In situ observation of ice crystal surfaces by advanced optical microscopy

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Growth and dissolution of ice and snow crystals are significantly important subjects that govern wide variety of phenomena on the earth, such as weather, environmental stock, animals and plants in the cryosphere, etc. However, details of their mechanisms are still unclear. To understand the mechanisms at the molecular level, one has to directly observe elementary steps, which hold the key to growth and dissolution, on surfaces of ice and snow crystals. Such observation by atomic force microscopy (AFM) has been considered to be very difficult mainly because of a quasi-liquid layer. Recently we developed laser confocal microscopy combined with differential interference contrast microscopy (LCM-DIM), by which elementary steps of protein crystals (3-6 nm in height) could be visualized with sufficient contrast levels [1]. Hence in this study we tried to apply LCM-DIM to in situ observation of elementary steps on ice crystal surfaces.

Figure 1a shows an optical micrograph of an ice crystal surface growing from vapor at -20 degree C, clearly demonstrating spiral steps originated from the vicinity of the point B. The time course of the contrast between the points A and B is shown in Figure 1b, as a time-space plot. This figure indicates that steps advanced in a direction from right to left. Figure 1b also demonstrates that the step velocity decreased as step bunching increased.

1) G. Sazaki, et al., J. Crystal Growth, 262, 536-542 (2004).

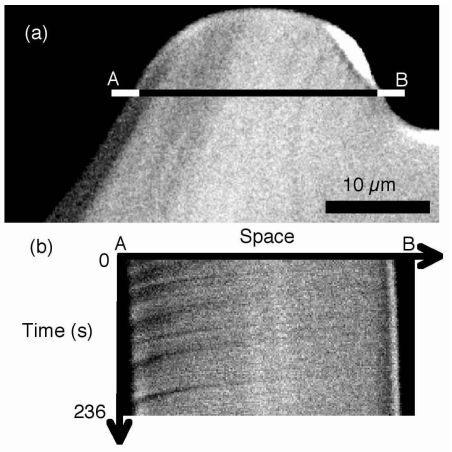

Figure 1. In situ observation of an ice crystal surface growing from a vap or phase: (a) an optical micrograph, (b) a time-space plot.