Influence of stress on calcite growth

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Calcite, the most widespread crystalline form of calcium carbonate, is ubiquitous both in nature and in the industry. In particular, its precipitation by living organisms under the form of shells is the major CO_2 sink inside the ocean, and it is used in multiple industrial sectors (ordinary cement manufacturing, paper bleaching, toothpastes, etc.). Therefore the knowledge of its mechanisms of growth, both organic and inorganic, are of foremost importance, in the modelling of the carbon cycle, in the simulation of oil reservoirs, or in the design of better cements.

One parameter, although almost always present during calcite growth, has not been considered in most studies. When calcite grains grow from nuclei, they eventually enter into contact, and stresses develop at their interfaces, particularly if the material grows inside a mold (lime mortar), or underneath other sediments (limestone). So far, we have no idea on how this stress modifies the growth kinetics, or the morphology of the grown surface. To address this issue, we have used an atomic force microscope (AFM), both to imply a local stress on a growing calcite surface, and to image it (Fig. 1). We have found that the stress has a double influence: it slows down significantly the growth, and induces a change of the type of growing phase. Calcite biomineralization proceeds in presence of organic materials, among which amino acids are widespread. Therefore we have investigated the influence of pentaglycine on the growth kinetics. This amino acid shows the striking ability to cancel the phase transition induced by the applied force.

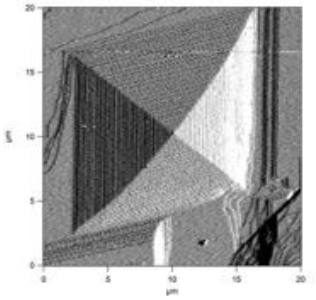

Figure.1: Deflection retrace image of spiral growth on calcite surface in a supersaturated solution.