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Application News

No. A570

Spectrophotometric Analysis

Measurement of Time-dependent Change of Metal Nanoparticles
– Application of Ultrafast Scanning Speed of UV-1900 –

Metal nanoparticles have the unique properties and are applied to various fields. The relationship between particle size distribution/particle shape and optical properties of gold nanoparticles was demonstrated in Application News No.534. This time, absorption spectra of gold nanoparticles and silver nanoparticles used as antibacterial coating were measured with the newly developed UV-1900 UV-VIS spectrophotometer. The light reduction phenomenon which was caused by their clumping after adding a salt solution to them was also measured with it.

"Survey" (about 29,000 nm/min) is added to the wavelength scanning speed of the UV-1900 and allows the spectrum measurement in the long wavelength range only in a few seconds. It is effective for the investigation of the light reduction phenomenon which is shown in this report and needs the spectrum measurement in the long wavelength range in a short time.

K.Sobue

Measurement of Gold and Silver Nanoparticles

The external appearance of the UV-1900 is shown in Fig. 1. The UV-1900 is a small-footprint spectrophotometer (450(W) × 501(D) × 244(H) mm) and its hardware design is done based on ergonomics. The UV-1900 uses a color touch panel as a control panel and features the easy-to-navigate user interface which can grasp the current status and operating procedures at a glance.

Commercial gold and silver nanoparticles*1 whose nominal particle sizes were 10 nm, 30 nm and 50 nm were examined. The concentration of gold and silver nanoparticles solutions was 0.02 mg/mL and 0.01 mg/L, respectively. Fig. 2 and 3 are their spectra measured by conditions shown in Table 1.

The absorption peaks shifted toward longer wavelengths for both as the particle size increased. The absorption of metal nanoparticles is attributed to the surface plasmon resonance (SPR). The resonance wavelength depends on the particle size.

*1 Gold nanoparticles (solvent: 0.1 mM PBS) and silver nanoparticles (solvent: water) manufactured by SIGMA-ALDRICH

Fig. 1 Eternal Appearance of UV-1900

Table 1 Measurement Conditions

Instrument	: UV-1900
Wavelength range	: 300 to 1000 nm (Gold Nanoparticle) 300 to 700 nm (Silver Nanoparticle)
Scan Speed	: Survey
Sampling Pitch	: 1.0 nm

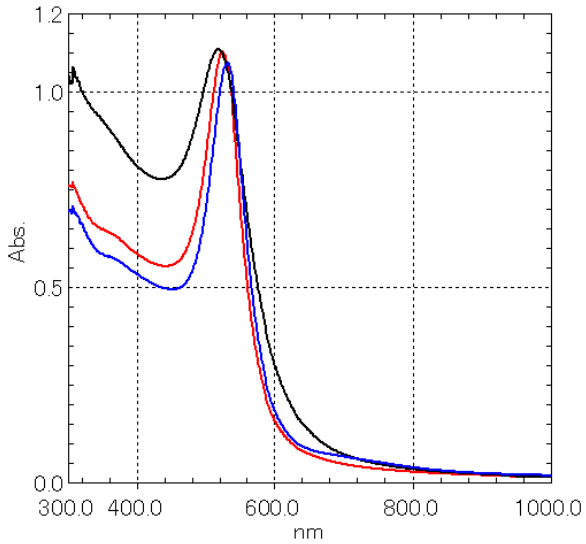

Fig. 2 Absorption Spectra of Gold Nanoparticles with different particle size
Black: 10 nm, Red: 30 nm, Blue: 50 nm

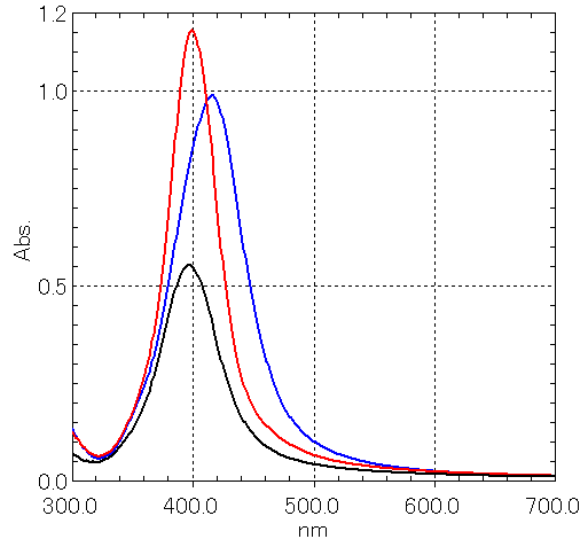

Fig. 3 Absorption Spectra of Silver Nanoparticles with different particle size
Black: 10 nm, Red: 30 nm, Blue: 50 nm

Light Reduction Phenomenon due to Clumping of Gold and Silver Nanoparticles

0 seconds, 30 seconds, 1 minute, 2 minutes and 4 minutes after 600 µL of 25 wt.% NaCl aqueous solution was added to 3 mL of 30 nm gold nanoparticles solution, its absorption spectra were measured. The results are shown in Fig. 4. Fig. 4 is drawn with a screen shot function of the UV-1900. In the same way, 0 seconds, 30 seconds, 2 minutes, 5 minutes and 10 minutes after 25 wt.% NaCl aqueous solution was added to 50 nm gold nanoparticles solution, its absorption spectra were measured. The results are shown in Fig. 5. The addition of 25 wt.% NaCl aqueous solution to both gold nanoparticles solutions caused the light reduction near the peak wavelength and raised absorbance in the wavelength range from 700 nm through 800 nm.

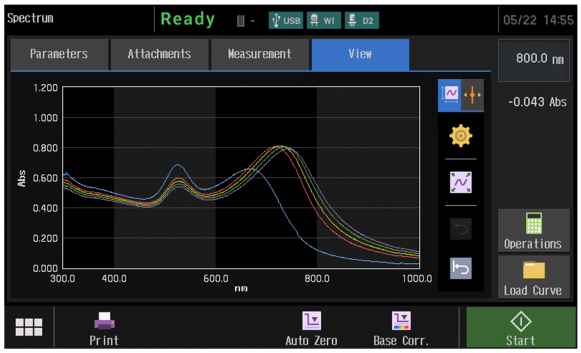

Fig. 4 Absorption Spectra of 30 nm Gold Nanoparticles Aqueous Solution After Adding NaCl Aqueous Solution From the top, 0 seconds, 30 seconds, 1 minute, 2 minutes and 4 minutes after adding NaCl solution

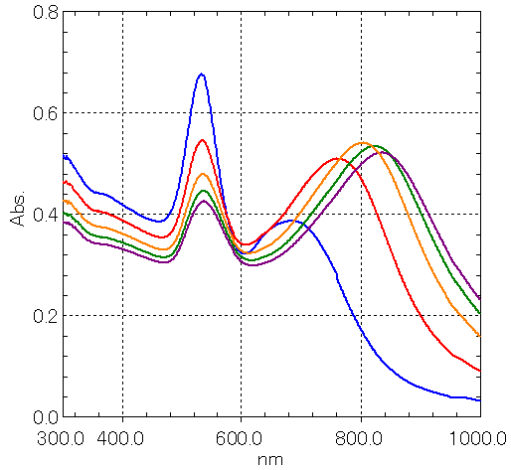

Fig. 5 Absorption Spectra of 50 nm Gold Nanoparticles Aqueous Solution After Adding NaCl Aqueous Solution Black: 0 seconds, Red: 30 seconds, Blue: 2 minutes, Green: 5 minutes, Purple: 10 minutes after adding a NaCl solution

The measurement results after adding 25 wt.% NaCl aqueous solution to 30 nm and 50 nm silver nanoparticles solutions are shown in Fig. 6 and 7. The addition of 25 wt.% NaCl aqueous solution caused the light reduction near the peak wavelength and raised absorbance in the wavelength range from 500 nm through 600 nm. Fig. 8 shows photographs of gold and silver nanoparticles solutions before and after adding 25 wt.% NaCl aqueous solution to them. In the case of gold nanoparticles solution, the red solution turned black. However, silver nanoparticles solutions didn't show the color changes.

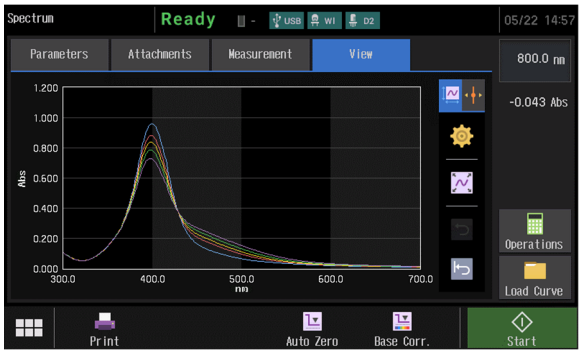

Fig. 6 Absorption Spectra of 30 nm Silver Nanoparticles Aqueous Solution After Adding NaCl Aqueous Solution From the top, 0 seconds, 30 seconds, 1 minute, 2 minutes and 4 minutes after adding NaCl solution

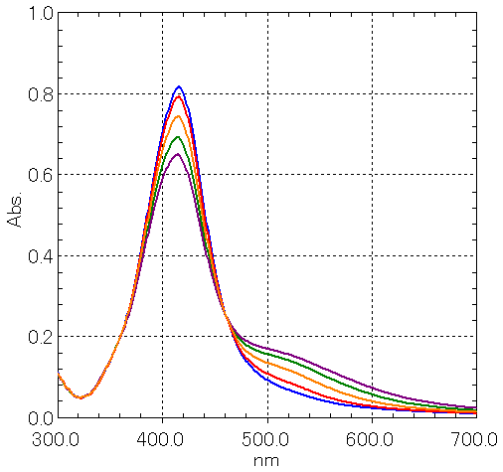

Fig. 7 Absorption Spectra of 50 nm Silver Nanoparticles Aqueous Solution After Adding NaCl Aqueous Solution Black: 0 seconds, Red: 30 seconds, Blue: 2 minutes, Green: 5 minutes, Purple:10 minutes after adding a NaCl solution

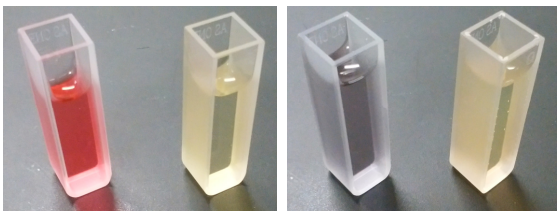

Fig. 8 Photographs of Gold and Silver Nanoarticles Solutions before and After Adding NaCl solution Left: Gold, Right: Silver

Conclusion

The results obtained with the UV-1900 UV-VIS spectrophotometer demonstrated that the optical properties of gold and silver nanoparticles depend on the particle size. The light reduction phenomenon which was caused by their clumping after adding a salt solution could be measured as the spectra by the use of "Survey" scanning speed.

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