Measurement Method of High Absorbance (Low Transmittance) Samples by UH4150

INTRODUCTION

With UH4150, a detector can be selected depending on the analysis purpose. When analyzing a solid sample which doesn't contain any diffuse components, by selecting the direct light detector, the measurement of high absorbance can be performed with less noise, compared with the integrating sphere detector.
One of the methods to measure high absorbance with a good accuracy is to use an attenuator. The standard installation of UH4150 includes the 1/100 attenuator. By using it in combination with the additional 1/100 attenuator in the sample chamber (on the reference side), the attenuation equivalent to that by a 1/10000 attenuator can be obtained and the measurement of very high absorbance (6 – 7) becomes possible. This time, using a light shielding apparatus as examples, the method for high absorbance analysis is introduced here.

SAMPLE

Sample: : Light shielding apparatus

INSTRUMENT CONDITIONS

Instrument : UH4150 Slit : 8 nm

Scan speed : 300 nm/min Measurement wavelength range: 400 ~ 700 nm

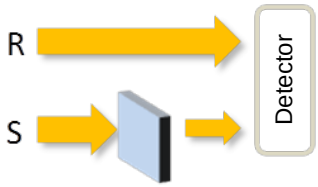
ACCESSORY

Direct light detector
(P/N : 1J1-0129)

Glass filter holder
(P/N : 210-2109)

Attenuator
(P/N : 1J0-0551)

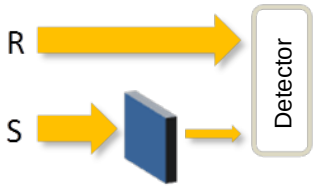
[Analysis of Low Absorbance (High Transmittance) Sample]



Low Absorbance Sample

A double beam spectrophotometer calculates the measurement value based on the light intensity ratio between the sample side and reference side.
In the analysis of a low absorbance (high transmittance) sample, the light intensities of the reference light and sample light are balanced. Thus, the analysis with little noise is possible.

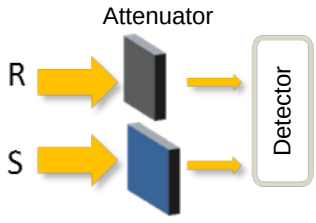
[Analysis of High Absorbance (Low Transmittance) Sample: Without Attenuator]



High Absorbance Sample

In the analysis of a high absorbance (low transmittance) sample, the light intensity on the sample side is low.
As a result, the reference light and light intensity are not well balanced, resulting in a spectrum with a large noise level.

[Analysis of High Absorbance (Low Transmittance) Sample: With Attenuator]



High Absorbance Sample

When analyzing a high absorbance (low transmittance) sample, the light intensity balance with the sample side can be adjusted by setting an attenuator on the reference side. As a result, the noise is reduced and the accurate measurement of high absorbance is possible.
This time, the 1/100 attenuator, which is built in with the instrument was used in combination with a manually added 1/100 attenuator so as to obtain the effect equivalent to the attenuation by 1/10000 attenuator.

Figure 1 Effect of Attenuator

KEY WORDS

Material/Processing Material Related, Glass/Ceramic, Other Material/Processing Material Related, Light Shielding Apparatus, Attenuator, Attenuation Rate, ND Filter, Polarizer, Absorption Spectrum, Transmittance Spectrum, Reflectance Spectrum, Glass, Film, Attenuate, Transmittance, Reflectance, UV, UH4150, UH4100, U-3900H, U-3900

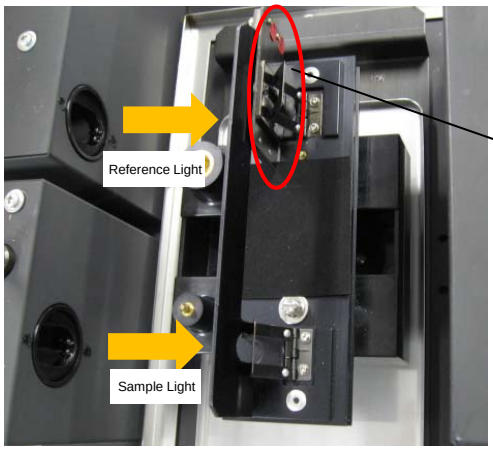
Spectrophotometer (UV)

Sheet No. UV130005-01

UH4150

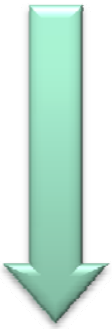
Measurement Method of High Absorbance (Low Transmittance) Samples by UH4150

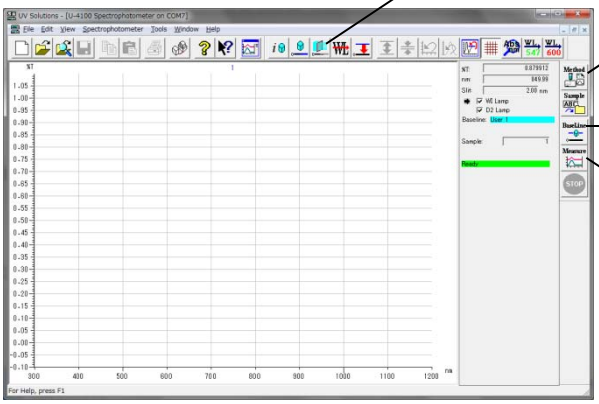
[Analysis Method for High Absorbance Using Attenuator]



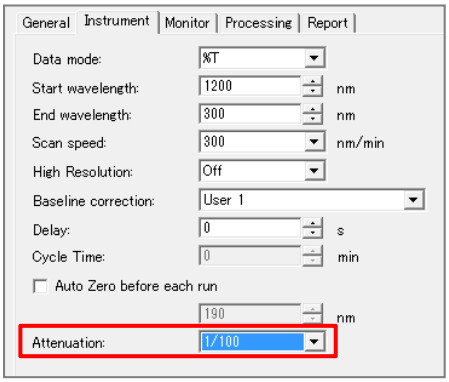
(1) Set the additional attenuator in the holder on the reference side

1/100 Attenuator





The analytical conditions below are set in the order of the icons in the screen.



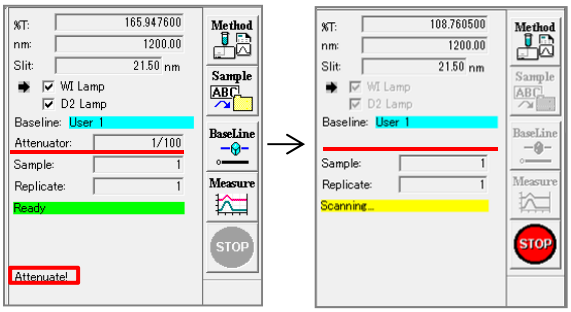
(2) Enter the analytical conditions.
Select the attenuation rate from the attenuation tab.
This time, 1/100 is selected and OK is clicked.

KEY WORDS

Material/Processing Material Related, Glass/Ceramic, Other Material/Processing Material Related, Light Shielding Apparatus, Attenuator, Attenuation Rate, ND Filter, Polarizer, Absorption Spectrum, Transmittance Spectrum, Reflectance Spectrum, Glass, Film, Attenuate, Transmittance, Reflectance, UV, UH4150, UH4100, U-3900H, U-3900

Spectrophotometer (UV)

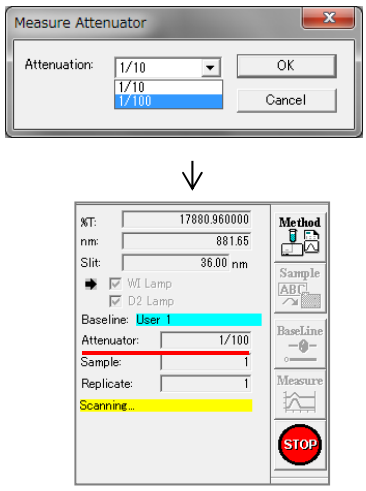
Sheet No. UV130005-02



(3) This will be shown on the right top of the analysis screen after the analytical conditions are entered. "Attenuate!" will be displayed to indicate that the attenuation rate of the attenuator is not being obtained.

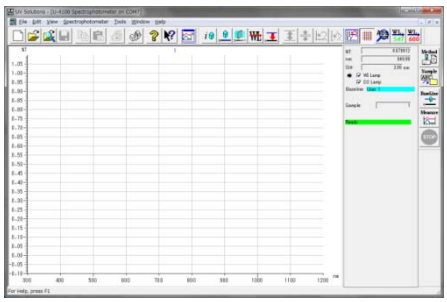
First, press Baseline for the baseline corrections.

The attenuator built in with the instrument is automatically removed and the baseline will be corrected under that condition.



(4) Press the attenuator attenuation rate after the baseline correction to obtain the attenuation rate of the attenuator. Then, select the attenuator attenuation rate that you set in the conditions. Press OK. This time, 1/100 is selected.

The attenuator built in with the instrument is automatically inserted and the attenuator attenuation rate is obtained.



(5) The baseline has been corrected and attenuator attenuation rate has been obtained.
Set the sample and start the measurement.

Figure 2 Measurement Method of High Absorbance Using Attenuator

KEY WORDS

Material/Processing Material Related, Glass/Ceramic, Other Material/Processing Material Related, Light Shielding Apparatus, Attenuator, Attenuation Rate, ND Filter, Polarizer, Absorption Spectrum, Transmittance Spectrum, Reflectance Spectrum, Glass, Film, Attenuate, Transmittance, Reflectance, UV, UH4150, UH4100, U-3900H, U-3900

Spectrophotometer (UV)

Sheet No. UV130005-03

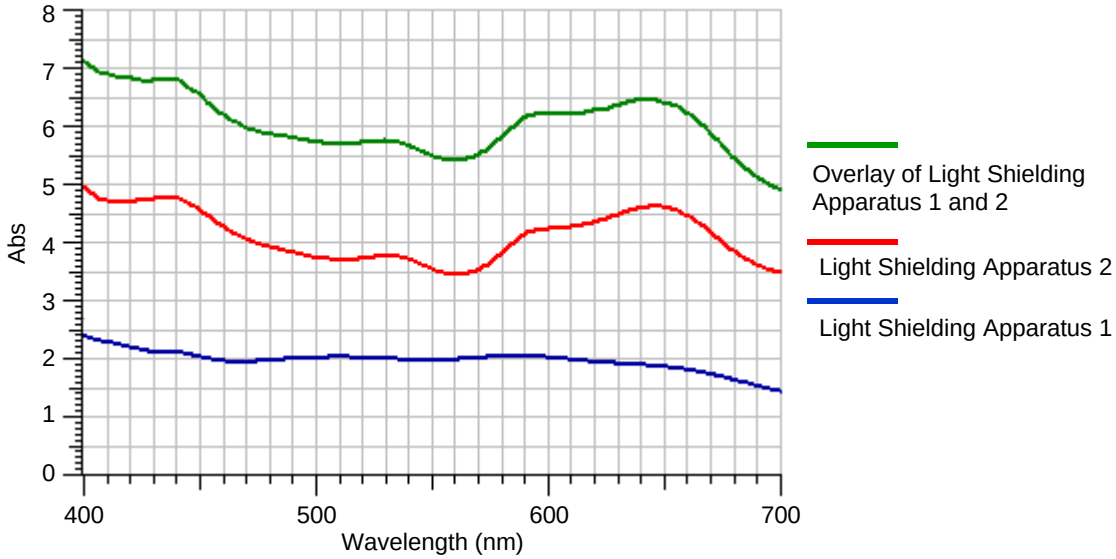


Figure 3 Absorption Spectra of Light Shielding Apparatus

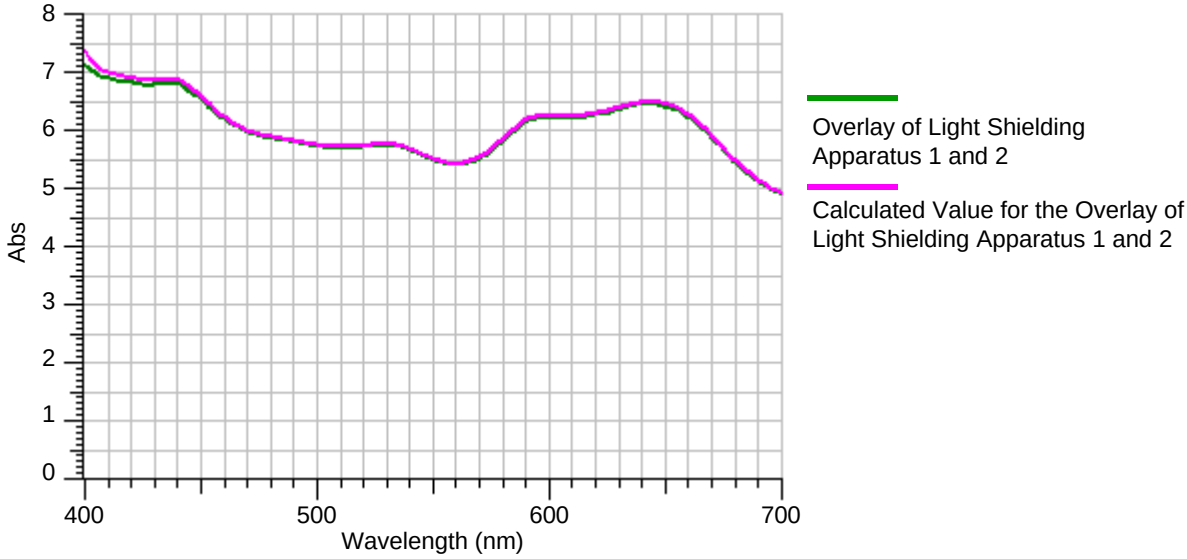


Figure 4 Absorption Spectra of Actual Measurement Value and Calculated Value

To obtain the attenuation equivalent to the rate of 1/10000, two attenuators (built-in with the instrument, manual) were used. Under this condition, two types of light shielding apparatus were analyzed.
Figure 3 shows the measurement results for each of the light shielding apparatus 1 and 2 and the result obtained by overlaying the apparatus 1 and 2. Even for the measurement of the high absorbance of about 6-7, the spectrum with little noise was obtained.
Figure 4 shows the spectrum obtained by overlaying the light shielding apparatus 1 and 2 by calculation. When it was compared with the actual measurement value (overlay of the apparatus 1 and 2), the spectrum was found to be equivalent, confirming the validity of the result.

KEY WORDS

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Spectrophotometer (UV)

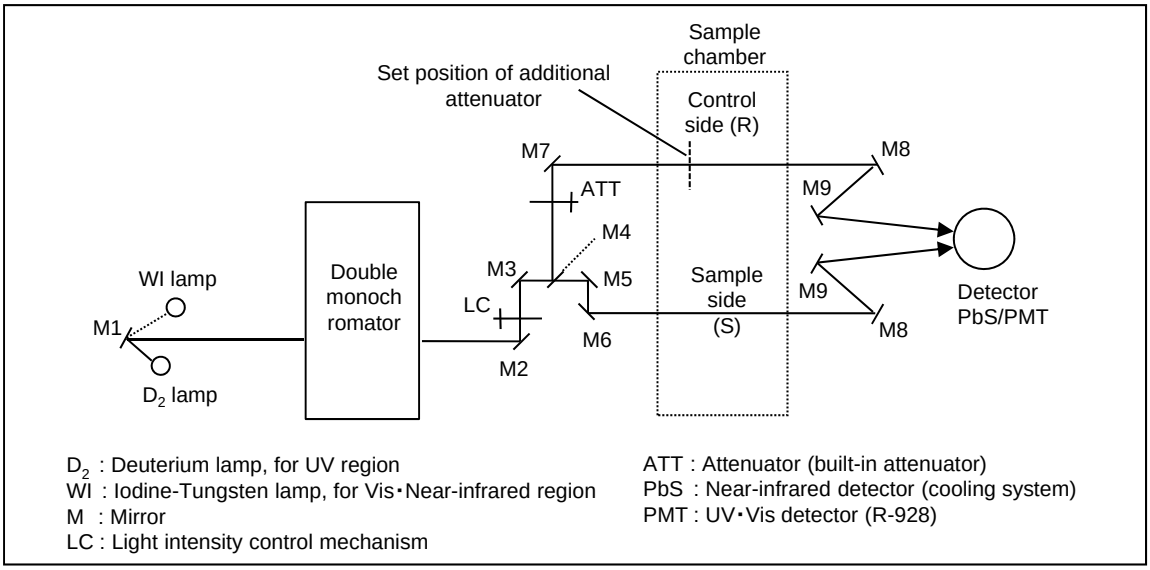
Sheet No. UV130005-04

Measurement Method of High Absorbance (Low Transmittance) Samples by UH4150

(Supplemental Explanation 1) Relationship Between Signal Processing (Differential Feedback Method) of UH4150 and Attenuator

UH4150 employs the differential feedback method. With a PMT detector for the UV-Vis region, the applied voltage for the detector is automatically controlled depending on the change in the light intensity. With a PbS detector for the near-infrared region, the light intensity entering the detector is automatically controlled by the opening and closing of the slit. The advantages are the improved S/N and the shorter sampling integration time (improved throughput).
The base of this control is the light beam on the control side (R) or sample side (S), whichever is with the higher light intensity. Thus, when the absorbance of the sample is high (low transmittance), the applied voltage is set lower for the measurement value on the sample side, resulting in the change in the number of digits for the measured value. By using an attenuator, the light intensities on the control side (R) and sample side (S) are balanced and the low light intensity on the sample side (S) is appropriately controlled, resulting in the improved measurement accuracy.

(Supplemental Explanation 2) The Set Positions for the Built-in Attenuator and Additional Attenuator



D_2 : Deuterium lamp, for UV region
WI : Iodine-Tungsten lamp, for Vis･Near-infrared region
M : Mirror
LC : Light intensity control mechanism
ATT : Attenuator (built-in attenuator)
PbS : Near-infrared detector (cooling system)
PMT : UV･Vis detector (R-928)

Figure 5 Schematic Diagram of UH4150 Optical System*

The built-in attenuator is set in the position after the M4 mirror (sector mirror) dividing the beam into double-beams. It will be inserted when an attenuator is set under the analytical conditions.

(Supplemental Explanation 3) Example of Attenuator Selection

Table 1 An Example of Attenuator Selection

Absorbance	Transmittance	Attenuator
Abs3 ~ 4	0.1 ~ 0.01(%)	1/10
Abs4 ~ 5	0.01 ~ 0.001(%)	1/100
Abs5 ~ 6	0.001 ~ 0.0001(%)	1/1000 (combination of 1/10 and 1/100)
Abs6 ~ 7	0.0001 ~ 0.00001(%)	1/10000 (combination of 1/100 and1/100)

Table 1 shows the guideline for the attenuator selection. While it will also be selected depending on the spectral shape of the sample, the selection of the attenuator is made based on the absorbance or the transmittance range of the sample.

* Due to the limited space, the description partly differs from the actual optical system.

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Spectrophotometer (UV)

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