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Technical Explanation

Introduction to Model UH4150AD UV-Vis-NIR Spectrophotometer

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1. Introduction

An UV-Vis spectrophotometer is an instrument that measures transmission, reflection, and absorption spectra in the ultraviolet (200-380 nm) and visible (380-780 nm) regions. These instruments are used to make measurements in a wide variety of settings, including academic studies, research and development, and quality control in fields such as material science, environmental science, pharmaceuticals, and biology-related disciplines. UV-Vis-NIR spectrophotometers extend the range of measurable wavelengths to the near infrared (780-3300 nm[*1]), and have been used for purposes such as double-beam light measurements capable of correcting baseline drift, as well as in double monochromators optimized for measuring samples with low stray light and high absorption.1) For these reasons, UV-Vis-NIR spectrophotometers exhibit high stability and accuracy and have been used for a variety of purposes, including not only characterization of optical properties of elements such as camera lenses and laser windows but also research and development and quality control for optical devices such as high-density data-recording disks and vehicle-mounted sensors.

In recent years, demand has grown within the field of optical thin films such as band-pass and notch filters for measurements of highly absorbing samples in specific wavelength regimes with even higher accuracy and reduced stray light. To this end, in this article we present the UH4150AD spectrophotometer (Figure 1), a new product developed specifically for high absorption and ultra-low-transmissivity measurements.

[*1] Reduced to 780-2600 nm when an integrating sphere installed

Fig. 1 The UH4150AD spectrophotometer

2. Key features of this product

In this section we discuss three major features of the UH4150AD.

(1) Allows measurements in cases involving high absorption / ultra-low transmittance: absorbance 8 (UV/ visible)
Since the adoption of a new grating-grating double monochromator reduces stray light in the spectrometer, the instrument is capable of increasing the absorbance range and measuring up to absorbance 8.

(2) Parallel flux allows high-accuracy measurements of mirror reflection[*2]
By equipping the UH4150AD with an integrating sphere, it is possible to make measurements with a parallel flux, as with the predecessor instrument.[*3] In particular, with a parallel flux, the incidence angle is roughly uniform over the sample, allowing high-accuracy measurements of mirror reflection (Figure 2)

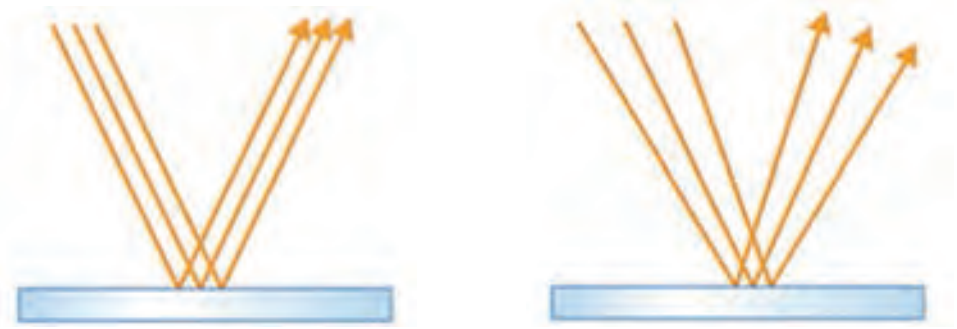

Fig.2 Schematic illustrations of parallel flux and concentration of light flux.

(3) The structure of the sample chamber is identical to that of predecessor instruments[*3]
The sample chamber in the UH4150AD uses the same structure as its predecessor instruments. This allows large samples to be placed in the chamber and retains the convenience of allowing a variety of accessories for previous-generation instruments to be used. By combining detectors and sample holders in various ways, the construction of the system in response to various demands is possible. (Figure 3).

[*2] With integrating sphere installed [*3] UH4150 spectrophotometer

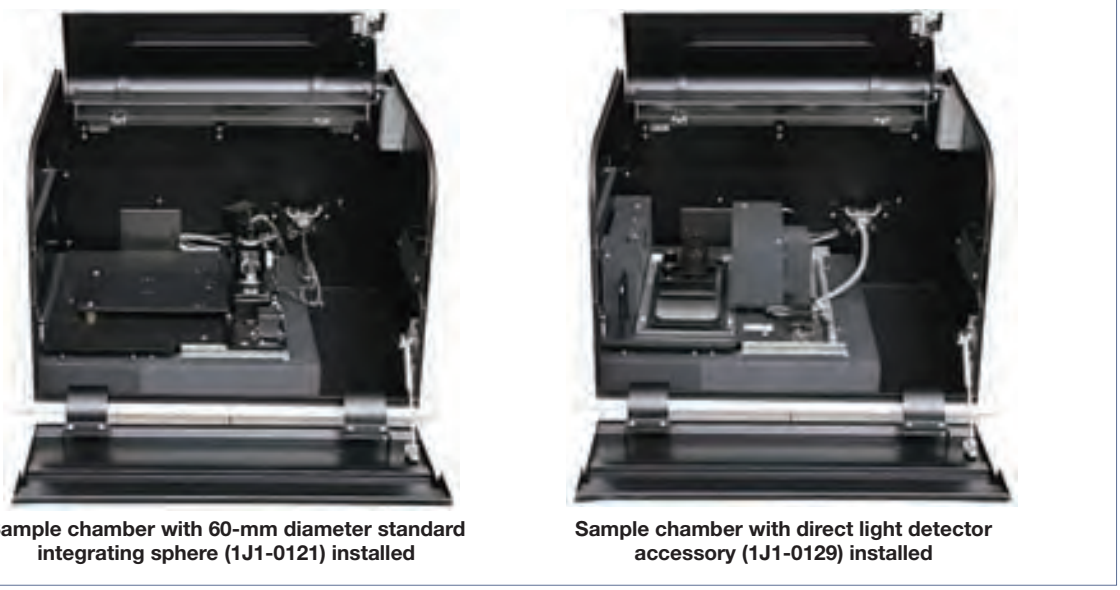

Fig.3 Typical detector choices

3. Applications of the UH4150AD to high-absorbance measurements

3-1. $Co(No_3)_2$ measurement example

In this example, we use the UH4150AD to measure concentration series of $Co(No_3)_2$ aqueous solutions and verify the linearity of the resulting absorbance curve. Figure 4 shows absorption spectra for aqueous solutions of $Co(No_3)_2$, while Figure 5 shows the relationship between absorbance and concentration at a wavelength of 510 nm. The absorbance vs. concentration curve is seen to maintain good linearity (R^2=0.999) all the way up to absorbance 8.

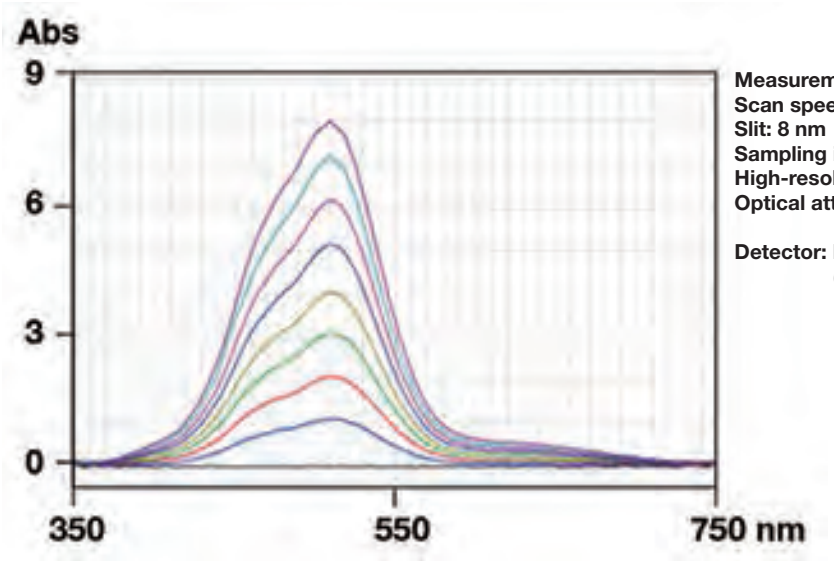

Fig.4 Absorption spectra for $Co(No_3)_2$

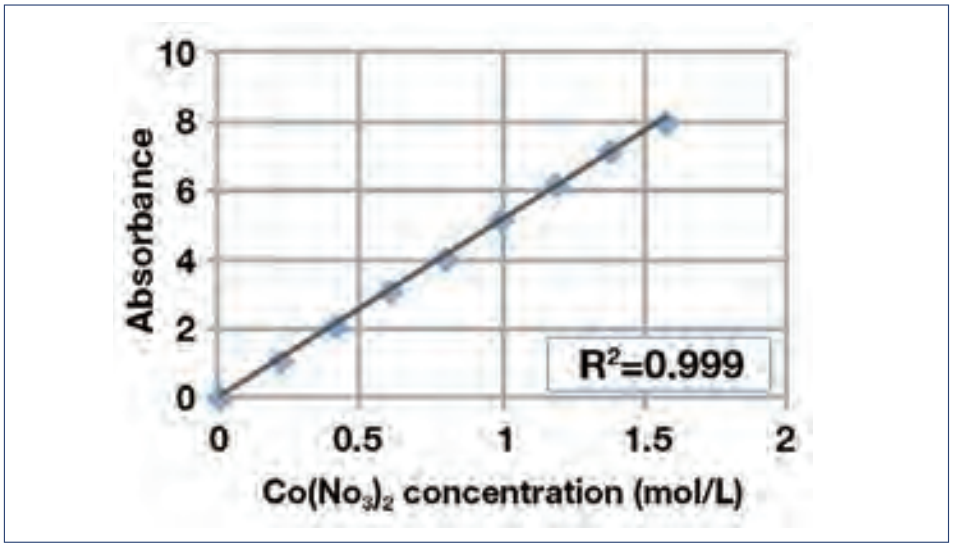

Fig.5 Calibration curve for $Co(No_3)_2$ aqueous solutions at wavelength 510 nm

3-2. Filter measurement example

In this example we measure absorption spectra for three filters with different absorbances and compare the absorption spectrum obtained with all three filters combined to the sum of the individual spectra measured for each filter in isolation. Absorption spectra are shown in Figure 6. The measured spectrum is in excellent agreement with the predicted spectrum.

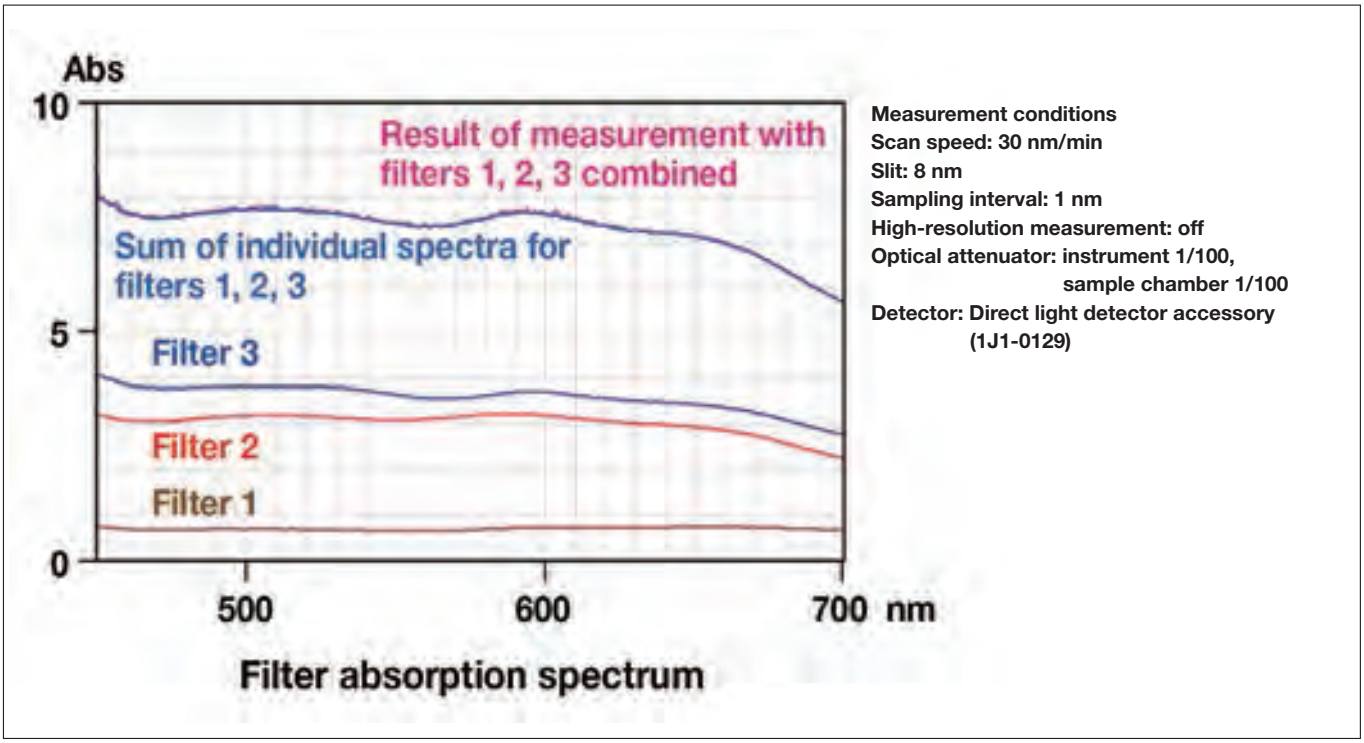

Fig.6 Filter absorption spectra

4. Conclusions

The UV-Vis-NIR UH4150AD spectrophotometer is custom designed for measurements of high-absorbance, ultra-low-transmittance samples. It offers more reliable measurements for characterization and quality control of optical thin films such as bandpass and notch filters.

References

1) Takayuki Wakui, Toshihiro Shirasaki, "UV-Vis Spectrophotometer", Keisokugijyutsu, 10 Gatugoubessatugou, Bunsekikiki/souchi to sono syuhou, 46, Nihonkougyousyuppan (2007), (Japanese).

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