Combining in situ interferometry and Kinetic Monte Carlo to study mechanisms of nanoconfined crystallization

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Crystallization pressure, σ_c, is well documented in the geological record[1] and the weathering of buildings and monuments[2]. One may easily deduce the thermodynamic limit of this pressure $\sigma_c=(RT/v)ln(c/c_0)$, where v is the molar volume c the concentration in the solution and c_0 the concentration in equilibrium with the solid. Crystallization pressure can only occur out of equilibrium $(c/c_0>1)$ where several processes com4pete to control the rate and thereby the pressure. The study of these processes at the pertinent scale in the grain contact are necessary to understand the true limits of crystallization pressure.

We present novel techniques of measurement and Kinetic Monte Carlo simulations of crystal growth in a nanoconfined fluid film supporting normal stress and discuss the molecular scale crystal growth by step flow coupled to mass transport and normal stress in the fluid film.
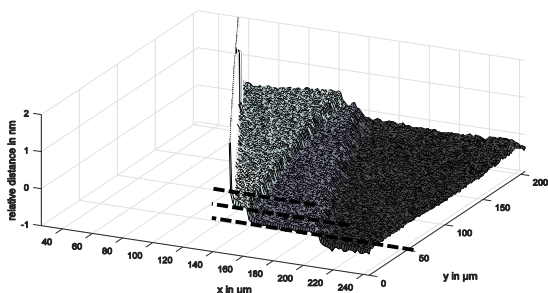

Figure 1: Wave-like growth of molecular layers (step flow) on $NaClO_3$ confined in a 30 nm water film measured *in situ* by reflected interference contrast microscopy.

[1] Gratier, J.P. et al, *How travertine veins grow from top to bottom and lift the rocks above them: The effect of crystallization force*, Geology **40**, 1015 (2012).
[2] Flatt, et al, *Chemo-mechanics of salt damage in stone*, Nature Communications **5,** 4823, (2014).