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Experimentally probing ionic solutions in single-digit nanoconfinement

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Understanding transport and behavior of ionic solutions in single-digit nanoconfinement is crucial to explain the behavioral transition of confined solutions. This is particularly the case when the system length scale crosses the classical key length scales describing energetics and equilibrium of ionic solutions next to surfaces. Experimentally probing nanoconfinement would open large perspectives to test modelling or theory predictions. Here, using a new test vehicle that consists in 3 and 5 nm-height silica nanochannels associated with an original characterization technique based on the interface hard X-ray reflectivity analysis, we directly probed the transport of solutions containing cations having increasing kosmotropic properties (XCl_2 with X: Ba < Ca < Mg) and obtained their distributions inside the nanochannels. We observed that cation adsorption decreases with the size of the confinement and that small cation adsorption is favored. In addition, nanochannel clogging occurs when ions tend to form ion pairs. These ion pairs may play the role of nano-sized prenucleation clusters leading to phase precipitation. These results evidence the specific ion effect in single-digit nanoconfinement that may result in dramatic changes of solution transport. In this line, our new method opens new perspectives for the characterization of ionic solutions and of interfaces in single-digit nanoconfinement.

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