**Group:** Advanced Materials for Chemical Sensitivity (AMCS)
**Project:** **Removal Advanced Materials for Electro-Driven Ion Separation**
**Supervisors:** Kaustub Singh, Louis de Smet

## Introduction

Water desalination is a form of water treatment which is of high priority for human survival and growth. Several technological advancements have been made to remove salt from water. Capacitive deionization (CDI) is one such promising technology. In CDI, two porous electrodes adsorb ions from the aqueous phase and later, in a second step, release the ions leading to electrode regeneration. Most work on CDI use electrodes with materials based on carbon where ions are stored in the electrical double layer along the carbon surface. Another class of materials for ion storage which has recently received attention are intercalation compounds, which are examples of redox-active materials, due to their potential for higher salt adsorption, lower energy consumption, and tunable ion selectivity.

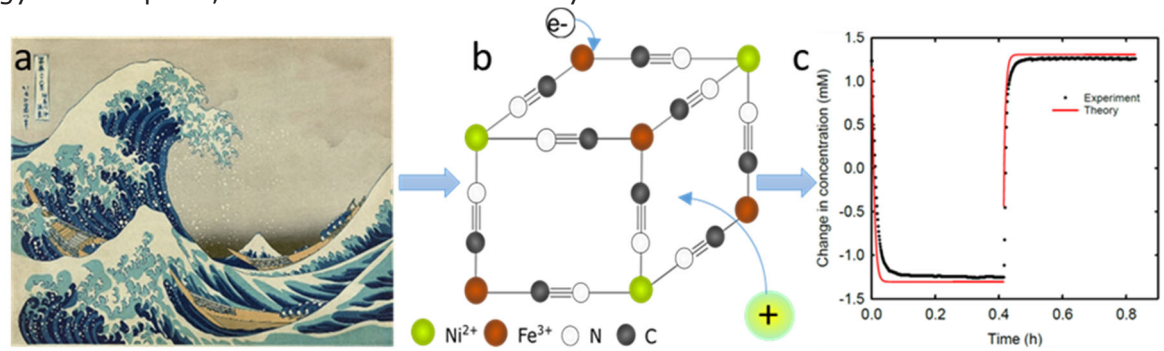


**Figure 1**. a) The great wave off Kanagawa, early 19th century artwork from Japan uses Prussian blue, b) the open framework structure of a Prussian blue analogue, c) a typical desalination cycle obtained from a CDI setup using electrodes fabricated out of PBA.

## Project description and goals

We aim to explore intercalation compounds derived from Prussian blue (PB), called the Prussian blue analogues (PBAs), for water desalination. PB has been used extensively as a dye in artworks (Fig. 1a), but also in medication strategies for heavy metal poisoning and recently, in energy storage. We aim to use the open framework structure (Fig. 1b) of PB, and its analogues, for removing salt from wastewater. The active PB(A) particles can be characterized to ascertain their size and chemical composition. Electrodes can be fabricated out of these materials with support from a conductive additive and a polymeric binder. Electrochemical characterization of electrodes can be performed to estimate their charge storage capacity which gives an idea about the salt adsorption performance of the electrodes. Finally, these electrodes can be employed in a CDI setup for desalination of low salinity wastewater, a result of which is given in Fig. 1c.

The active material can be modified by replacing the iron atom in the PB lattice with other transition metal elements like nickel, copper, and vanadium among others to enhance the salt adsorption capacity of the electrodes. Also, the operation conditions such as operating current/voltage, flow-rate, and salt concentration through the desalination cell and their effect on the overall performance of the cell will be studied. Finally, within this PhD project a model will be developed to explain the desalination performance observed with PBA electrodes.

Projects for BSc, MSc and internship students will be defined along one or more of these lines, depending on the interests and background of the student.

## Techniques to be used

Material synthesis + coating preparation. Scanning Electron Microscopy / Energy Dispersive X-Ray Spectroscopy, X-ray (powder) Diffraction, X-ray Photoelectron Spectroscopy and various electrochemical methods.

## For more information

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