Impact of salt on sorption isotherms of water in nanoporous media

Hugo Bellezza[1], Marine Poizat[1],
Mark Busch[2], Stella Gries[2], Juan Sanchez[2], Patrick Huber[2], Olivier Vincent*[1]

[1] *CNRS, Univ Lyon, University Claude Bernard Lyon 1, Institut Lumière Matière, F-69622, France*

[1] *Hamburg University of Technology, Institute for Materials and X-Ray Physics (M-2), 21073, Germany*

**e-mail: olivier.vincent@univ-lyon1.fr*

Abstract

Salt water is ubiquitous in nature (e.g. geomaterials, soil, clouds formation) and in technology (e.g. desalination, concrete weathering, heritage conservation). In most of these situations, salt water is confined within a porous medium, often with pores down to the nanometer scale: for example, crystallization and dissolution cycles induced by humidity changes are known to induce structural damage to building materials, artwork, etc [1]. And yet, these processes are not well characterized, especially when pores are in the nanometer range [2]. Here, we investigate the response of the salt water confined in several porous silicon and alumina samples (average pore diameter from 3 nm to 20 nm) to humidity cycles. We performed sorption isotherms where we monitored optically water content in the porous medium. We systematically characterized how the salt concentration impacts the shape of the isotherms and compared these results to a minimal model coupling solution thermodynamics to capillarity, nucleation and confinement effects [3]. We also probed the appearance of the crystal and its structure by X-ray diffraction.

References

[1] Robert J. Flatt et al. "Chemo-mechanics of salt damage in stone". en. In: *Nature Communications* 5.1 (Sept. 2014). Bandiera_abtest: a Cg_type: Nature Research Journals Number: 1 Primary_atype: Research Publisher: Nature Publishing Group Subject_term: Chemical physics;Geophysics Subject_term_id: chemical-physics;geophysics, p. 4823. ISSN: 2041-1723. DOI: 10.1038/ncomms5823.

[2] Michael Steiger. "Crystal growth in porous materials—I: The crystallization pressure of large crystals". en. In: *Journal of Crystal Growth* 282.3-4 (Sept. 2005), pp. 455–469. ISSN: 00220248. DOI: 10.1016/j.jcrysgro.2005.05.007.

[3] Olivier Vincent et al. "How Solutes Modify the Thermodynamics and Dynamics of Filling and Emptying in Extreme Ink-Bottle Pores". In: *Langmuir* 35.8 (Feb. 2019). Publisher: American Chemical Society, pp. 2934–2947. ISSN: 0743-7463. DOI: 10.1021/acs.langmuir.8b03494.