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Application News

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Spectrophotometric Analysis

Relationship Between Particle Size Distribution/Particle Shape and Optical Properties of Gold Nanoparticles

Metallic nanoparticles are known for their specific properties and are employed in a wide range of fields. In particular, gold nanoparticles are attracting attention in fields such as bioimaging and high-density data storage media because its optical properties change according to particle size and shape.

This article presents the findings of using the UV-2700 UV-VIS spectrophotometer to measure changes in optical properties according to differences in the size and shape of gold nanoparticles, the SALD-7500nano nano particle size analyzer to examine particle size distribution, and the SPM-9700HT scanning probe microscope to examine particle shape.

K.Sobue, H.Maeda, S.Onomura

Optical Properties According to Particle Size Distribution and Particle Size

Fig. 1 shows the exterior of the SALD-7500nano and Fig. 2 shows the exterior of the UV-2700. Commercially-available gold nanoparticles were prepared for the sample [*1]. The SALD-7500nano was used to examine the particle size distribution of samples with nominal particle sizes of 50 nm, 80 nm, and 100 nm. Measurement was performed using 0.1 mM PBS as the dispersion medium and the BC75 batch cell as the measurement unit. Fig. 3 shows particle size distributions of gold nanoparticles. Particle size distributions with median sizes close to the nominal particle sizes were obtained.

Next, Fig. 4 shows the results of using the UV-2700 to measure the absorbance spectra of samples with different particles sizes. Table 1 lists the measurement conditions. We can see that the absorption peaks shift toward longer wavelengths as the particle size increases. The absorption of gold nanoparticles occurs due to surface plasmon resonance (SPR) and the resonance wavelength shifts depending on particle size.

Fig. 1 SALD-7500nano Nano Particle Size Analyzer

Fig. 2 UV-2700 UV-VIS Spectrophotometer

Table 1 Measurement Conditions

Instrument used	:	UV-2700
Measurement Wavelength Range	:	400 to 800 nm
Scanning Speed	:	Intermediate
Sampling Pitch	:	1.0 nm
Slit Width	:	1.0 nm

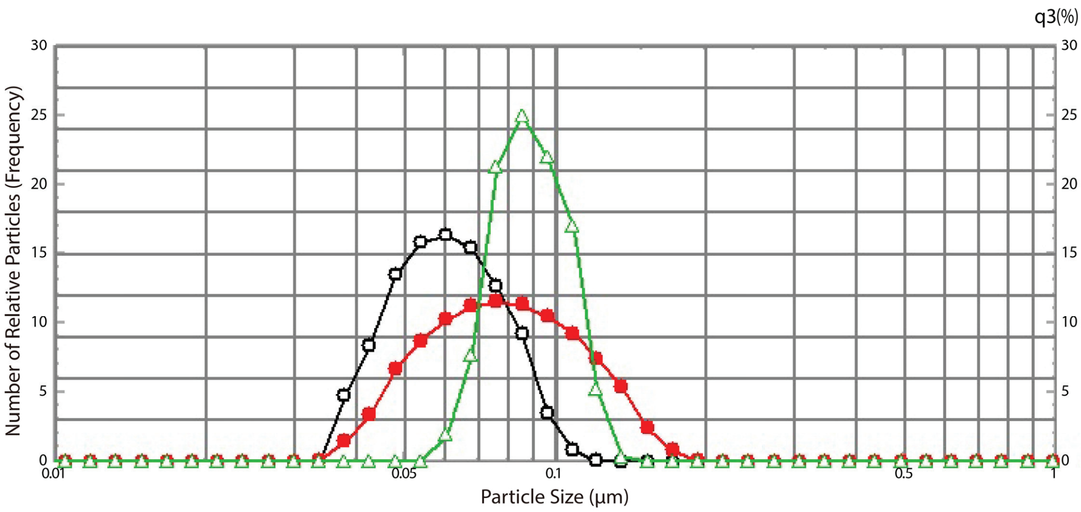

Fig. 3 Paticle Size Distributions of Gold Nanoparticles Black: 50 nm, Red: 80 nm, Green: 100 nm

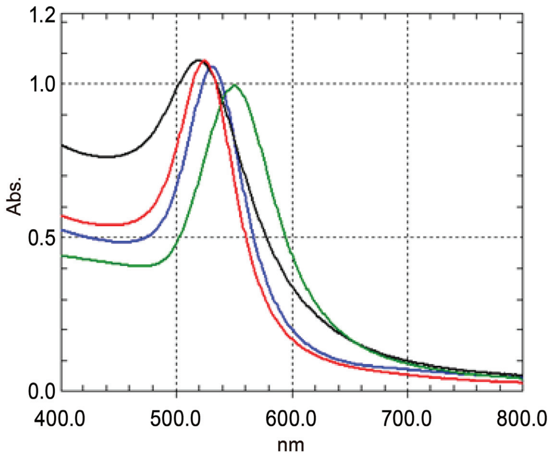

Fig. 4 Absorbance Spectra of Gold Nanoparticles of Different Sizes
Black: 10 nm, Red: 30 nm, Blue: 50 nm, Green: 80 nm

Observation of Particle Shapes and Optical Properties According to Shape Differences

Fig. 5 shows the exterior of the SPM-9700HT. Gold nanoparticles with a nominal core size of 100 nm and with differing shapes were prepared as the samples. Particle shape was observed in dynamic mode using the SPM-9700HT. In order to observe the particle shape, the dispersion liquid of each gold nanoparticles was dropped about 5 µL on a mica substrate and air dried. Fig. 6 shows 2D images of multiple particles and Fig. 7 shows magnified 3D images of single particles. The scan range of the 2D images is 10 µm × 10 µm and the z range is 130 nm. The scan range of the 3D images is 200 nm × 200 nm and the z range is 100 nm (spherical particle) and 120 nm (spiky particle). We confirmed that the size of gold nanoparticles was uniform from Fig. 6, and that there were spherical gold nanoparticles and gold nanoparticles with irregular spikes from Fig. 7.

Next, Fig. 8 shows the absorbance spectra measured using the conditions in Table 1. We confirmed that the absorption peaks differ depending on particle shape. The absorption of gold nanoparticles occurs due to surface plasmon resonance and can be deduced that the differences in particle shape cause the distribution of electromagnetic waves to change resulting in the appearance of absorption peaks at differing wavelengths.

Fig. 5 SPM-9700HT Scanning Probe Microscope

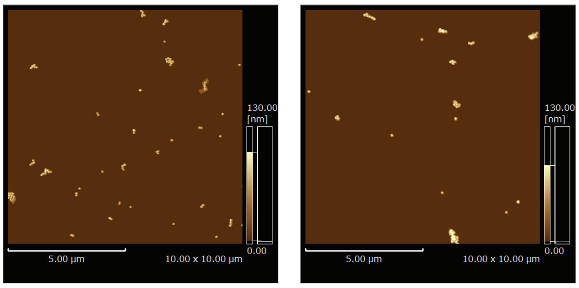

Fig. 6 Topographic Images Observed Using SPM (scan range = 10 µm × 10 µm, z range = 130 nm)
Left: Spherical Particles, Right: Spiky Particles

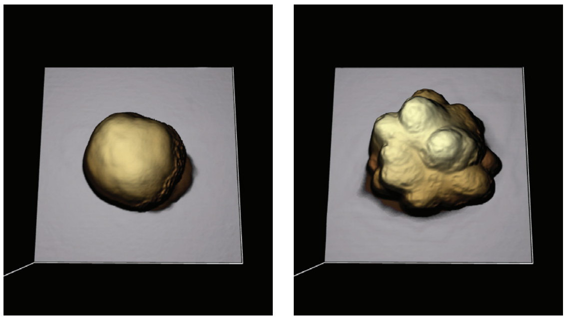

Fig. 7 Topographic Images Observed Using SPM (scan range = 200 nm × 200 nm)
Left: Spherical Particle (z range = 100 nm),
Right: Spiky Particle (z range = 120 nm)

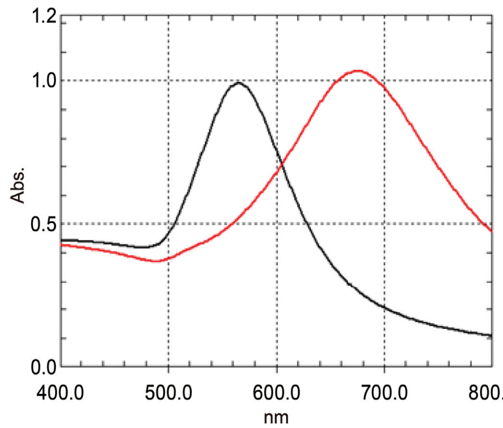

Fig. 8 Absorbance Spectra of Gold Nanoparticles of Different Shapes
Black: Spherical Particle, Red: Spiky Particle

Summary

We examined the particle size distribution of gold nanoparticles using the SALD-7500nano nano particle size analyzer and observed the shape of gold nanoparticles using the SPM-9700HT scanning probe microscope. We also observed the optical properties caused by differences in the size and shape of gold nanoparticles using the UV-2700 UV-VIS spectrophotometer.

*1 0.1 mM PBS solvent was used with gold nanoparticles and Gold NanoUrchins manufactured by Sigma-Aldrich Co. LLC.

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