Single Sub-Millimeter Linear Assembly of Polystyrene Microparticles by Optical Trapping at Protein Solution Surface

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We have been studying the assembling of polystyrene (PS) microparticles (MPs) at solution surface by optical trapping [1]. In this case, a large assembly with a unique rearrangement is driven by optical force at D_2O surface. This phenomenon has never been observed inside a solution. In previous work [2-3], we found the 1 μm PS MP assembly grew in one-dimensional, which we called stick-like linear assembly formation, at the surface of high concentration lysozyme solution. Both assemblies of PS MPs and lysozyme extended to a few tens of micrometer from the focal point. In this work, we challenge how long we can prepare the stick under the conventional optical trapping condition.

We added the PS MPs with the diameter of 3 μm into a high concentration lysozyme solution and performed optical trapping with a near-infrared laser. As shown in Fig.1 (a-c), PS MPs form a stick-like assembly while an assembly of lysozyme expands to form a large domain (Fig.1 c). The direction of its elongation is always pointing at one direction at a time. Surprisingly, the stick-like assembly of 3 μm PS MPs keeps elongating to the outside from the focal point, and its length is longer than 100 μm (Fig.1 d). In addition, the direction of elongation, time scale of the formation and elongation, and the length of the assembly are stochastic. Note that the stick-like assembly has been observed only with high concentration lysozyme, and the length of 1 μm PS MP assembly has never reached 100 μm. We consider that stronger optical force is loaded on larger size of PS MP and will discuss on this “single sub-millimeter linear assembly” from viewpoints of dynamic coupling of PS MP assembling with highly concentrated lysozyme domain formation. This study will hopefully provide a new fabrication method of MP aggregation at protein solution surface.

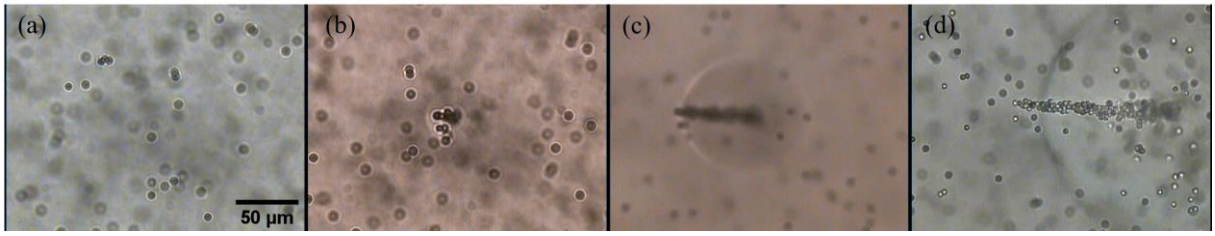

Fig. 1 Transmission images of lysozyme assembly involving 3 μm PS MPs formed by optical trapping at D_2O solution surface. The lysozyme concentration is 375 mg/ml. Laser power is 1 W after the focusing. The focus of 1064 nm trapping laser is at the center of the images (a-c). (a) Before turning on trapping laser, (b-c) At 10 sec and 1 min after turning on, respectively. (d) Soon after switching off irradiation of ~~at~~ 6 min. The focus is at right side.

References. [1] J.-S. Lu *et al., J. Phys. Chem. C,* **2020**, *124*, 27107–27117. [2] P.-W. Yi *et al.*, Abstract of **2020** Spring Meeting of JSAP. [3] P.-W. Yi *et al.*, Abstract of **2020** Autumn Meeting of JSAP.