Dynamics of Capacitive Water Deionization
from In Operando SAXS using Synchrotron Radiation

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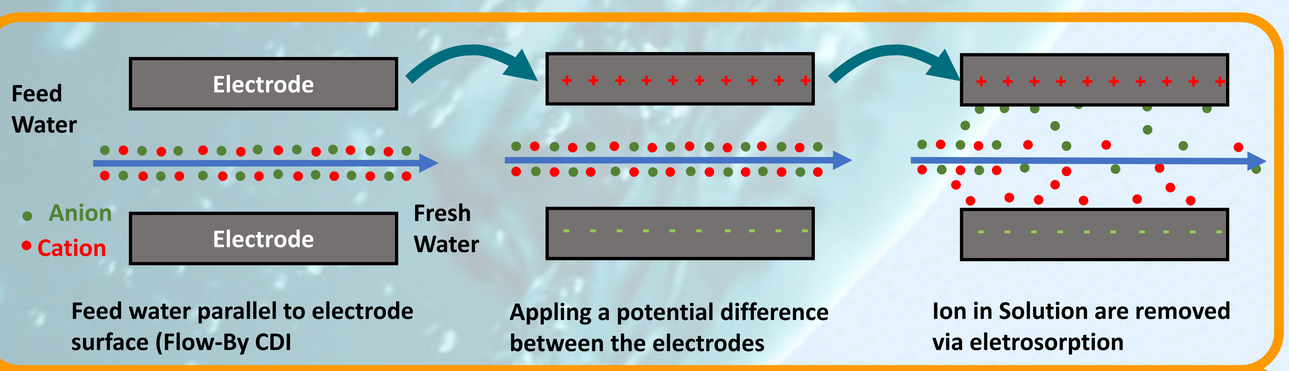
WHY?

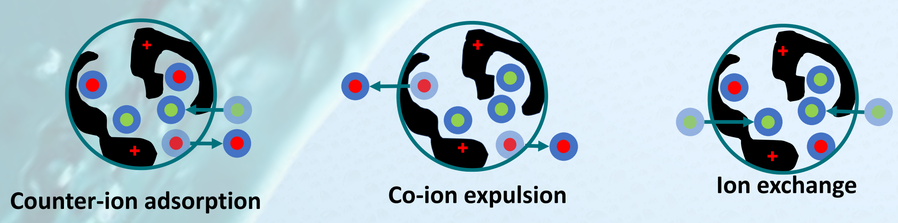
Nanoporous carbon electrodes are used in capacitive deionization (CDI), an increasingly important method for brackish water treatment. The present study uses synchrotron radiation to investigate the intricacies of CDI by in-operando Small Angle X-ray Scattering (SAXS). First proof of principle experiments were carried out at the SAXS beamlines at ELETTRA and DESY using a customized desalination cell. The experimental setup, designed for small- and wide-angle X-ray scattering, enables time-resolved observation of changes of the X-ray transmission- and scattering signals due to ion-electrosorption in the carbon nanopores during desalination.

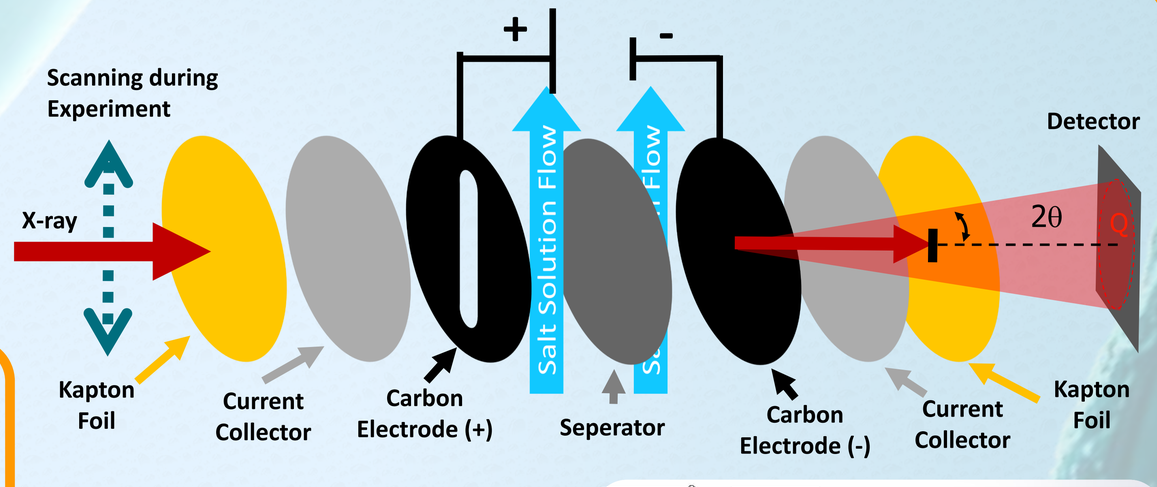
HOW?

The experiments depicted on this poster were performed at DESY. MSP-20 carbon powder together with 10wt% PTFE was used as electrode material, 25mM/L CsCl solution was used as electrolyte supplied with 0ml/min (Static Condition) and 5ml/min (Flow Condition) flow rates. The schematic below elucidates the sandwich like structure used inside the CDI cell. A long hole (3x27mm) was made in the positive electrode, only changes in the negative electrode were measured with the beam. Underneath the schematic images of the cell and technical drawings are depicted.



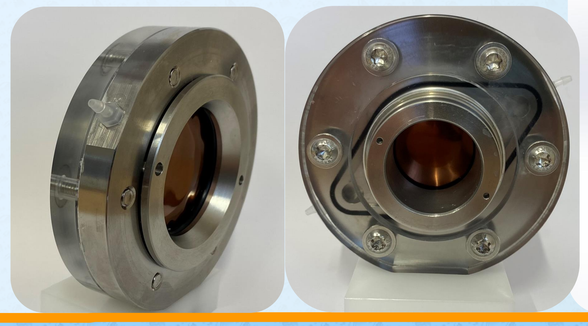
Mechanisms for balancing charges:

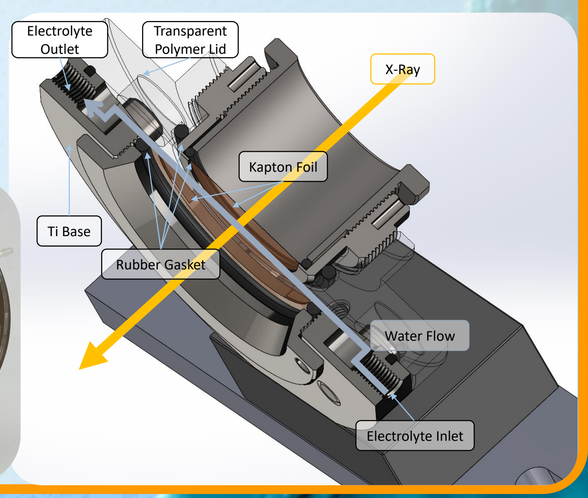




DESY.

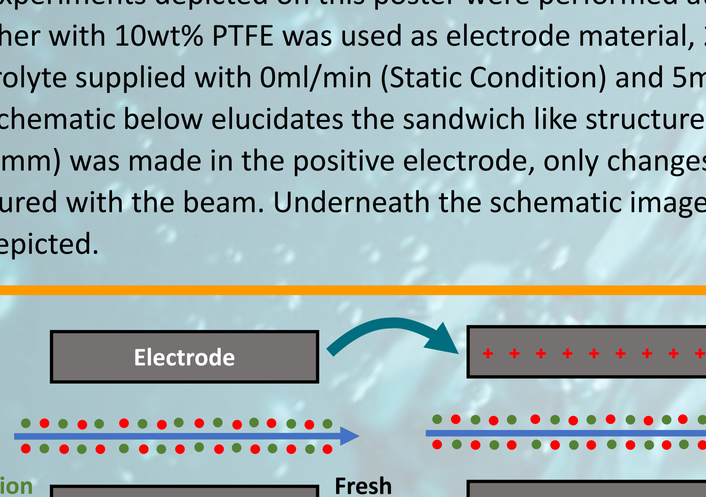
Cell and Setup used @DESY





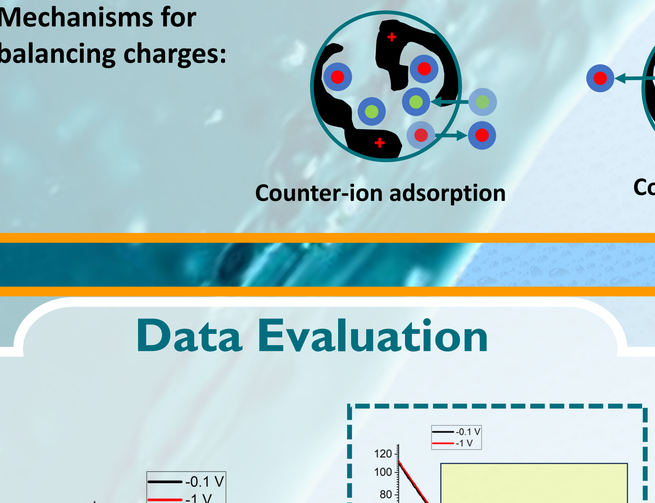
WHAT?

Data Evaluation



Small changes elucidated by calculating Integrated Intensity between q 0.8-3 nm^{-1} $= \int I(q)q^2dq$

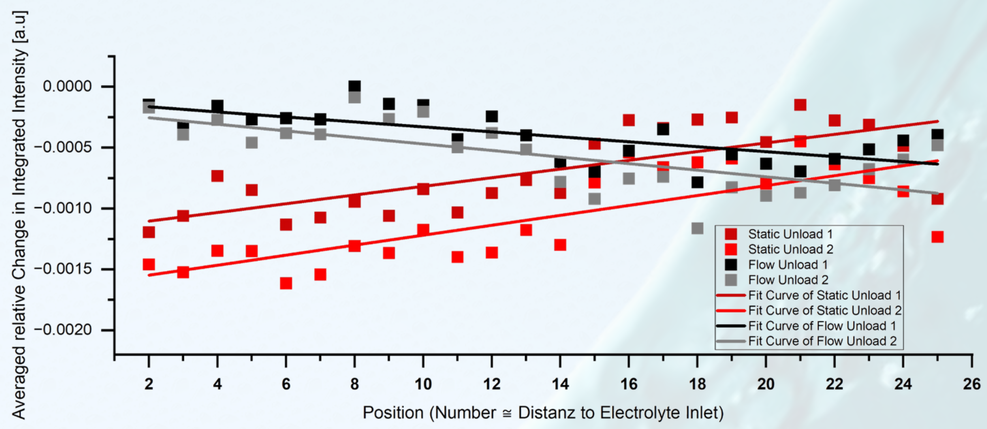
Normalized to the average of the first three values

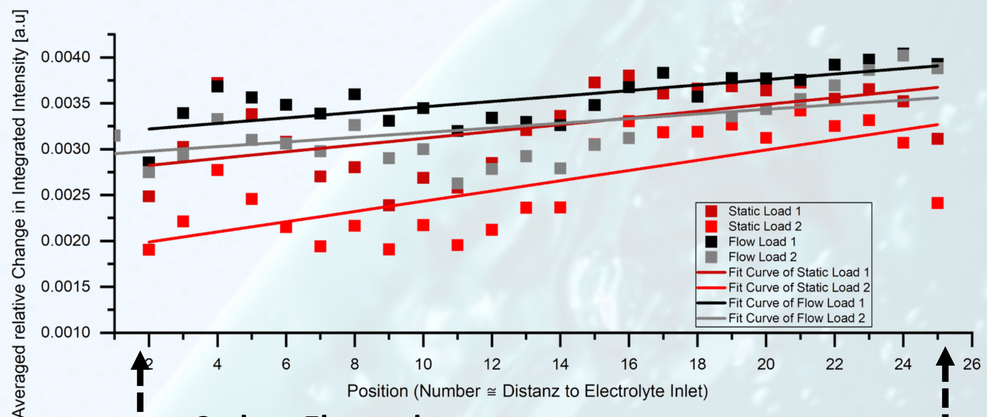


Systematic changes can be identified dependent on the applied voltage.

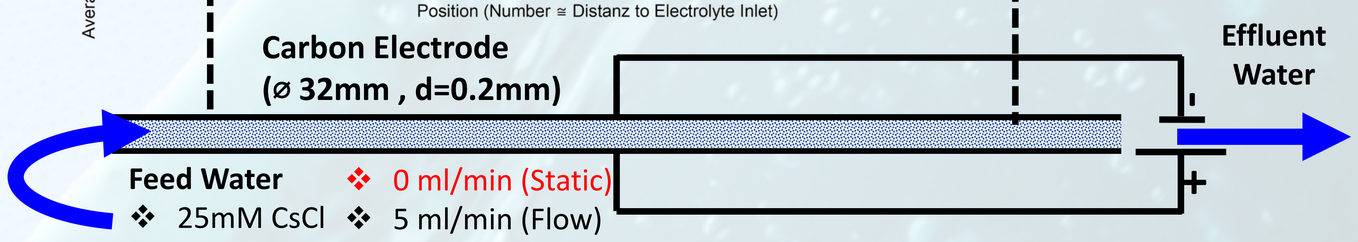
Averaging rel. Integrated Intensity 900s prior to voltage jump to identify changes over the sample position

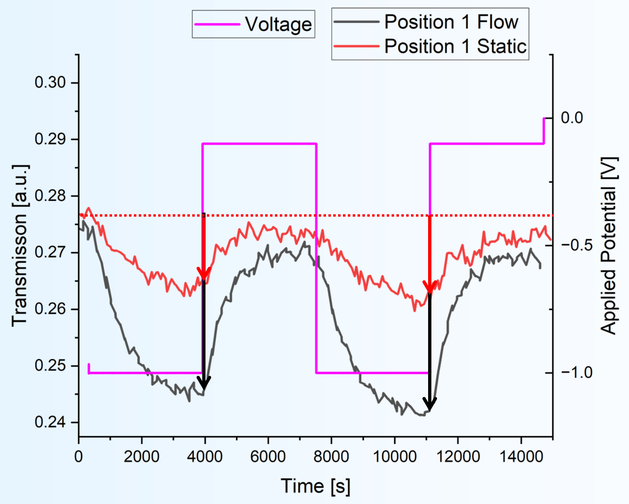
Spacial Changes





Changes of the slopes for the loading and unloading indicate higher cation uptake on the negative charged electrode in flow condition compared to static condition





XRT-Analysis on Position 1 for Static and Flow condition elucidates that the dynamic flow of liquid promotes counter ion adsorption -> Crucial for desalination

Take Away

- First reported in-operando CDI study using SAXS and XRT with custom cell
- Spacial and temporal ion concentration changes can be identified
- Stepstone for systematic future investigations

WHO?

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