MS14. Mineralogical crystallography: Nature as a source of inspiration for new materials

Chairs: Nikolai Eremin, Rossella Arletti

MS14-P1 Crystal branching phenomena in calcite as a consequence of anisotropic impurity incorporation at nonequivalent step type geometries?

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The growth behavior of calcite at different physico-chemical conditions is due to its abundance in natural (biogenic and abiogenic) and artificial (e.g. hot water pipelines) systems of general interest. Since the first AFM investigations on {104} calcite growth hillocks it is known that incorporation of Mg^{2+} as an impurity in the $CaCO_3$ system is distributed unequally at different step type geometries (obtuse and acute) of the growth spiral [1]. This results in different sectors of Mg^{2+} enrichment known as sector zoning [2].

Due to the high resolution and short observation period in AFM experiments only the starting conditions of impurity influenced crystal growth behavior was studied in detail but long term consequences on the macroscopic scale were neglected.

We observed in Mg^{2+} containing gel based calcite growth experiments (duration of 2 months) pronounced crystal branching phenomena and complex pathological morphologies. From optical microscopy and EBSD pole-figures we derived that the branched sub-units are not parallel to their substrate resulting in systematic undulous extinction behavior in cross polarized light. We assume that impurity incorporation is the principal cause for the establishment of an ordered dislocation network which is responsible for this tilted sub-units.

Beside growth striation due to diffusion controlled transport mechanism in the porous medium and the negative distribution coefficient of Mg^{2+} in calcite [3] we suggest that the kink type selective incorporation at nonequivalent steps is responsible for such a strain induced branching process.

These observations explain potentially the long known undulous optical extinction behavior of Mg-Calcites known as radiaxial fibrous calcites (RFC) and fascicular optic fibrous calcites (FOFC), respectively [4].

References:

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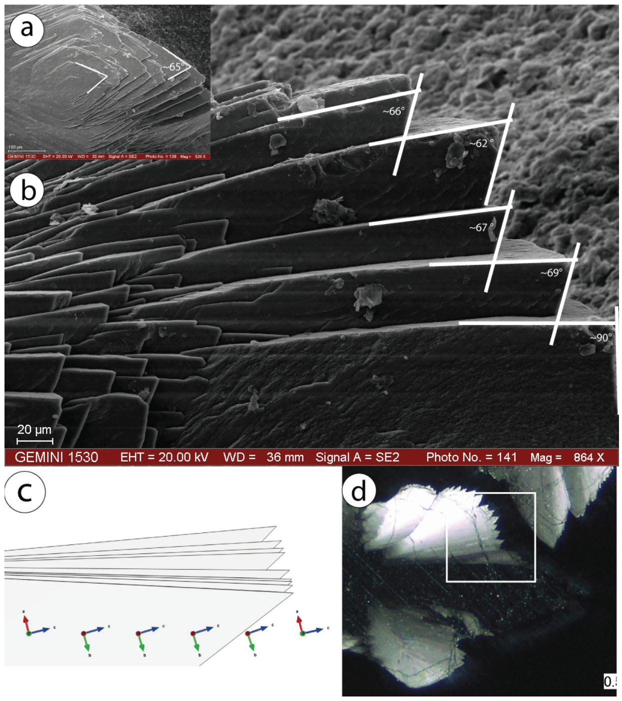

Figure 1. a) Crystal branching phenomenon of an in gel grown calcite crystal. b) Same crystal-type tilted by 90°. c) Set of slightly tilted {102} rhombohedra resemble the observed growth morphology as in b). d) Thin section seen with crossed polarizers. Note the distinct growth segments and undulosity.

Keywords: Calcite, Crystal branching, Undulosity, Dislocations