



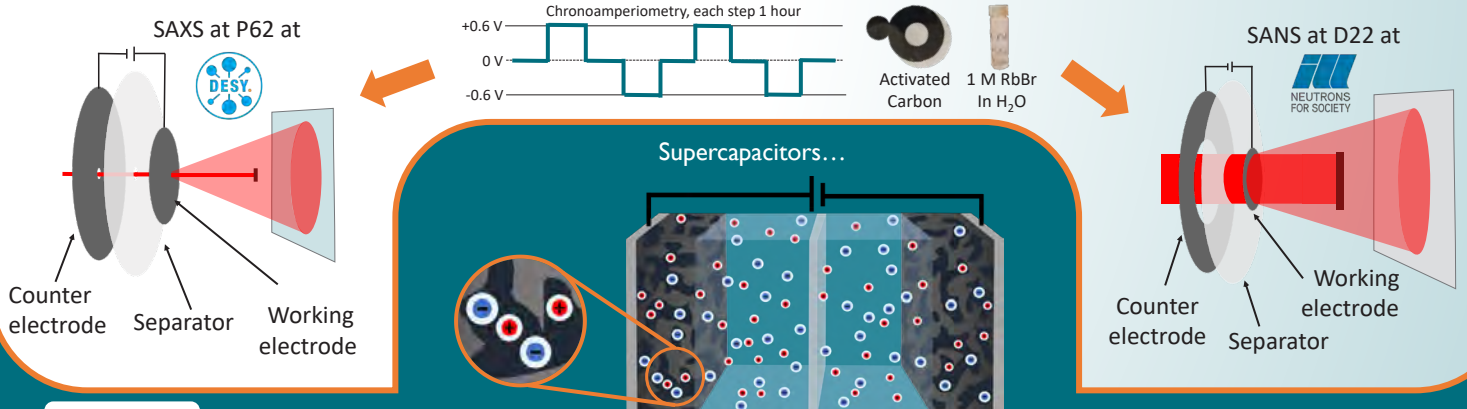
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WHY?

In light of the global transition from fossil fuels to renewable energy sources, there is an increasing demand for efficient high-power storage of electrical energy. While supercapacitors offer a promising solution, the current understanding of the fundamental underlying process - the electric double layer (EDL) formation in nanoconfinement of porous carbon electrodes - is still limited. Experimental approaches aimed at unraveling charge storage mechanisms, global ion and solvent concentration changes and local ion and solvent rearrangement are scarce...

HOW?

...to address this critical gap, we explore the suitability of a combination of in-situ Small Angle X-ray and Neutron Scattering (SAXS and SANS). We used 1 M RbBr aqueous electrolyte and activated nanoporous carbon electrodes for applied potentials between -0.6 V and 0.6 V.

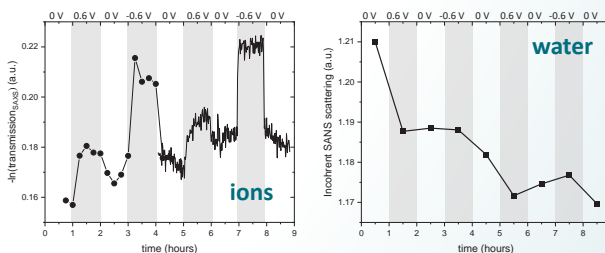


WHAT?

...store charge via electric double layer formation in carbon nanoconfinement. Mechanisms include:

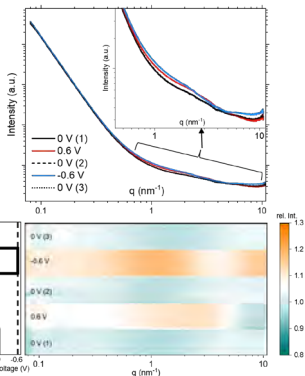


SAXS transmission and SANS incoherent contributions: Global ion and water concentration changes



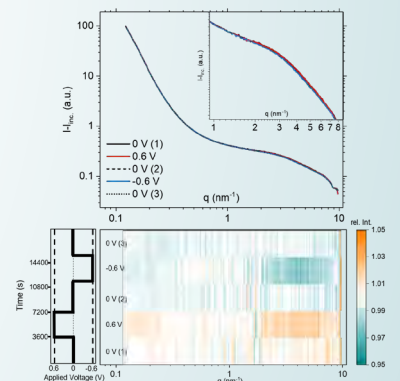
Global ion concentration changes follow the negative logarithm of the SAXS transmission (left), while the water concentration follows the SANS incoherent contributions (right). SAXS transmission reveals the charge balancing mechanisms to be predominantly ion exchange and counter ion-adsorption for this particular system.

SAXS: Local ion rearrangement



Intermediate q -region hints local ion rearrangement: Shift of the maximum at positive applied potential towards smaller q indicates anions seeking a higher degree of confinement. The high q -region contains information on partial ion-ion or ion-water structure factors.

SANS: Local water rearrangement



The absence of pronounced changes in the relative scattering intensity in the intermediate q -region suggest there is no significant water rearrangement. Changes in the high q -region contain information about the water-water, ion-water and ion-ion partial structure factors.

SAXS is suitable to determine 1) the charge balancing mechanism, 2) global ion concentration changes, and 3) local ion rearrangement, while SANS offers insights into 4) global water concentration changes and 5) local water rearrangement. Both SAXS and SANS offer valuable information on partial ion-ion and water-ion and water-water structure factors, but analysis is challenging.

AND NOW?

For a more quantitative analysis, the complexity of the system necessitates further contrast variation (e.g. Anomalous SAXS, various electrolyte salts, D₂O solvent for SANS) or the use of modeling and simulation approaches.