HOW SALT-INFUSED NANOSPONGES RESPOND TO HUMIDITY CHANGES

LABORATORY : Institut Lumière Matière

TEAM(S) : LIQ@INT

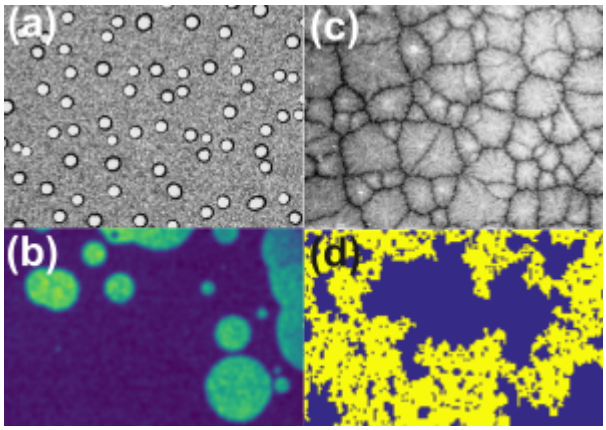
CONTACT(S) : VINCENT Olivier

CONTACT(S) DETAILS: olivier.vincent[at]univ-lyon1.fr / Tel. 0472448070

KEYWORD(S) : Soft Matter / Porous Media / liquids

SCIENTIFIC CONTEXT :

We are interested in fundamental physics problems that are relevant in various important societal and engineering contexts. In particular, we study how evaporation and condensation of salty water happens in complex systems, triggered by variations in external humidity. These phenomena are crucial for e.g. water harvesting in dry climates, cloud formation in the atmosphere, new strategies for energy production/ conversion, smart optical/mechanical metamaterials, sustainable architecture and heritage conservation, etc. but raise basic, unexplored question with rich physics. Recently, we have successfully characterized and described how the interaction between condensation/ evaporation and capillary/osmotic phenomena dictate the equilibrium states of salt solutions confined in single nanopores. Now we are investigating larger scale phenomena in extended systems formed of many interacting pores (formation of arrays of microdroplets, stochastic nucleation patterns) and are trying to understand how they emerge from the behavior in single nanopores.



(a) Spontaneous microdroplets (b) Nucleation and growth (c) Crystal pattern (d) Simulations

MISSIONS :

We are pursuing several investigations that combine experiments and modeling. We are looking for a motivated student to contribute within our team making progress in one (or several) of these directions:

1) [Experiments] Spontaneous formation of microdroplet arrays at the surface of nanoporous media (high humidity, Fig. (a)): what dictates the typical size and spacing of these patterns?

2) [Experiments] Characterize the stochastic nucleation, growth dynamics, and final patterns of salt deposits that appear from the supersaturated solution at low humidity (Fig. (b-c)).

3) [Simulations] Invasion/percolation patterns induced by the evaporation/condensation of water with continuously evolving salt content in disordered pore networks (Fig. (d)).

These investigations will use a combination of optical techniques (microscopy, image analysis, interferometry etc.), homemade high-precision environmentally controlled cells, numerical simulations (Monte Carlo), and theoretical (analytical/scaling) approaches. Knowledge of Python and proficiency in English will be appreciated.

OUTLOOKS :

It is possible to do an M2 internship prior to the PhD program on a related topic (see M2 section).

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