Crystal orientation of calcite components in coccoliths: EBSD analyses of submicron crystals

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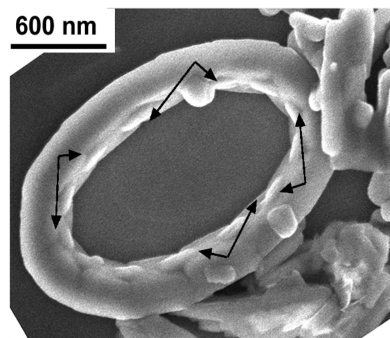
Introduction

Coccolith is a calcified scale with species-specific fine structure produced by marine unicellular alga. A coccolith consists of several tens of submicron-sized calcite ($CaCO_3$) crystals which interlock together to form a ring. In order to understand its biomineralization mechanism, an understanding of calcite crystallography and morphology is important. Conventionally electron diffraction (ED) in a transmission electron microscope (TEM) is applied for such investigation [1]. However, a pair of diffraction patterns is generally required for one crystal to unambiguously determine its orientation by ED and the morphology is not so obvious in TEM. Electron back-scattering diffraction (EBSD) is a method to obtain crystallographic information in a scanning electron microscope (SEM). Compared to TEM, SEM is easy to understand morphology and an EBSD pattern can uniquely determine the crystal orientation. Spatial resolution of EBSD expected is less than 100 nm. In this study, we have determined crystal orientation of calcite components in coccoliths from several species.

Results and Discussion

Coccoliths suspended in water were dispersed on a silicon wafer coated with an amorphous silicon film. EBSD used was ThermoNoran PhaseID system equipped to Hitachi S-4500 field-emission type SEM. An example of the analyses is shown below. In the figure, the long and short arrows indicate the direction of the **a** and **c** axes in each crystal, respectively. The species is *Pleurochrysis carterae* and the crystals observed on this side are all V units [1]. The **a** axes are approximately parallel to the base plane and the **c** axes are standing by 50 ~ 60° from the basal plane. Note that the crystal orientation is almost uniform with respect to the circumference.



Reference

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Association of Eu(III) and Cm(III) with *Halomonas* sp.

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Introduction

Halophilic bacteria live in high inonic strength brine. The mechanisms of metal association with these bacteria is poorly understood. We examined the effects of ionic strength on the adsorption of lanthanides and actinides onto the cells of the halophilic bacterium *Halomonas* sp.

Expetimental

Halomonas sp. was isolated from the Waste Isolation Pilot Plant repository in Carlsbad, US. The cells were grown in media containing 10, 15, or 20 w/v% NaCl. The logarithmic distribution coefficient (log K_d) was measured by using the cells at the late exponential phase. After washing the cells with the same concentrations of NaCl, log K_d of Eu(III) and Cm(III) was determined at pH 5 as a function of NaCl concentrations. The coordination environment of Eu(III) adsorbed on *Halomonas* sp. was elucidated by time-resolved laser-induced fluorescence spectroscopy (TRLFS). For TRLFS measurements, samples were prepared by adding cells to a solution of 1.0×10^{-3} mol dm^{-3} Eu(III) with 20 w/v% NaCl.

Results and Discussion

log K_d of Cm(III) was apparently larger than that of Eu(III) at all the NaCl concentrations examined. Chemical properties of Eu(III) and Cm(III) are almost identical. One of the main differences between Eu(III) and Cm(III) is the presence of 5-f electrons which endow Cm(III) with a soft character. Our findings suggest that the difference in log K_d is reflected due to the difference in the affinity of Eu(III) and Cm(III) for the functional groups present on the bacterial cell surface. At around pH 5, the hydration number for hydrated Eu(III) ion is about 9 while that of Eu(III) adsorbed on the cells was about 4, showing that the Eu(III) on the cells was highly dehydrated. The ligand field of Eu(III) on *Halomonas* sp. was about 10 times stronger than that of the hydrated Eu(III) ion. These results indicate that the coordination environment of Eu(III) on *Halomonas* sp. is dense with the components of the outer cell surface. The unique membrane structure may have a different affinity for Eu(III) and Cm(III).