Control of Surface Structure of Sodium Chloride Crystals

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Observation of the surface structure of a crystal grown in a multi-crystal system suggests some interesting growth phenomena which might be related to the quality of product crystals. In a previous study [M. Yokota et al., AIChE J., Vol. 42, No. 5, 1487-1490 (1996)], we reported interesting growth behavior of a sodium chloride crystal. That is, regularly arrayed fine crystals (RAF) appeared on the surface of crystals grown in a multi-crystal system. Additionally, formation of RAFs caused purity drop of crystals because of mother liquor inclusion. On the other hand, adhesion of small crystals on the surface of a large crystal, which is now well-known phenomenon, also could be a characteristic phenomenon occurring in a mulit-crystal system. However, the effect of adhesion of small crystals on the quality of large crystals has not been clarified yet.

In this study, the effect of adhesion of small crystals on the surface structure and the purity of a large seed crystal was examined by using an optical microscope and an atomic force microscope.

When a large seed crystal of sodium chloride was allowed to grow in a clear solution, the surface of the crystal was smooth. However, in the presence of suspended fine crystals, some fine crystals were observed to adhere on the surface. This adhesion of small crystals was sometimes followed by formation of cavities in the crystal. Additionally, the crystal growth rate of a seed crystal was sometimes enhanced temporally on the adhesion of a small crystal. From these observations, we deduced an important conclusion that the cavities were easily formed only when the degree of growth rate enhancement was larger than 2, which is defined as the ratio of the temporal maximum growth rate to the normal growth rate of the original seed crystal in the corresponding clear solution. Below this level, no cavity was found in the large seed crystal.

The result of atomic force microscopic observation gives us an idea of the mechanism of cavity formation as follows. Active steps generated on adhesion of a small crystal is likely to advance at a rate higher than the original steps of a seed crystal. This difference in the advancement rate of steps causes bunching and macro step formation, of which phenomena was able to be observed even under optical microscope, i. e., the macro step is inactive (does not advance), then the new active steps can over-grow on it. This could be a possible explanation for formation of cavities on the adhesion of small crystals.