In situ observation of dynamics of defects in a protein crystal

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The structural imperfections in crystalline materials, called crystal defects, exist commonly in crystals grown under realistic condition and they have important roles in crystal growth and dissolution. One of the best example is a dislocation, which occasionally promotes crystal growth under supersaturated condition by generating spiral growth steps on a crystal surface [1]. Dislocations also promote crystal dissolution with the formation of etch pits [2] because they have a localized energy and are therefore thermodynamically unstable [3]. Thus, to understand the origin and formation processes of defects can be useful for understanding crystal growth and dissolution processes.

Transmission electron microscopy (TEM) is one of the powerful techniques to detect defects because of great sensitivity to disorder of atoms or molecules in crystals. In addition, recent advancements in micro-fabrication techniques provide the liquid-cell for observation of liquid sample under TEM. For the purpose to study the relationship between crystallization processes and crystal defects in an aqueous solution, at first we employed these techniques to observe the crystal defects and its behavior using TEM with the liquid-cell. We used lysozyme protein crystals as a case study which we succeeded in observing its crystallization processes in its crystallization solution using TEM [4].

We observed tetragonal and orthorhombic lysozyme crystals which commonly crystallized in our experimental condition. Several types of contrasts in TEM image, which represented the crystal defects, were observed in growing or dissolving crystals. In this presentation, we will report the detailed analysis of contrasts in TEM image attributed to crystal defects, its behavior and the effects of defects in crystallization and dissolution processes.

Acknowledgement

We thank Ms. E. Furukawa for experimental support.
The authors acknowledge supports from a Grant-in-Aid for Research Activity Start-up from KAKENHI (26887001), for a grant for Young Scientists (A) from KAKENHI (24684033) and for a grant for Scientific Research (S) from KAKENHI (15H05731).

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Keywords: In situ observation, Transmission electron microscopy, Crystal defect, Crystal growth, Solution growth

