Stability of Surface Atomic Structures of Rock Salt Crystals Studied with Atomic Force Microscopy

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1. Monatomic Step Movements Helped by Adsorbed Water[1]

The velocities of monatomic step movements on NaCl and NaF(100) surfaces were measured as the functions of vapor pressure of water(Fig. 1). Step movements were observed for both crystals at $P(H_2O) \geqq 1.7$kPa(relative humidity of 52%) at 299K. A steep increase was observed with NaCl at about 2kPa(60%), while no such phenomenon was observed with NaF. By comparing the data with adsorption isotherms of water on powder samples[2], a model of adsorbed water was proposed (Fig. 2). Islands of two-dimensional water enables the transport of ions at the surfaces.

2. Hillock Formation Using the AFM Probe

By placing the AFM probe at a position on the alkali halide crystals, salt hillocks are formed by capillary condensation. Unlike with NaCl, the hillocks formed on NaF were basically square shaped indicating that they are single crystal[Fig. 3]. The block grew spontaneously once formed. A mechanism for the growth was proposed.

3. Surface Structures of Other Rock-salt-type Crystals

Cleaved LiF(100) face was stable and no step movements were observed. With MgO crystal, growth of $Mg(OH)_2$ and $MgCO_3$ crystals were observed. The process is probably related to hygroscopicity of Mg containing NaCl.

4. Growth Process Observed in Saturated Solution of NaCl in Water

Step structures during the growth process was observed(Fig. 5, 6). Dents are formed at intersections of neutral steps, where the steps are stable.

References

[1] Shindo, Ohashi, Baba and Seo, Surf. Sci., 357/358 (1996) 111.
[2] Barraclough and Hall, Surf. Sci., 46 (1974) 393.