4. Crystal Growth of Lysozyme in a Perfect Containerless Condition (Videos: 10 and 11)

<Explanation>

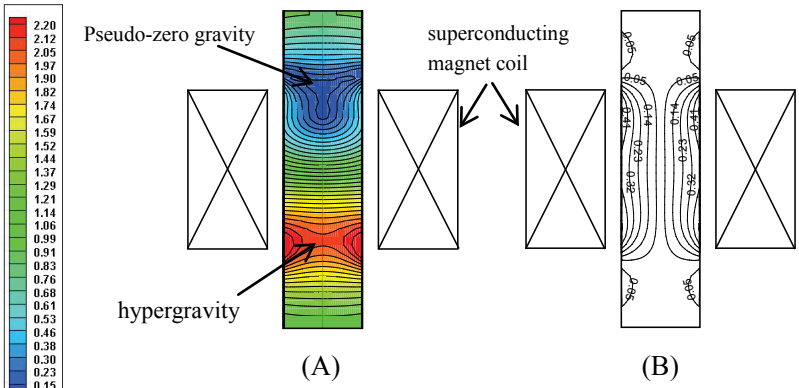

Fig.1 Distribution of Resultant Forces Generated inside the Superconducting Magnet Bore. (A) The hyper-gravitational condition is shown in red. The state of weak gravity is shown in green to blue. The condition of pseudo-zero gravity is realized near the upper edge. (B) Contour distribution of magnetic forces

Fig.1 shows the result of a three-dimensional numerical calculation for the distribution of the resultant forces when the gravity and the magnetic force have the same intensity in the vicinity of the coil edge of the solenoidal superconducting solenoid. Where the background is bluer, the state is closer to pseudo-zero gravity. This diagram indicates that a specific condition in the shape of an hourglass is assumed near the upper edge. In this position, the growth of lysozyme crystals has been carried forward by the batch method.

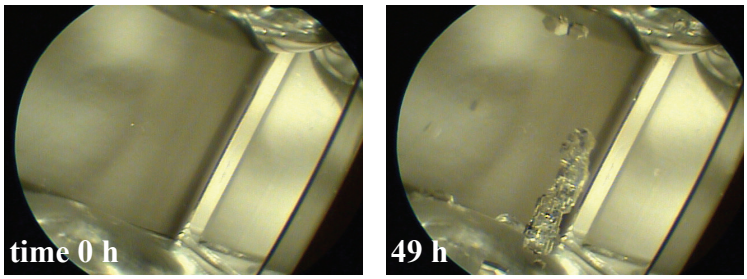

Fig.2 Process of lysozyme crystal growth under a perfect containerless condition. Due to the positioning of the observation system, the camera is slightly inclined against the sight.

Videos 10 and 11 show the specimen being viewed sideways with the use of a rigid scope. This observation was carried out at intervals of 15 minutes. Fig. 2 shows typical images viewed at that time. Since the inside of the bore is narrow, observation was performed with the tip of the rigid scope slightly tilted. Note the direction of gravity as indicated in Fig. 2.

The coagulation of fine crystals is confirmed about 4 hours after the insertion of the specimen in the magnet bore. In 4.5 to 5.5 hours after that, a crystal nucleus begins to be clearly visible. The nucleus goes

on growing into an oblong shape and its size increases gradually. After the lapse of 49 hours, the edge part comes in contact with the bottom of the vessel. It is an interesting fact that multiple particulates can be seen floating above the core crystal, though this is difficult to discern from the video images. These particulates settle down spirally along the surface in the shape of a well in Fig. 1.

The reason for the growth of crystals in the rod state is that the concentration of protein in the liquid is lowered during the growing process and the volume susceptibility is thereby reduced. As a result, the buoyancy of magneto-Archimedes levitation is reduced. As a result of the gradual lowering of the crystal levitation level, fine crystals tend to coagulate above the crystal and they grow into a rod shape.

<Conditions for crystallization>

0.025g of 0.200 mol/L HCl (Wako Pure Chemical Industries, Ltd.) was dripped into 2.000 g of water and 0.160g of lysozyme (MP Biomedicals, LLC) was added. Immediately after complete dissolution, this solution was put in the magnetic field of 1.851 T. The final conditions of the concentration are that 6.491 wt% is for lysozyme and 0.306 mol/kg is for gadolinium chloride. Unless the solution is produced in this order, this treatment may fail due to generation of white turbid sedimentation.

<Place of execution>

Faculty of Pharmacy, Osaka Ohtani University

<Research paper>

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