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

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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). Atomic step movements in humid air, and in solutions were monitored in realtime. Relation between step mobility and structural aspects including ionic arrangements, defects, adsorption structures, etc. were studied.

2. Surface structures of rock salt crystal in air

Mobility of atomic steps were monitored changing humidity (vapor pressure of water Pw). No step movement was observed with Pw<1780 Pa. Slow step movement was recognized at Pw=1850 Pa. At Pw=2210 Pa, the speed of step movements became as large as 2.5 nm/s. At that humididy, the surface must be mostly covered with water.

Step advancement is not interrupted by screw dislocations. However, larger hollows(typically 50 nm in diameter) can pin down steps at it even at Pw=2200 Pa. By making such hollows all over the surface, step movement, a process of degradation of the surface, will be markedly slowed.

3. Surface structure of rock salt in ethanol

When NaCl(001) was dissolved in ethanol, square pyramids having {011} faces as the sides begin to grow and cover the surface. Stable adsorption of ethanol, a surface active molecule, stabilize the {011} faces. A close-packed molecular model was proposed.

When $CdCl_2$ was added to ethanol, square pyramidal etch pits were formed. This time, the side walls are {118} faces having (001) terraces and {111} ledges. Adsorption of $CdCl_2$ chains at the ledge must be stabilizing the structure.

4. Surface structures of sulfate minerals

Dissolution of $CaSO_4$ crystals in electrolyte solutions were studied. Stabilities of atomic steps on different surfaces and in different directions were compared. Steric factors are very important in this case.