Effects of Humidity on Surface Atomic Structures of Rock Salt Crystal

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1. Introduction

Surface structures of rock salt and other ionic crystals were studied in atomic levels with Atomic Force Microscope(AFM). The change in the structure in humid air was monitored in realtime. Stabilities of step structures of sulfate minerals in electrolyte solutions were also studied.

2. Surface structures of rock salt crystal

The NaCl crystal shows perfect cleavage in (001) direction. However, the surface as cleaved in air has a lot of cleavage and slip steps. Along the slip steps, spiral steps accompanying screw dislocations were observed.

The terraces were entirely flat and individual atoms were identified. The steps did not move in the air with relative humidity of 40%. However, at the humidity of 60%, the spiral steps began to move by itself. It indicates that adsorbed water forms small islands on the surface and transports ion pairs from step to step.

Some parts of the steps retreated, while other parts grew. The movements are controlled by the curvature of the steps. Young-Laplace's equation holds for one-dimensional interface between two dimensional areas.

By placing the AFM stylus at the same position for 15 minutes and removing it, a small hillock of salt wes formed. Presumably, water was collected between the tip and the surface due to capillary condensation. It indicates that the shapes of the crystals are important to keep dryness.

3. Surface structures of sulfate minerals

Presence of directiona S-O bonds gives certain complexity to the surface structures of sulfate crystals. The conditions for the stability of flat surfaces of ionic crystals are; ① small number of bonds broken upon cleavage per unit area, and ② electric neutrality. We propose additional condition; ③ stable arrangement of electric dipoles. The stabilities of surface structures in electrolyte solutions are also discussed.