Morphological dynamics and packing structure of an optical trapping-induced colloidal assembly studied by salt effect

○Ching-Hsiang Tseng[1], Tetsuhiro Kudo[1], Shun-Fa Wang[1], Hiroshi Masuhara[1]
National Chiao Tung Univ. Taiwan[1],
E-mail: lawrence3014.ac01@nctu.edu.tw

When the laser is focused into solution, polystyrene nanoparticles diffusing in the solution receive the optical force and are trapped inside the irradiation area [1]. Recently, we discovered for the first time that optical trapping-formed assembly of 500 nm polystyrene nanoparticles dynamically evolves outside of the focal spot with sticking out rows of linear-aligned particles like a horn which is enabled by propagation of trapping laser through the assembly [2]. We confirmed that the periodic structure is formed at the center of the assembly through transmission spectral measurement. The 1064 nm trapping laser was focused at glass/solution interface propagates along the adjoining particles in this periodic structure, leading to horn formation. Namely, the assembly structure, light propagation, and horn formation are directly correlated with each other. Under the tightly focused laser beam, the particles randomly move and collide, resulting in formation of structure. We consider the interaction between polystyrene nanoparticles is an important factor that will affect how the light propagates to outside the irradiation area.

In order to realize how the interaction between nanoparticles affects the formation of horns, we change the solvent from water to sodium chloride aqueous solution with 25 μg/ml, 50 μg/ml, and 100 μg/ml. With increase in the concentration of sodium chloride, there is less electrostatic repulsive force between polystyrene particles. By utilizing the transmission spectra and transmission images, we observe that the inter-particle distance become shorter, and longer existing time of four-horn assembly by adding the salt, respectively. We consider that the structure is packed much denser in salt-added solution. Then, the light is able to propagate more efficiently, which results in more stable assembly. In addition, we will discuss about how the salt concentration affect assembly size, horn length, and horn structure stability.

Reference:

[1] A. Ashkin, J.M. Dziedzic, J.E. Biorkholm, and S. Chu, Opt. Lett. 11, 288-290 (1986)
[2] T. Kudo, S.-F. Wang, K. Yuyama, and H. Masuhara, Nano Lett. 16, 3058-3062 (2016)