Template adaptability is key in oriented CaCO crystallization

Beamline: X22B

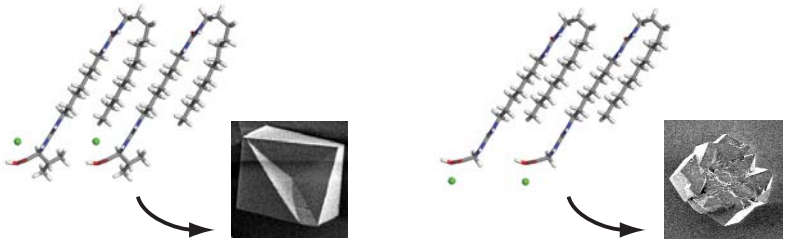
Technique: Liquid Surface X-ray Diffraction

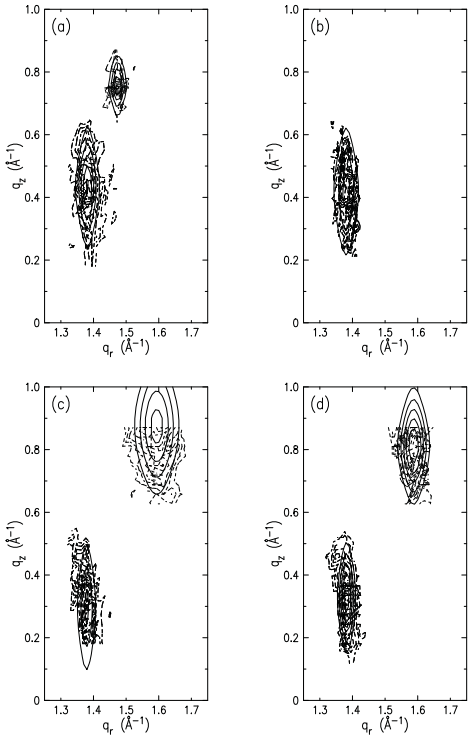
Researchers:
Seo-Young Kwak, Elaine DiMasi (BNL), Benoît P. Pichon, Nico A. J. M. Sommerdijk, et al (Eindhoven Technical University)

Publication:
N. Popescu et al, "Template adaptability is key in the oriented crystallization of $CaCO_3$"
J. Am. Chem. Soc. (2007) (in press. DOI 10.1021/ja075875t)

Motivation:
Langmuir monolayers on liquid surfaces are well established model systems to study biomineralization. We developed a family of surfactants designed to test an important mechanism in templated mineralization: the adaptability of the organic template.

Results:
The surfactants have amino acid based headgroups, which tune the structural adaptability of the film. Valine- and Glycine-based molecules nucleate calcite in different ways. X-ray reflectivity and in-plane diffraction confirmed the H-bonds between neighboring molecules, and showed that calcium from the subphase is complexed in the VAL compound, but assembled in a layer below the film for GLY. The more adaptable VAL template nucleates a specific calcite face.





The valine-based surfactant (top,left) nucleates a preferred face of calcite. The glycine-based molecule (top, right) forms calcite polycrystals. Using x-ray reflectivity and grazing-incidence diffraction (left), the film structures were determined for VAL on water (a) and $CaCl_2$ (b), and for GLY on water (c) and $CaCl_2$ (d). The 2nd peak's absence in (b) shows that calcium causes the VAL compound to release its two dimensional structure and adapt to the mineral being nucleated.