Internship project

Level : Master 2
Title : Nonlinear dynamics of nano-confined interfaces during growth
Institute, Group : ILM, Modélisation de la Matière Condensée et Interfaces
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Possibiltof PhD : yes

Mots clés: Physics, Theory, non-equilibrium physics, nonlinear dynamics and pattern formation

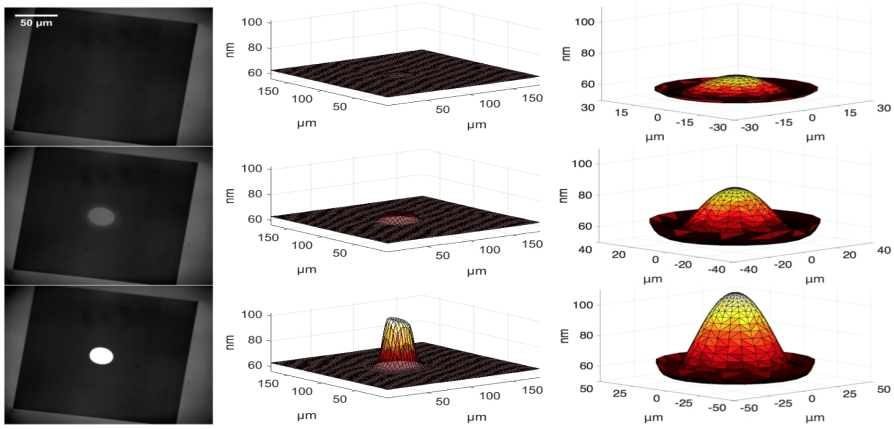
Résumé:

Crystal growth is a model system for non-equilibrium physics. As a consequence, it has been widely studied, and in particular the nonlinear dynamics giving rise to complex shapes such as those of snow flakes have attracted much interest [1,2]. However until now, most of these studies were devoted to free growth, i.e. gowth in infinite systems. Confinement, which breaks translation invariance, gives rise to a novel class of nonlinear dynamics and morphologies, which are relevant in natural sciences such as geology –where crystal growth is often confined in small pores or faults of rocks, and for biomineralization, the process by which living organisms produce minerals (e.g. for their skeleton) –where growth is confined into a soft and complex environment.

We have recently studied morphological transitions in interfaces confined by the presence of a flat wall. Evidences of cavity fromation in growth, or pointy shapes (depending on the from of disjoining pressure[3]) in dissolution have been obtained.

The aim of the project will be to study the nonlinear and non-equilibrium dynamics of these interfaces using nonlinear continuum models or on-lattice Kinetic Monte Carlo Simulations. The work can be analytical or numerical depending on the profile of the candidate. We could for example study the effect of thermal fluctuations, the formation of finite time singularities in the models, or the forces generated by the beaking of translational invariance during the growth process.

This work is linked to a european network (ETN Nanoheal http://www.nanoheal.uio.no/) whithin which collaborations with experimentalists are developped.



Nonlinear dynamics of the formation of a cavity in a NaClO3 crystal: (a) experimental images (Kohlert and Dysthe, Univ. of Oslo) (b) 3D reconstruction from experiments (c) model.

Références:

[1] Crystal surfaces in and out of equilibrium: a modern view,
Misbah C., Pierre-Louis O., Saito Y., Reviews of Modern Physics, 82 981 (2010).
[2] *Statistical Physics of crystal growth*, Y. Saito, World Scientific.
[3] *Intermolecular and surface forces*, J.N. Israelachvili, Academic Press.