Laser trapping in chemistry and materials science

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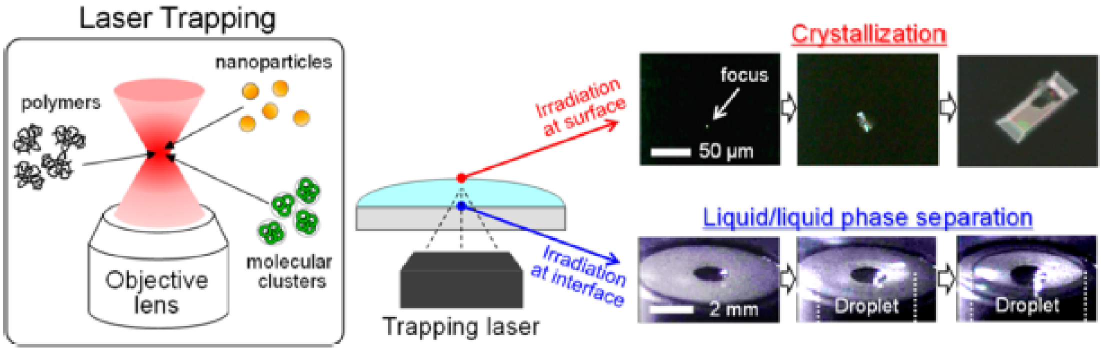
Upon focusing intense lasers of a few hundreds mW into a diffraction limit, small objects such as molecular clusters, polymers, and nanoparticles can be trapped in solution at room temperature, leading to new applications. We have been exploring new laser trapping phenomena in view of chemistry and material science, and here summarize our recent results and discuss future perspective.

1. Crystallization and liquid-liquid phase separation of amino acids by laser trapping

When intense CW 1064 nm laser is focused at an interface between a thin heavy water solution film of glycine and a glass substrate, the assembled molecules nucleate and evolve to a liquid-liquid phase separation, while they will crystallize if the trapping laser is focused on the solution surface (1). We can control the polymorph of the formed glycine crystal selectively by tuning trapping laser polarization and power.



2. Optical trapping and polarization-controlled scattering by femtosecond laser pulses

Optical trapping behavior of 50-nm-sized polystyrene beads in water was investigated by irradiating femtosecond 800 nm laser pulses. Their laser trapping is more efficient than that by CW laser, and further the nanoparticles are scattered out of the focal spot to the surrounding areas, in an alternating manner, perpendicular to the laser polarization (2). To understand these phenomena, we analyzed radiation (gradient and scattering) force of femtosecond laser pulses and their temporal force exerted on the nanoparticles by taking into account the impulsive peak power and the axial component of electric light field produced by high numerical aperture of objective lens.

3. Future perspective

We have also reported polymerization and solidification confined into small volume (3), J-aggregate formation (4), and so on, and are studying resonance effects in laser trapping. On the basis of these works we will discuss our future perspective.

(1) Sugiyama, T.; Yuyama, K., Masuhara, H. *Accounts Chem. Res.* 2012, 45, 1946-1954.
(2) Usman, A.; Chiang, W.-Y.; Masuhara, H. *J. Photochem. Photobiol. A* 2012, 234, 83-90.
(3) Ito, S.; Masuhara, H. et al, *J. Am. Chem. Soc.* 2011, 133, 14472-14475
(4) Tanaka, Y.; Yoshikawa, H.; Masuhara, H. *J. Phys. Chem. C* 2007, 111, 18457-18460