Linearly Aligned Polystyrene Particles Ejected from Their Assembly during Laser Trapping at Air/Solution Interface

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Laser trapping is a method to manipulate small objects without any contact by using a focused laser beam. Previously, we conducted the laser trapping of 200 nm polystyrene (PS) nanoparticles with high intensity at the air/solution interface, and we found that a single nanoparticle assembly is formed and expanded outside of the focal spot [1-2]. We also reported laser trapping and assembling of 500 nm PS particles at glass/solution interface. The prepared assembly was much larger than the focal spot with sticking out rows of linearly aligned particles like horns [3]. We proposed that these phenomena are due to the propagation and scattering of trapping laser from the center to outside of the assembly.

Here, we demonstrate the experiment of the laser trapping of 1 μm PS particles at air/solution interface. The assembly looks like a concentric circle pattern due to interference of trapping laser at the interface. It is notable that several particles aligned linearly are ejected out from the assembly (Fig. 1-IV) and its direction is same to that of the scattered light. We systematically change particle density and laser power, and use differently functionalized particles. The results show that higher particle density and higher laser power give more frequent ejection and more particles per each ejection. The particles with carboxylate surface (higher surface charge) are ejected more individually compared to those with sulfate ester one (lower surface charge). Here we propose two possible mechanisms for the ejection behavior based on light scattering and interparticle interaction. (I) When the assembly grows larger than the focus spot, the particles located at edge of the assembly receive stronger scattering force. Once the scattering force overcomes the gradient force, the particles are shot out of the assembly. (II) When the particles attracted toward the focus collide with the assembly, their momentum transfers to the assembly leading to the particles ejection.

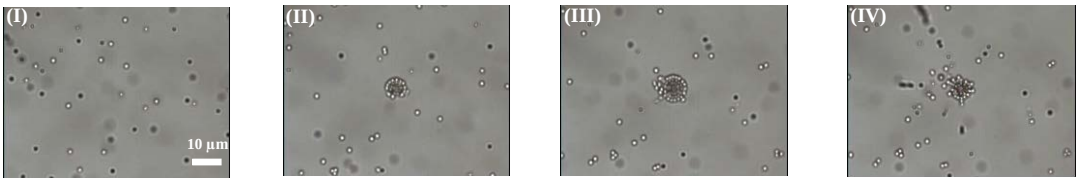

Fig.1 Transition images of the polystyrene particles assmebly. (I) Before turning on the laser, no aggregation. (II) At ~ 6 s after turning on the laser, the assembly appeared. (III) At ~14 s after turning on the laser, the assembly grows larger, and occurs rearrangement. (VI) At ~ 14.2 s after turning on the laser, several particles are ejected out in linearly aligned manner and the assembly shrinks.

[1] S.-F. Wang, K.-i. Yuyama, T. Sugiyama, H. Masuhara, J. Phys. Chem. C, 2016, 120, 15578–15585.
[2] S.-F. Wang, T. Kudo, K.-i. Yuyama, T. Sugiyama, H. Masuhara, Langmuir, 2016, 32, 12488–12496.
[3] T. Kudo, S.-F. Wang, K.-i. Yuyama, H. Masuhara, Nano Lett., 2016, 16, 3058–3062.