such applications include treating water for irrigation, extracting valuable materials, and remineralization. However, conventional techniques generally remove solutes indiscriminately, necessitating costly complementary treatments. Therefore, research and development of ion-ion selective separation processes in water have increased significantly in recent years.

Capacitive deionization (CDI) is a maturing electrochemical water treatment and desalination technique. Unlike common water treatment and desalination techniques, CDI cells operate in a time-dependent manner and show large internally generated pH and salt concentration gradients during operation. Therefore, CDI bears the potential for ion-ion selective separation processes, so a deep understanding of the governing mechanisms and trade-offs involved is necessary.

In this work, we developed and leveraged a novel theoretical framework to describe the electrosorption of species with a pH-dependent charge by CDI. We used this theoretical framework to explore boron removal, a severe bottleneck for efficient seawater desalination. We found the theoretical framework to be essential, revealing counterintuitive design rules. Furthermore, we managed to enhance boron removal, reaching the upper limit of the World Health Organization recommendations, see below. Also, we extended our understanding of CDI selectivity by studying nanofiltration membranes and electrodialysis. Based on these systems, we accounted for wall-ion exclusion effects for the first time and emphasized the importance of further investigating the impact of operating conditions and local processes to understand ion-ion selectivity by CDI.



Seminars Coordinator: Assoc. Prof. Matthew Suss.