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Effect of Surfactant Concentration to Aggregations of Nanogold Particles.

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This research presents a study of aggregation of colloidal gold nanoparticles using 400 nm diameter gold nanoparticles mixed with a surfactant (Plantacare 2000) at various concentrations. When observed under a microscope, we found that the nanoparticles aggregated to form nearly spherical clusters at the beginning of the formation, and then sedimented to the bottom of the container. These clusters moved with Brownian's motion and collided with each other in the horizontal plane, forming branch-like clusters in 2D. The appearance and size of the clusters were different depending on the concentration of surfactant. The clusters' size and appearance were rarely changed after mixing with surfactant for 90 minutes, and we found that the cluster's shapes were nearly spherical at low surfactant concentration ($c = 0.25\%$). At surfactant concentration between $0.50\% - 5.00\%$, the aggregates formed branch-like clusters with skinnier branches and smaller sizes at higher surfactant concentration. Moreover, we also found that, at surfactant concentrations between $2.50\% - 5.00\%$, nanoparticles and aggregates stuck to the bottom of the glass container quickly and rarely moved after 10 minutes. At $c = 0.25\%$, the 2D fractal dimension of the aggregates was measured to be $D = 1.88 \pm 0.04$, since the aggregates were nearly spherical. The fractal dimension decreased to the minimum of $D = 1.50 \pm 0.12$ at $c = 1.50\%$, similar to $D \sim 1.45$ found in diffusion-limited cluster aggregation (DLCA). At surfactant concentration above 1.50% , the fractal dimension increased until it reached the value of $D \sim 1.66$ at $c = 5.00\%$.

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