Optical Trapping and Assembling of Protein at Solution Surface

National Chiao Tung University, Taiwan.[1] Nara Institute of Science and Technology, Japan. Kobe University, Japan.[3]

°Po-Wei. Yi[1,2], Tetsuhiro Kudo[1], Eri Chatani[3], Ryohei Yasukuni[2], Yoichiroh Hosokawa[2], Teruki Sugiyama[1,2], Hiroshi Masuhara[1]

E-mail: victor651402@gmail.com

Optical trapping has been utilized widely in biology and physics for manipulating nano- and microscale objects such as molecules and particles. We have been studying molecular crystallization [1] and polystyrene (PS) nanoparticles (NPs) assembling at solution surface [2] and glass/solution interface [3], where molecular clusters and NPs are trapped at the focus, extending to the outside and reaching a few tens μm. This phenomenon "Optically Evolved Assembling" was also demonstrated for a highly concentrated solution of lysozyme protein, and the large expansion of their assembly was confirmed by transmission imaging [4]. In this work, we study the phenomenon systematically by applying fluorescence imaging and Raman micro-spectroscopy.

We used the Rhodamine B-labeled lysozyme for observing the fluorescence image. As shown in Fig. 1, the fluorescence intensity increases from the focus to the outside during the irradiation of trapping laser. The lysozyme concentration becomes locally higher with time, and their assembly expands to a few tens μm. After turning off the trapping laser, the highly concentrated lysozyme domain decreases to the initial value. The Raman spectra are measured at the focus during the trapping, and its intensity increases without appreciable spectral change. The result indicates that lysozyme is initially attracted to the focus and distributed to the outside without its denaturation. Furthermore, we incorporated the PS particles with the diameter of 1 and 20 μm and found their unique trapping and ejection behavior, which is also ascribed to the lysozyme assembling at the solution surface. We conclude that the highly concentrated lysozyme domain is successfully formed and becomes dramatically larger than the focal spot. We expect our concept "Optically Evolved Assembling" holds in the lysozyme solution and promote a new fabrication method of protein at the solution surface.

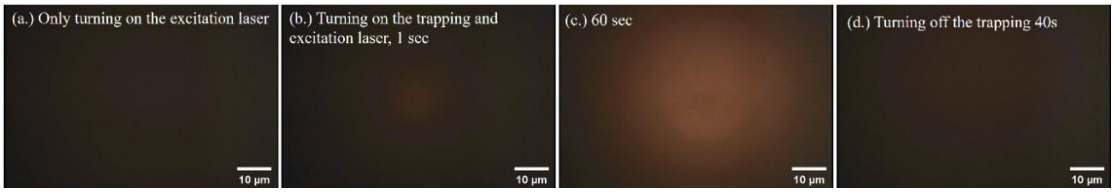

Fig. 1 Fluorescence images of the mixed D_2O solution of lysozyme and Rhodamine B-labeled lysozyme upon laser trapping. The total lysozyme concentration is 375 mg/ml, and its 0.01 % is Rhodamine B-labeled lysozyme. Laser power is 1 W. The focus of 1064 nm trapping laser is located at the center of the image.

References. [1] T. Sugiyama *et al.*, Acc. Chem. Res. **45**, 1946 (2012). [2] S.-F. Wang *et al.*, Langmuir, **32**, 12488 (2016). [3] T. Kudo *et al.*, Nano Lett. **16**, 3058 (2016). [4] P.-W. Yi *et al.*, Abstract of 2020 Spring Meeting of JSAP.