Laser trapping-induced periodical structure of polystyrene particles and its transformation at solution/glass interface

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Upon laser trapping, polystyrene particles diffusing in solution can be three-dimensionally trapped and gathered in an irradiated area. When a 1064 nm laser is tightly focused to the solution/glass interface, the assembly of polystyrene particles of 500 nm in diameter expands from the focus to a few tens μm outside [1]. Interestingly, linearly aligned particles stick out from the assembly like a horn, depending on laser polarization. We proposed that these horns are formed by a propagation of the trapping laser through the adjoining particles in periodic structure of the assembly. Here we directly visualize the structure in the assembly center and discuss its formation mechanism by utilizing a dual objective lens microscope.

A single assembly much larger than the irradiated area is prepared; one example by linearly polarized laser is shown in Fig. 1. With time, structural transformation occurred from the outer to the central parts, and four-horn formation dynamics was directly observed with linearly polarized laser. Laser polarization dependence is demonstrated and the assembly formed with circularly polarized laser is shown in Fig. 2. After laser irradiation, we switched off the laser for 10 sec and switched on again, which provides orientational/diffusional relaxation and reassembling keeping the high local concentration. Thus, structural control of the assembly from hexagonal to tetragonal was demonstrated together with the four horn formation. The hexagonal and tetragonal structures without horn and with 4 or 6 horns, respectively, are well interpreted in terms of propagation of the trapping laser through the assembled particles. Also we will demonstrate high potential of dual objective lens microscope in elucidating laser trapping dynamics.

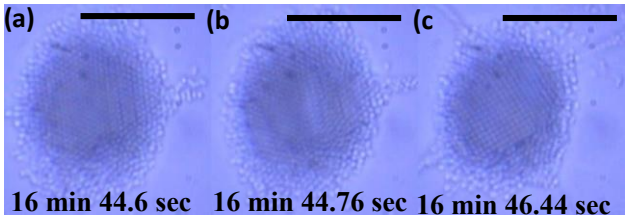

Fig.1 Transmission image of a large assembly formed by linearly polarized laser. Black bar indicates the length of 10 μm.

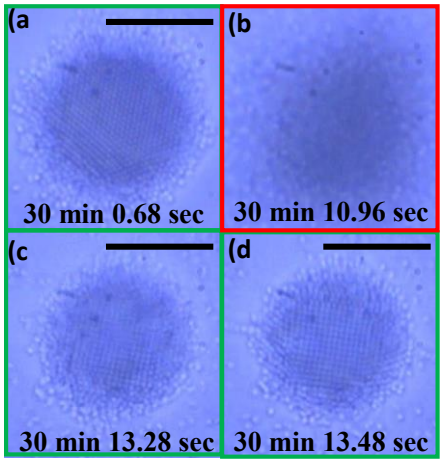

Fig.2 Transmission image of a large assembly formed by circularly polarized laser. Green block: laser on. Red block: laser off. Black bar indicates the length of 10 μm.

[1] T. Kudo, S.-F. Wang, K. Yuyama, H. Masuhara, Nano Lett., **16**, 3058–3062 (2016).