226h Size Reduction of Gold Nanoparticles Induced by Pulsed Laser Light and Its Kinetic Study

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Nanoparticles can change their sizes when irradiated with pulsed laser light. Whereas this phenomenon is well-known, the detail kinetics, such as what to extent particles reduce their sizes per one pulse, and the mechanism of the phenomenon still remain to be answered. Through the observation of the evolution of size distributions of gold nanoparticles (the mean diameter of 25 nm) under pulsed laser irradiation by transmission electron microscopy (TEM), it is found that the size distribution of gold nanoparticles changed from the initial mono-modal one to bimodal one during the irradiation of pulsed laser light. One peak is at 16-24 nm and the other at 6 nm with valley at 12 nm. While the peak position for large particles shifted to smaller diameter with the increase in the total number of shots, the one for small particles hardly changed, indicating that large gold nanoparticles gradually reduced their sizes, and consequently the volume removed from large particles turned into smaller particles than 12 nm. On the basis of the peak shift for large particles in the size distribution, we revealed that (1) the volume of particles was lost by 0.5-11% per one pulse, depending on the irradiated laser intensity, and (2) the size reduction phenomenon was caused by the photo-thermal process. Nanoparticles are heated by photon energy absorbed by nanoparticles and the formation of gold vapor around the hot nanoparticles is responsible for the size reduction. With this technique, we can change the size of nanoparticles after their synthesis step. One pulse irradiation of laser light with proper intensity is expected to give us a rapid and simple way for the size control of nanoparticles.