Optical trapping induced remote assembling at solution surface

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Optical trapping with a tightly focused laser beam has played an innovative role for the noncontact manipulation of nano- and microscale objects. Generally, in solution, it is believed that target objects are trapped only in the laser focal spot where the deep optical potential is formed. Our group has demonstrated that optical trapping at interfaces shows various unique assembling behaviors including molecular crystallization [1], colloidal particles assembling and rearrangement [2,3] or swarming [4], in which optical potential can expand from the focal spot (~ 1 μm) to outside a few tens of μm by the light scattering and propagation of the trapping laser. Here, we report a new optical trapping induced assembling phenomena covering the sub-millimeter area at the solution surface.

We irradiated a tightly focused 1064 nm laser beam (spot size ~ 1 μm) on the surface of 1 μm polystyrene (PS) microparticle (MP) solution. 1 μm PS MPs formed a 2-dimenional assembly with a hexagonal closed packing (HCP) structure around the laser focus. With an increase of irradiation time, the assembly size grew more than 10 μm, and some MPs were splitted from the central assembly and flowed out. Interestingly, the detached MPs reminded assembled and HCP structure even the trapping laser was irradiated not on the detached ones but on the central assembly (Fig. 1a). The central and detached assemblies were both dissolved when the trapping laser was switched off (Fig. 1b). If the trapping laser was switched on again, some assemblies were remotely formed again (Fig. 1c). The presented study implies that hidden long-range interactions among colloidal particles act at solution surface and potentially opens a new avenue for optical trapping induced assembling and crystallization.

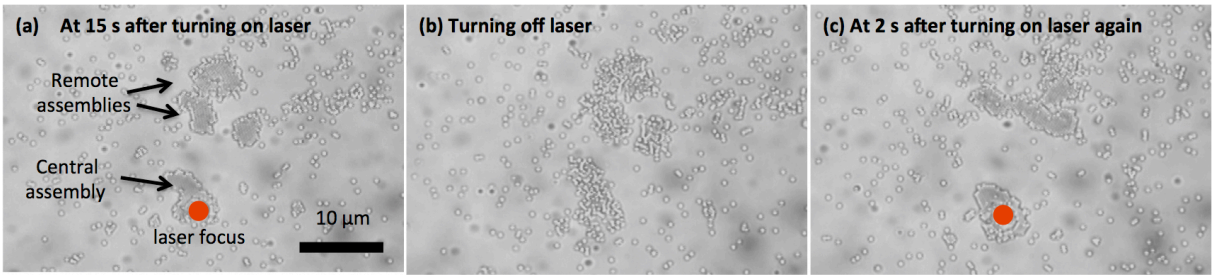

Figure 1 A series of transmission images showing a remote assembling of 1 μm PS MPs at solution surface, observed at 15 s after turning on trapping laser (a), after turning off laser (b) and at 2 s after turning on laser again (c).

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[3] J.-S. Lu *et al.*, *J. Phys. Chem. C* **2020**, *124*, 27107. [4] T. Kudo *et al.*, *Nano Lett.* **2018**, *18*, 5846.