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Introducing Hitachi's UH5200/5210 Double-Beam UV/Visible Spectrometer Series: Key Features and Measurement Examples

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1. Introduction

A *UV/visible spectrophotometer* is an instrument that irradiates a sample with monochromatic light—obtained by passing white light through a prism or diffraction grating—and detects the transmitted light to identify substances present in the sample and measure their concentrations. Spectrophotometers are used in a wide range of academic and industrial fields, including materials science, environmental studies, pharmaceuticals, and bioengineering, and may be subdivided into categories—such as *photometers, single-beam* instruments, and *double-beam* instruments—based on the measurement precision and objectives. In particular, the high stability of double-beam spectrophotometers makes these instruments a common choice for applications in research and development, quality control, and environmental monitoring. More specifically, *R&D* applications of double-beam spectrophotometers include controlling the concentration of functional components of foods and beverages, quantifying nucleic acids and analyzing proteins, and identifying the functional properties of substances such as paints and light-absorbing agents; *quality-control* applications include analyzing food additives, measuring the purity of pharmaceuticals and controlling their ingredients, and confirming compliance with RoHS restrictions on hexavalent chromium and other toxic substances; and *environmental-monitoring* applications include measuring organic-matter content in drinking water and waste water and quantifying nutrient salts (such as phosphorus and nitrogen) in environmental water.

In this article we present key features of Hitachi High-Tech's UH5200/5210 double-beam UV/visible spectrophotometer (Figure 1), a new product designed for reliability and ease of use.

Fig. 1 The UH5200/UH5210 double-beam UV/visible spectrophotometer.

2. Key Features and Fields of Application

2-1. Choice of two operating configurations based on measurement objectives

The UH5200 series lineup consists of the UH5200, a standalone instrument, and the UH5210, a PC-controlled instrument.

The UH5200 features a 10.4-inch backlit color LCD display with 800×600-pixel resolution—higher than the previous-generation U-2900 system—to allow detailed visualization of calibration curves and measured spectra. The layout of the display screen is unchanged from that of previous-generation instruments, offering users a familiar operating experience with enhanced readability thanks to a new graphic design. A dedicated keyboard allows accurate, worry-free input (Figure 2).

The UH5210 is a fully PC-controlled instrument. Its control software is UV Solutions Plus, a new platform that is an update to the UV Solutions control software of the previous-generation U-2900 system with expanded functionality, including display of data lists and data-processing results in tabular form, report layouts, and performance validation (Figure 3). The UH5200 also offers the option of adding the UV Solutions Plus software platform to allow PC control.

Fig. 2 UH5200 measurement menu screen and keypad.

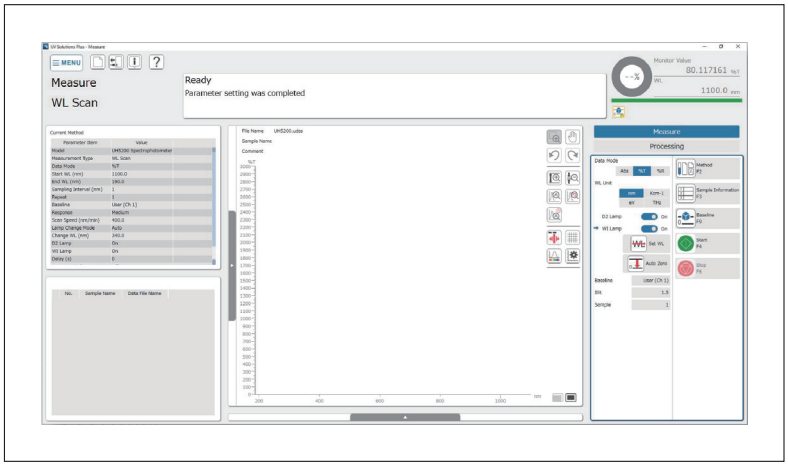

Fig. 3 UV Solutions Plus home screen.

2-2. Basic performance: Reliability

The optical systems of UH5200 instruments use Seya-Namioka monochromators, a widely used type of monochromator based on a concave diffraction grating (Figure 4). Concave diffraction gratings serve both to focus and to disperse light, thus allowing optical systems to be implemented with fewer mirrors. Reducing the number of mirrors in a spectrophotometer not only reduces optical losses, but also shortens optical path lengths, yielding a brighter optical system. Hitachi's proprietary *ruling engine* technology for fabricating diffraction gratings enables bright, aberration-free optical systems. In addition, the use of a *double-beam* optical system—in which half-mirrors are used to split the optical path into two segments, compensating for variations in optical energy, including from the light source—ensures measurement stability over long periods of time.

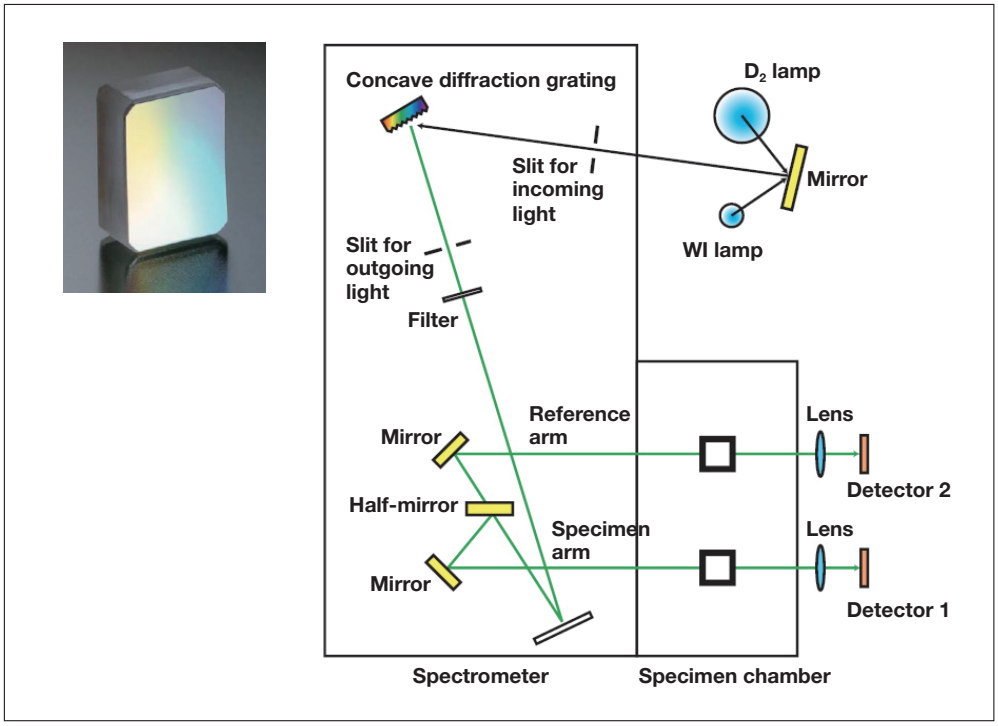

Fig. 4 Optical system of UH5200 series instruments.

2-3. New features

1) New lamp controls designed for safety and environmental impact

Making accurate spectrophotometer measurements requires a lamp capable of stable operation for long periods of time. UH5200 series instruments are equipped with the capability to turn the lamp on and off automatically, thus avoiding unnecessary on-time. When the lamp is turned on, the instrument monitors its output and automatically notifies the operator when this output has stabilized, indicating that measurements may now begin. Also, as a new safety provision, the UH5200 series now incorporates a sensor to detect whether the lamp chamber is open or closed during the lamp-replacement process (Figure 5).

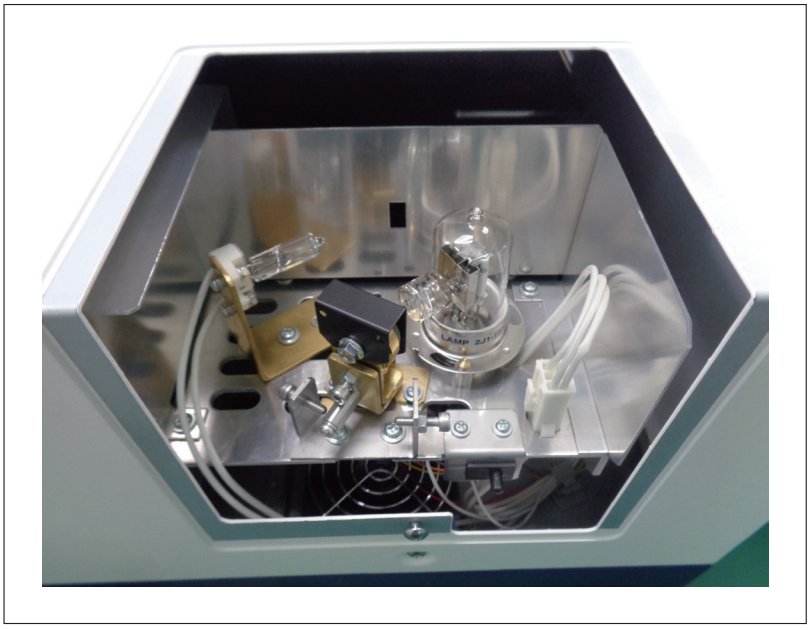

Fig. 5 The lamp chamber.

2) Support for bar-code readers in standalone configuration

UH5200 instruments provide USB ports for connecting external devices such as keyboards, bar-code readers, or thumb drives (Figure 6)[*1)]. Bar-code readers may be used to streamline the process of specifying names for measurement specimens, while thumb drives (USB memory sticks) may be used for data storage.

*1) External input devices are provided by operators, not included with the UH5200 system.

Fig. 6 UH5200-series instruments provide USB ports (left) for connecting external devices such as bar-code readers (right).

3. Sample Measurements

3-1. Measuring hexavalent chromium: absorption spectroscopy of diphenylcarbazide

Environmental regulations designed to protect the health of individuals affected by pollution of public bodies of water, as well as environmental regulations governing pollution in ground water, have tightened the permissible threshold for hexavalent chromium from 0.05 mg/L to 0.02 mg/L. In general, environmental regulations protecting human health specify that measurements are to be made using absorption cells with an optical path length of 50 mm. Here we present measurements of hexavalent chromium using an UH5200 equipped with a custom-made auto-sipper compatible with 50-mm optical-path-length cells. The autosipper improves measurement throughput—and, when combined with an autosampler to automate the mounting of measurement specimens in the instrument, can significantly reduce the effort required from human operators.

Figure 7 shows absorption spectra obtained in wavelength-scan mode (left) and a calibration curve obtained in photometry mode (right). For a peak absorption wavelength of 542 nm, the calibration curve over the range 0-400 µg/L exhibits a perfect linear relationship with a correlation coefficient R=1.000.

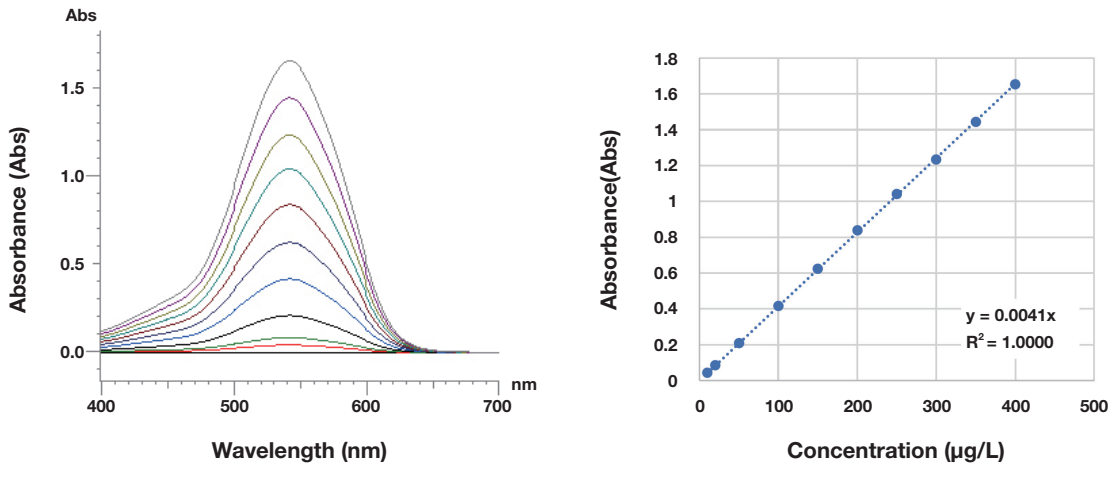

Fig. 7 Results of hexavalent-chromium measurements using a 50 mm cell.

3-2. Measuring DNA: UV absorption

DNA exhibits an absorption peak at 260 nm, and the DNA concentration of a specimen may be determined by measuring the absorbance at this wavelength. This allows the use of spectrophotometers for quantitative analysis of DNA extracted from test bodies. Figure 8 shows absorption spectra for specimens prepared with various lambda-DNA concentrations (left) and a calibration curve for quantitative analysis (right), measured using a 50 µL cell. We obtain high-quality spectra with absorption peaks near 260 nm. For measurement of trace specimens, the optional *micro-sample cell* may be used to measure specimen volumes as small as 1.5 µL.

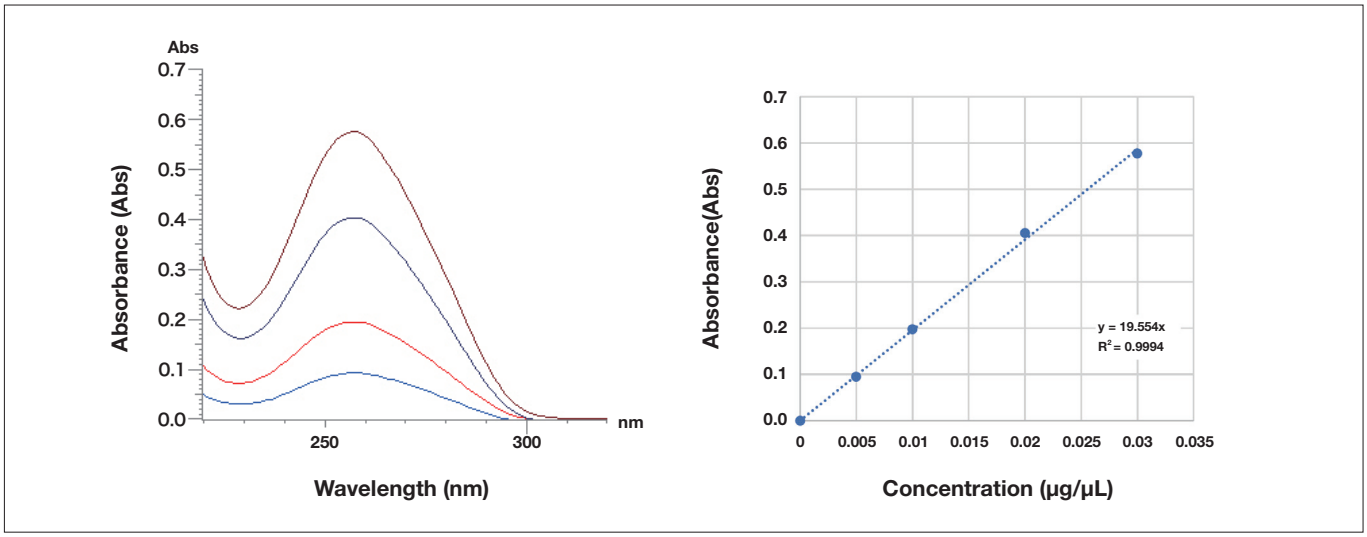

Fig. 8 Measurements of lambda-DNA

4. Conclusions

In this article we surveyed key features of the UH5200 spectrophotometer series and presented measurement examples to illustrate its capabilities. The UH5200 series is a new product line designed for reliability and ease of use, and we expect it to prove useful in a wide range of fields.

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