Gold Nanoparticle Swarming Controlled by Particle Size and Wavelength of Trapping Laser

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Laser trapping is known as a method to manipulate nano- and micro-scale materials by trapping them inside optical potential. We reported that a single large assembly with dynamically swarming gold nanoparticles (Au NPs) was extending outside the focus at glass/solution interface by laser trapping. The dumbbell-shaped swarm was formed perpendicularly to linear polarized laser light. We proposed that scattering and trapping cooperatively evolve, namely, light scattering of trapped Au NPs expands optical potential, which traps more NPs leading to wider scattering. These processes are continuously developing until the scattering light cannot gather further NPs.

Here we examine particle size and laser wavelength dependence of swarm formation by carrying out the laser trapping of Au NPs at glass/solution interface with Ti:Sapphire laser (continuous wave (CW) or femtosecond modes (fs), 800 nm in wavelength). We observe 200 nm and 150 nm Au NPs swarming perpendicular to laser polarization, while 100 nm Au NPs are trapped as a round assembly rather than the dumbbell-shaped swarm (Fig. 1). It is worth noting that this swarming of 150 nm Au NPs is observed with 800 nm CW laser but was not with 1064 nm CW laser. Scattering cross section at 800 nm wavelength for 150 nm Au NPs is larger than that at 1064 nm wavelength, which results in this difference.

In addition, this dumbbell-shaped swarm are also prepared by fs pulsed laser trapping. The extending direction and particle size dependence are similar to the results with CW laser, which will be examined also from the viewpoint of nonlinear optical effect in fs laser trapping.

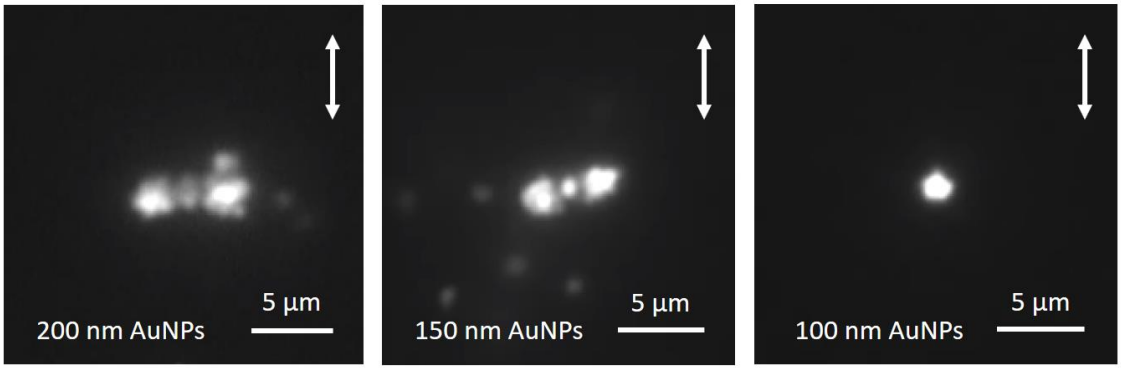

Figure 1. Dumbbell-shaped swarming of Au NPs was formed by Ti: Sapphire laser (CW, 800 nm, 15 mW) when particle size is larger than 150 nm. Laser polarization is given as arrow.