SELF AMPLIFYING CRYSTALLIZATION IN THIN LIQUID FILMS

M.Qazi , H.Salim and E. Jambon-Puillet, N.Shahidzadeh[1]

[1]Institute of Physics/University of Amsterdam, Soft matter group, Amsterdam, The Netherlands;

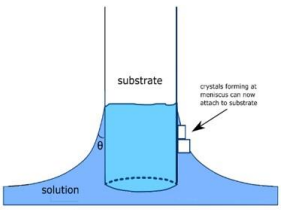
n.shahidzadeh@uva.nl

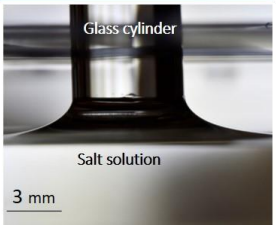
Salt creeping consists of the precipitation and growth of crystals from evaporating salt solutions far from the solution boundary, i.e. the contact line with a solid surface. It is both a fascinating phenomenon and a major nuisance whenever salt solutions are present and evaporate. The latter can cause weathering of artworks, sodification of soils and corrosion of outdoor electronics. Indeed, because of the spreading of salt solution due to creeping, even a well-protected surface can corrode in a very short time. Even though salt creeping occurs quite commonly, the mechanisms involved in the process are still poorly understood[1,2] and a quantitative description of the creeping mechanism and its universality with respect to different salts is still missing.

We have investigated the dynamics of vertical salt creeping on glass substrates in contact with different aqueous salt solutions during evaporation. With our novel experimental approach[4], we are able to quantify the time evolution of the contact angle of the salt solution meniscus, as well as the amount of crystals growth (i.e. creeping) on the solid substrate.

We show that there exists a critical contact angle below which salt creeping occurs, provided also the nucleation of multiple crystals is favoured. The precipitation of new crystals happens ahead of the contact line by the meniscus that progressively advances over the crystals forming also nanometric precursor films. High-resolution Scanning Electron Microscopy reveals the existence of nanocrystals very far from the macroscopic limit of the creeping zone.

The increase of the evaporative area in this way, causes an exponential increase of the crystals mass in time. The self-amplifying process then results in spectacular three-dimensional crystals at macroscopic distances far from the solution.





These findings also allow us to control the creeping by using surfactants as crystallization modifiers We show that the addition of surfactants to the salt solution have an opposite influence on creeping dictated by their role as crystallization modifiers rather than their impact on the wetting properties:

REFERENCES:

1. Van Enckevort, W. J. P.; Los, J. H. On the creeping of saturated salt solution, *Cryst. Growth Des.* **2013**, *13* (5), 1838–1848.
2. R. Hird, M. D. Bolton, Migration of sodium chloride in dry porous materials. *Proc. R. Soc. A Math. Phys. Eng. Sci.* **2016**, *472*, 20150710.
3. Qazi, M. J.; Liefferink, R. W.; Schlegel, S. J.; Backus, E. H. G.; Bonn, D.; Shahidzadeh, N. Influence of Surfactants on Sodium Chloride Crystallization in Confinement *Langmuir* **2017**, *33* (17).
4. Qazi, M., Salim, E. ,Jambon-Puillet, E., Shahidzadeh, N. ; Salt creeping as a self-amplifying process, submitted **2019**.