Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16927

Crystal growth in nano-confinement: non-equilibrium effects governed by atomic step kinetics

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The motion of atomic steps controls the growth of crystals that are formed in confinement in a broad range of phenomena such as Earth sciences, biomineralization and material science. Their observation and modeling open a playground for the study of non-equilibrium kinetic processes at the nanoscale. We report on the modeling of the nucleation and the motion of atomic steps, show that a single atomic layer can move a macroscopic crystal, and suggest that their peculiar dynamics in confinement plays a role in pressure solution and the force of crystallization.

We first report on the modeling of recent in situ observations of the dynamics of atomic steps on nano-confined crystals that lead to kinetic localization of nucleation in the vicinity of the contact edge, and to directed non-equilibrium instabilities [1]. We then discus the role of substrate roughness on atomic step motion. We introduce a phase field model [2], and show that the force applied on a crystal can lead to nano-cavities on a crystal facet in the vicinity of a protuberance of the substrate. The depth of these cavities corresponds to an integer number of steps.

Felix Kohler, Olivier Pierre-Louis & Dag Kristian Dysthe Nature Communications volume 13, 6990 (2022).

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