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Wetting/drying mechanisms associated with nanoconfined salt solutions: an optical reflectance study on vapour phase imbibition and adsorption

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The wetting and drying cycles of salt solutions confined in conductive nanoporous electrodes are conceived to generate energy from low-grade waste heat by coupling the pore drying/wetting process with the charging/discharging cycles of the electrodes. This could be realised by ascertaining the optimal physical conditions that allow a systematic control and manipulation of the electrically charged layers that develop inside the porous host matrices. We realise this objective by (1) carrying out optical reflectance study of water vapour sorption isotherms in nanoporous glass membranes with/without pre-adsorbed salt solutions to unravel the thermodynamics of salt solution cluster evolution, (2) carry out imbibition of water vapour into the nanopores and/or drying of nanopores with/without pre-adsorbed salt solutions to understand the impact of salt concentration and relative humidity on the kinetics of pore-filling and emptying, and (3) conduct vapour sorption and wetting/de-wetting experiments in nanofluidic devices with only a single nano-pore/channel to precisely quantify the kinetics of mass transport. In this regard, CONFIT 2022 gives an excellent platform to learn and evaluate the possibility of employing inelastic neutron scattering methods for gaining rich information on the multitude of dynamic populations of the nanoconfined water and their evolution as a response to factors such as relative humidity and salt solution activity. In particular, to understand the mechanisms associated with the second order pore filling/emptying character in the presence of confined salt solutions, which will be correlated with the information on salt cluster evolution gained through complementary synchrotron experiments. A general agreement between the optical and neutron scattering studies shall pave the way for conducting future experiments with the non-transparent conducting electrodes actually relevant for the energy harvesting process.

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