Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS31-P06 Room:Convention Hall Time:May 19 18:15-19:30

”In-situ” observation of the normal growth rate and surface concentration filed of a lysozyme crystal under microgravity

Kenta Murayama[1*], Katsuo Tsukamoto[1], Hitoshi Miura[1]

[1]Department of Earth Sciences, Tohoku University

Since the convection in solution is restrained in microgravity environment, the rate of the supply of a solute to the crystal surface is governed by diffusion. Therefore, it has been widely believed that the crystal growth rate decreases compared with the case on the ground. The generation of defects is also believed to be restrained due to shortage of impurities on the crystal surface. As the result, it was expected that the quality of the crystal is improved in microgravity. But actual growth rate of protein crystal was equal or increased in microgravity environment is obtained in the protein crystal growth experiment using a satellite. However, in order to have such a discussion, we have to measure the normal growth rate of the crystal precisely under microgravity where convection is controlled.

We carried out the microgravity experiment in the International Space Station (ISS) that gives ideal environment without convection. A protein crystal grows within the specially designed cell, whose temperature is controlled with two interferometers to clarify the relationship between the growth rate and surrounding environment.

The ”in-situ” observation of the concentration field around the crystal and the measurement of normal growth rate of (110) surface were carried out by using the Mach-Zehnder and the Linnik interferometer, simultaneously. The sample used for the experiment is a tetragonal lysozyme (solution concentration 30 mg/ml, 50 mM Acetic acid buffer pH4.5, NaCl 2.5%). The crystal growth cell was conveyed to ISS after enclosing a seed crystal and solution on the ground. The cell is made of silica glass and has enclosed a seed crystal and a couple of glass with the inside. The glass serves as a reference, when measuring a growth rate with the interferometer. The seed crystal was chemically fixed to avoid deterioration and dissolution by temperature elevation during transportation to ISS. A seed crystal was prepared on the wall of the cell with the direction of that (110) surface became to be perpendicular to the optical path of the Linnik interferometer. Peltier devices control the temperature of the cell and solution. Supersaturation of the solution was controlled by the change of temperture.

Concentration gradient at the interface under the microgravity was observed and had a gentle slope compared with that obtained under gravity. But concentration has fallen considerably to bulk at the interface. Moreover, the time dependence of the interface concentration profile was fluctuated irregularly.

Compared with the case under gravity, growth rate of the lysozyme crystal under micro gravity became larger about 30% at the maximum. The critical supersaturations for two-dimensional nucleus formation were obtained from the supersaturation dependences of the growth rates and were 1.2 under micro gravity and 0.7 on the ground. Under micro gravity, two-dimensional nucleus formation was suppressed and spiral growth becomes predominant in comparison with the case under gravity. Even if the temperature of solution was maintained at constant, the crystal growth rate was fluctuated. The supersaturation of the interface was also changed by time, but the tendency does not always accord with fluctuation of the growth rate.

These observations suggest that not only the concentration change at the interface but also growth kinetics of crystal surfaces and the change of the angle of a growth hillock cause fluctuation of the growth rate of the crystal.

Keywords: lysozyme, interferometer, crystal growth