A new approach to reproducible epitaxial growth of protein crystals

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In recent years, heteroepitaxial growth of organic crystals has attracted a great deal of attention for the development of materials science and engineering. Epitaxial growth of organic materials has unique characteristics in comparison with the inorganic materials. For example, the lattice mismatch between the growing layer and substrate substance is a critical factor in the epitaxy of inorganic crystals, but not in the epitaxy of organic crystals. This is clear evidence that the conventional theory and methodology derived from the studies on inorganic materials are not always useful for the epitaxial growth of organic materials.

For decades, most of studies on the epitaxial growth of organic crystals have been devoted to only chain and planar molecules, which have symmetric and simple structures. However, inducing the epitaxial growth of proteins, which have three dimensional and complex structures, and elucidating the mechanism of the epitaxy could be very important for making a significant contribution to the universal theory of crystal growth. Nevertheless, only a small amount of studies on the epitaxy of proteins have been carried out, so far.

McPherson et al. first demonstrated the epitaxial growth of protein on inorganic crystal substrates about 20 years ago. However, the reproducibility of this phenomenon has yet to be confirmed. On the other hand, recent studies have revealed that oriented lysozyme crystals can be nucleated on organic thin films. These results suggest that the epitaxial growth of protein crystals could be induced if appropriate organic substrates are employed. Moreover, it was also reported that the orientation of lysozyme crystals was changed depending on the NaCl concentration in the crystallization solution. Since the interaction between protein and substrate molecules changes according to the net charge and its distribution of protein molecules, it is crucial to clear the effects of the compositions of the crystallization solution on the orientation of protein crystals. This means that attention must be paid to the compositions of the crystallization solutions as well as surface structures of substrates for the epitaxial growth of protein crystals.

Here, the author reports the first demonstration of the reproducible epitaxial growth of protein crystals. Two topics are mainly picked up in this paper, namely, the molecular arrangement of organic substrates and the components of solution. Fatty acid thin film is one of appropriate substrates because there are many kinds of fatty acids of similar molecular structures with different molecular length, and the surface structures of the thin films are easily controlled. The crystallization of a protein on various fatty acid thin films and the influence of the surface structure of these films and molecular length on the epitaxy of protein crystals are exhibited. In addition, the effect of the components of solution on the epitaxial growth is displayed.