Laser trapping and necklace-like assembly formation of polystyrene microparticles at solution surface

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Upon an irradiation of a tightly focused laser beam, micro and nanoparticles diffusing in solution are optically trapped at the focal spot three-dimensionally. We have been studying intensively on the laser trapping at an interface, such as glass/solution and air/solution interfaces, where optical potential expands from the focus to outside of focal spot up to few tens micrometer through light propagation and scattering of the trapping laser [1, 2].

We here report that a large 150 μm-sized assembly of polystyrene microparticles with necklace-like patterns (see Figure 1) is prepared by light propagation through whispering gallery mode under the laser trapping of focal diameter about one micrometer. We performed the laser trapping (1064 nm in wavelength) of polystyrene microparticles (mixture solution of 20 μm and 1 μm in diameter) at solution surface. The light propagation is directly confirmed by 1064 nm backscattering imaging, and finite difference time domain simulation well supports the idea that the optical potential is expanded outside the focal spot based on whispering gallery mode. With optimizing the experimental conditions to be exactly resonant to whispering gallery mode with high Q factor, we believe that a millimeter order assembly is possible to be prepared by a single tightly focused laser beam.

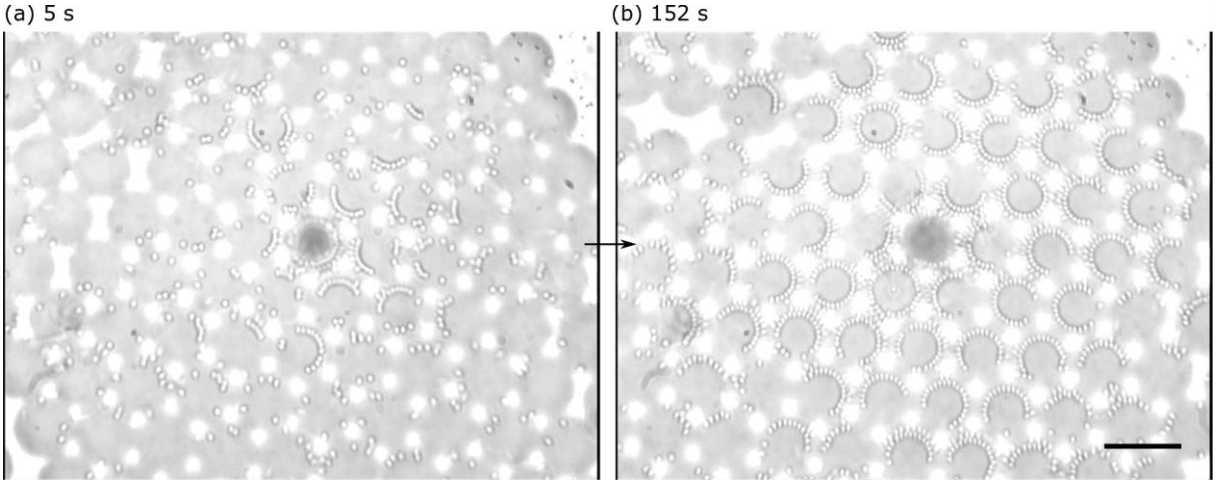

Figure 1. Transmission images of laser trapping and assembling of 1 μm polystyrene microparticles on many 20 μm polystyrene microparticles at D_2O solution surface. (a-b) Temporal changes of the single assembly under laser trapping. The laser is turned on at 0 s. The length of the black bars is 20 μm and the size of the whole assembly is approximately 150 μm.

1. T. Kudo, S.-F. Wang, K. Yuyama, H. Masuhara, Nano Letters 16, 3058-3062 (2016).
2. T. Kudo, S.-J. Yang, H. Masuhara, Nano Letters 18, 5846-5853 (2018).