Optical Trapping Assembling of Protein with Polystyrene Particle at Solution Surface

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Optical trapping has been a powerful tool for assembling micro- and nano-sized particles and protein molecules three-dimensionally in solution. At the solution surface and interface, we have demonstrated so far new assembling phenomena such as crystallization of amino acids [1], periodic structure formation of polystyrene (PS) nanoparticles (NPs)[2], and swarming of gold NPs[3]. All the assemblies expand along the surface and interface from the focal point reaching a few ten μm, which we call "Optically Evolved Assembling". In this work, we expect new optical trapping phenomena for protein solution with PS particle.

The first interesting result was obtained by adding 1 μm-sized PS microparticles (MPs) to lysozyme solution. A stick-like assembly grew straightly from the focal point to outside along the surface during the irradiation (Fig. 1). After switching off the laser, the MPs underwent dispersion. Note that a single disc-like assembly of MPs was fabricated without lysozyme. In the second experiment, we introduced the trapping laser to irradiate on a single 20 μm-sized MPs in the lysozyme solution. Aggregates were deposited on the MP, although only the central part of the MP was irradiated. The aggregates were stable for a while after switching off the laser. Third, we carried out the trapping experiment in lysozyme solution without MPs and found a large morphological change of the lysozyme aggregate, expanding quickly from the focus to a few ten μm for high concentration of lysozyme. This suggests that a new lysozyme assembly is formed and it dispersed once stopping the irradiation of trapping laser. We summarize the present phenomena as "Optically Evolved Assembling" of proteins at solution surface and will directly clarify scattering, propagation, and/or interference of the trapping laser through the growing assembly. The present work will be useful for which is an important issue for promoting protein manipulation and eventually developing engineering of protein assembling

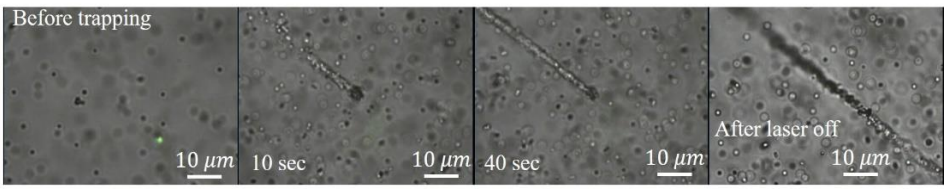

Fig.1 Optical trapping at a solution surface for 1μm-sized MPs in 375 mg/ml lysozyme solution by a 1064 nm laser of 1 W. A stick-like assembly is generated and dispersed with and without the laser irradiation

References. [1] H. Masuhara, et al., Pure Appl. Chem., 83, 869 (2011). [2] S. F. Wang, et al., Langmuir, 32, 12488 (2016). [3] T. Kudo, et al., Nano Lett. 18, 5846 (2018).