Dynamic optical matter of gold nanoparticles prepared by optical trapping in plastic pattern

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Optical trapping, which uses a tightly focused laser beam to confine tiny objects, enables precise manipulation of materials and the exploration of microscopic phenomena. In our recent studies, we observed a dynamic behavior of gold nanoparticles (Au NPs) at the glass/solution interface. We identified a dynamic optical binding network as the basis for the "optical trapping and swarming"[1] of Au NPs, which expands perpendicular to the linear polarization of the trapping laser, now described as "dynamic optical matter"[2].

Using microchannels, we aimed to compress and precisely control the morphology of Au NPs in optical trapping and swarming, exploring applications of dynamic optical matter. Polycaprolactone (PCL) plastic patterns were fabricated via Melt Electrospinning Writing (MESW)[3]. Microchannels with variable widths and heights of a few micrometers confined the 400 nm Au NPs. When irradiated with a 1064 nm laser, the Au NPs formed dynamic optical matter within the pattern structures. After 3 minutes of irradiation, the optical matter evolved into a dumbbell-shaped morphology show dynamic fluctuations and migration of Au NPs (Fig. 1a). The plastic patterns allowed morphology control, enabling compression or extension of the optical matter (Fig. 1b, 1c). This study shows how microchannels can flexibly manipulate optical matter, facilitating the formation of various structures such as disk-like, dumbbell-shaped, and triangular assemblies. This control over optical trapping and dynamic optical matter offers a new way for creating customizable optical structures.

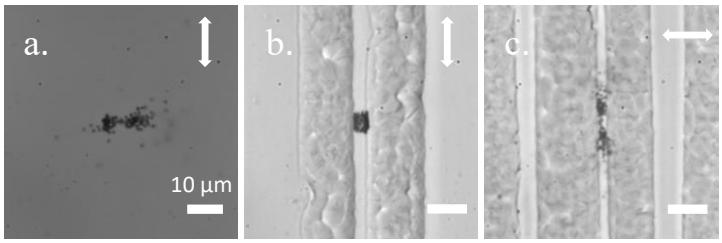

Figure 1. Linearly polarized laser irradiates for 3 minutes. The arrows represent the laser polarization direction. (a) The dynamic optical matter in free space. The dynamic optical matter in plastic microchannel with width of (b) 3.2 μm and (c) 2.4 μm.

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