

Hitachi Spectrophotometer

U-4100

Hitachi High-Tech



U-4100

HITACHI

Customize the system powerful, to fit your laboratory needs for both UV region and large sample measurement.

You can customize U-4100 to fit your needs with a wide range of optional accessories line-up, which include monochromators, detectors and sample compartments.

Take advantage of the wide selection of accessories, that includes high-sensitivity integrating sphere which is ensured up to 175 nm and large sample compartment which is used for large sample nondestructive measurement etc., U-4100 offers you the good configuration to meet diversity of laboratory demand.

U-4100 offers a total analysis solution for applications in the wide range of field, Semi-conductor, New material development and Biotechnologies.

Ultraviolet Region Measurement system

With operating range up to 175 nm, high-sensitivity integrating sphere provides you reliable and accurate measurement.

Large sample measurement system

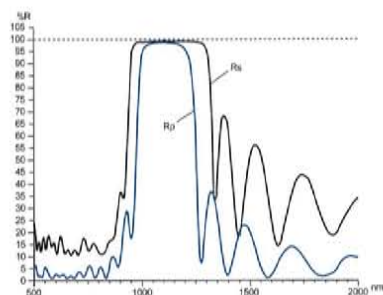
Large sample compartment provides you ever-bigger sample (430 X 430 at maximum) nondestructive measurement.

Liquid sample measurement system

Stray light reduction (0.00008%) delivers dependable and accurate calibration curve in high concentration.

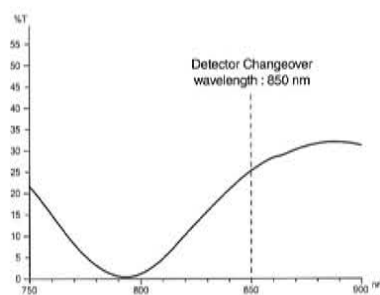


Accurate polarization characteristic measurement



Accurate polarization characteristic is crucial in optical parts manufacturing. This chart shows the reflectance characteristic of the S and P-polarized light on a reflecting mirror for microfabrication system.

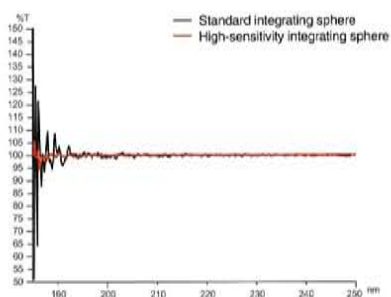
Reliable measurement without any steps caused by detector changeover



This transmittance spectrum doesn't show any steps caused by detector changeover, which is unavoidable, between visible to near-infrared region.

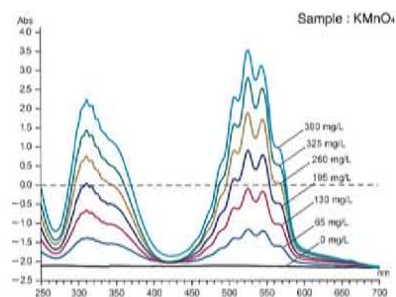


Measurement with integrating sphere in short-wavelength region up to 190nm



The instrument you can depend on meets the growing demands of short-wavelength region analysis.

Wide dynamic range



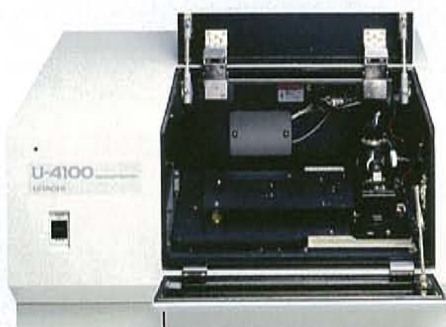
Quantitative analysis you can count on. (Liquid sample measurement system)

Customize the system powerful, to fit your laboratory U-4100 offers you the good configuration to meet diversity

Unmatched scalable sample compartment

Solid sample, Large sample and UV region measurement system have a common sample compartment. (Only Large sample measurement system has different size sample compartment cover. The instrument provides you high-sensitivity solid sample measurement with integrating sphere as standard equipment and variety of applications with combination of reflection measurement accessory and the sample compartment.

Solid sample measurement system

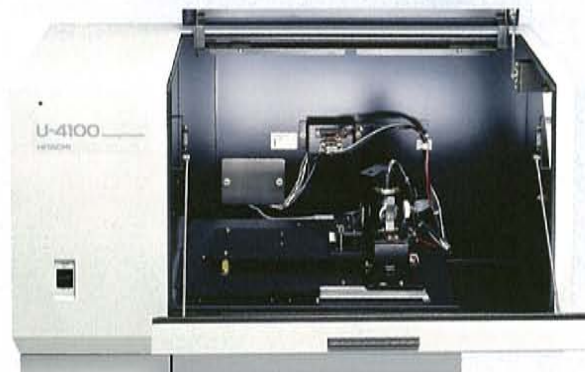


Perfect choice for solid sample transmittance and reflectance measurement. With combination of variety of reflectance accessories etc., the system provides you the best solution to fit your laboratory needs.

System configuration

Monochromator	Prism-grating
Sample compartment	Standard
Detector	Standard integrating sphere, InGaAs (Option)
Measuring wavelength range	240 to 2,600 nm
Sample size	Max. 200×200 mm

Large sample measurement system



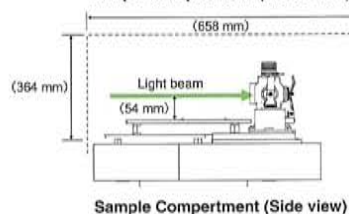
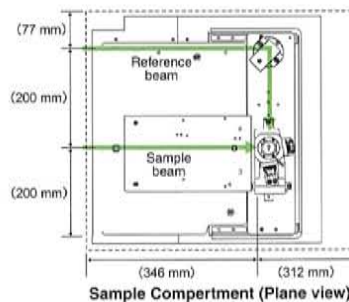
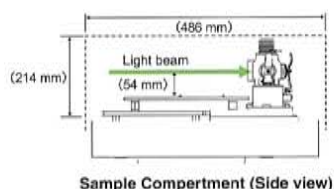
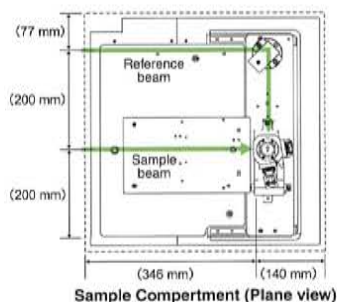
The best used as optical parts and electronics material transmittance and reflectance measurement, for instance large glass, Silicon-wafer and liquid crystal main board.

System configuration

Monochromator	Prism-grating
Sample compartment	Large size
Detector	Standard integrating sphere, InGaAs (Option)
Measuring wavelength range	240 to 2,600 nm
Sample size	Max. 430×430 mm

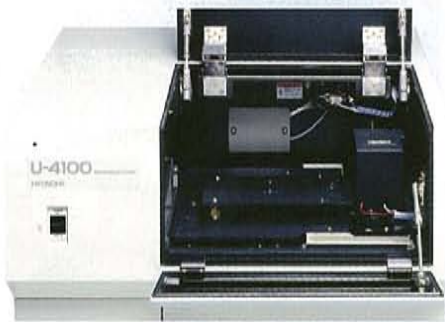
Optional accessory InGaAs detector for U-4100 Spectrophotometer

This accessory, InGaAs detector is used to equip with U-4100 solid sample or large sample measurement system. And this is noise reduction and further high-sensitivity system than PbS detector.



needs.
laboratory demand.

Ultraviolet Region measurement system



Specialized for UV region analysis with specific optical parts of light source, monochromator and detector. This is optimum choice for transmittance and refractance measurement in UV region, like excimer laser parts.

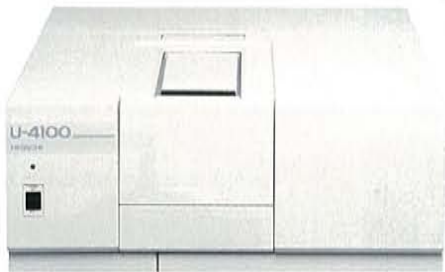
System configuration

Monochromator	Grating-grating
Sample compartment	Standard
Detector	High-sensitivity integrating sphere
Measuring wavelength range	175 to 2,600 nm
Sample size	Max. 200×200 mm

Liquid sample compartment

This instrument is shipped with liquid sample compartment and 10mm rectangular cell holder as standard equipment.

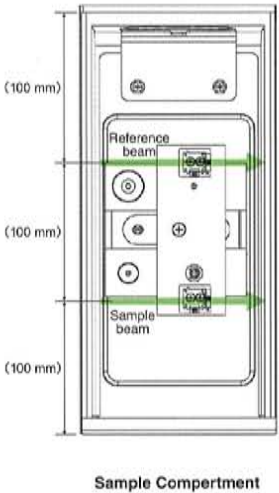
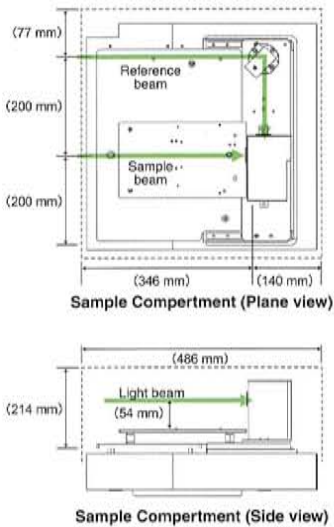
Liquid sample measurement system



The best choice for liquid sample absorbance measurement. Wide wavelength and measurement range by photometric system of a direct incidence to detector provides variety applications of absorbance and transmittance measurement.

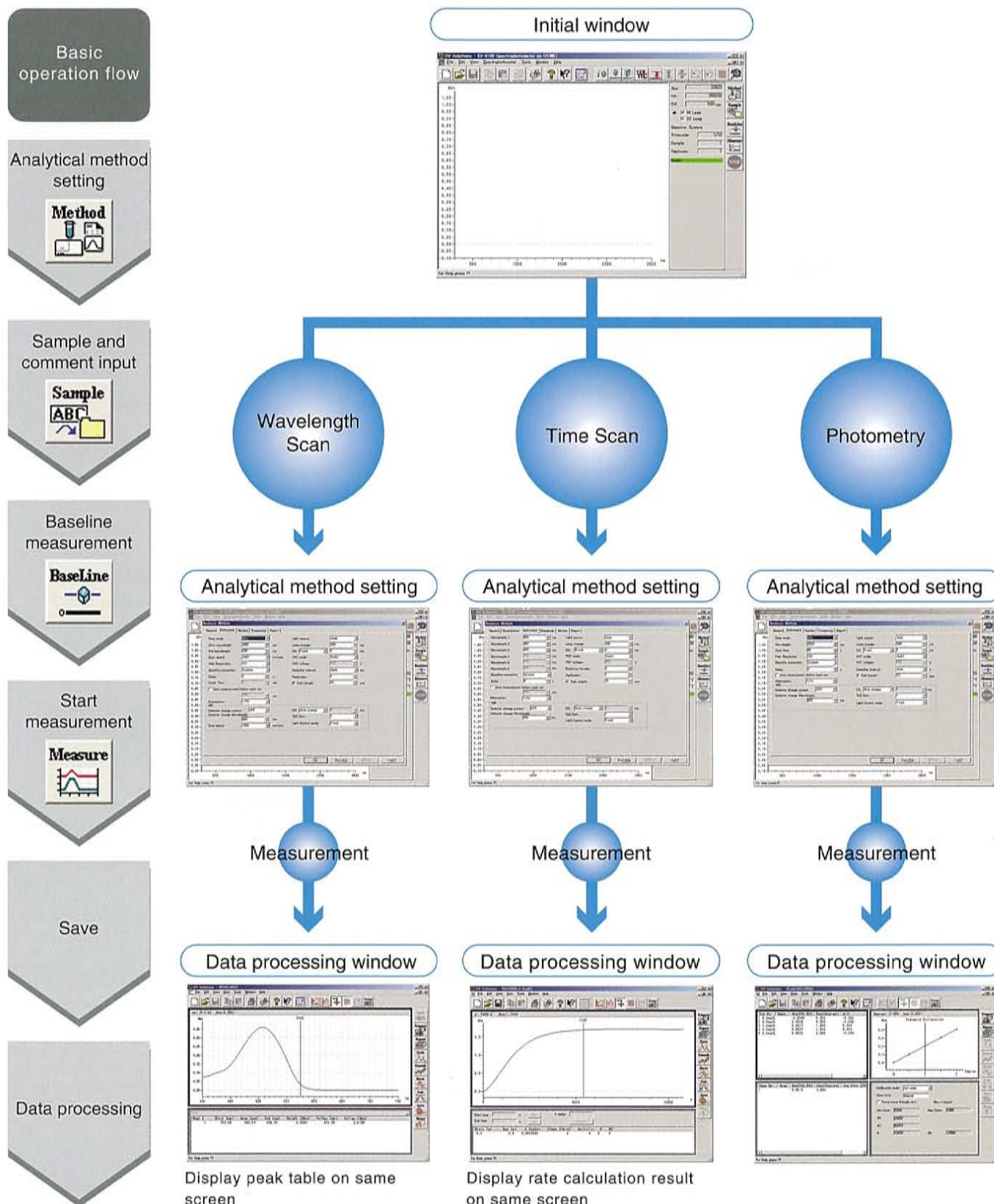
System configuration

Monochromator	Prism-grating
Sample compartment	10 mm rectangular cell holder
Detector	Photomultiplier (UV-Vis) Cooled PbS (NIR)
Measuring wavelength range	185 to 3,300 nm
Sample size	10 mm rectangular cell



Brand-new software, this is UV Solutions.

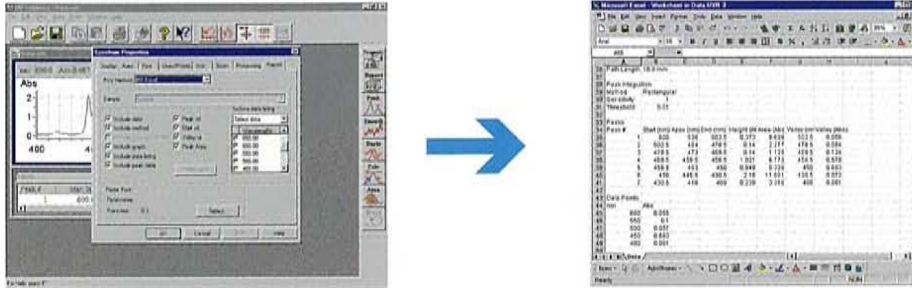
This user-friendly interface provides you with everything you need



This software provides you powerful, versatile report generation

●DDE (Dynamic Data Exchange)

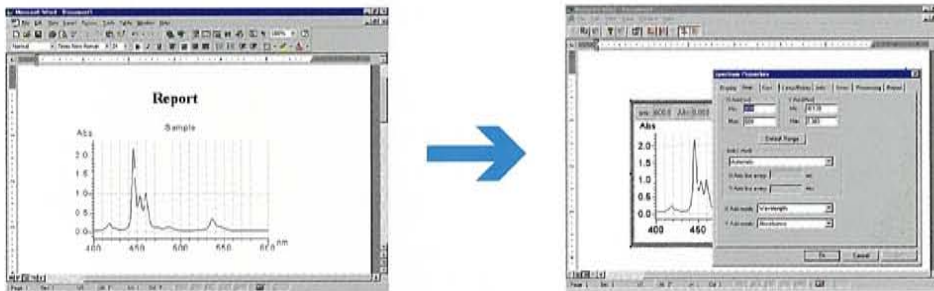
This transfers measurement data to commercial-release software, which may include Microsoft Excel[®] spreadsheets and graphics.



Note : Microsoft[®] Excel, Microsoft[®] Word must be prepared separately

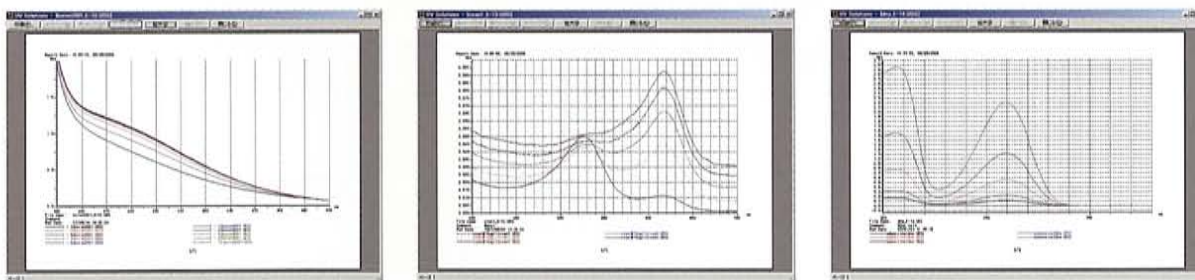
●OEL (Object Linkage Embedding)

This provides, after export data, advanced flexibility in formatting of spectra data (i.e., line type and color) on Microsoft Word[®].



●Print preview

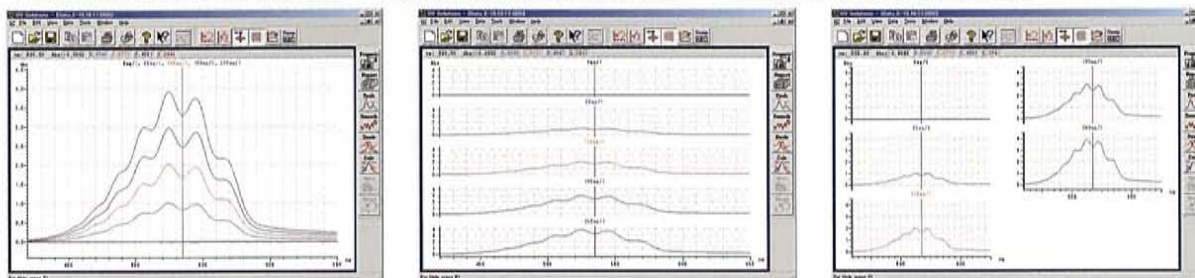
You can check print image on display in advance. This provides flexible setting spectrum color, line type, character type and size, display format.



●Overwriting

This provides simplicity of Measurement data overwriting

- Auto overwriting after measurement
- Overwriting based on display data
- Overwriting based on archive data.



Wide Variety of A complete Provision of Optional Accessories for more Application.

5° specular reflectance accessory (relative) (P/N 134-0100)



Specifications

Sample size	Relative reflectance measurement: 25×25 to 100×150 mm
Wavelength range	240 to 2,600 nm

specular reflectance accessory (absolute)

5° specular reflectance accessory (P/N 134-0102)



12° specular reflectance accessory (P/N 134-0104)



30° specular reflectance accessory (P/N 134-0105)



45° specular reflectance accessory (P/N 134-0106)



Used for measuring the absolute reflectance of a sample by the V-N method in order to determine the reflection characteristics of metal film and glass surface with respect to incident angle, for example. The 12°, 30° and 45° specular reflectance accessories must always be used in combination with a polarizer. Sample is to be mounted on the side face.

Specifications

Sample size	Absolute reflectance measurement: 25×25 to 100×150 mm
Wavelength range	240 to 2,600 nm

Vertical 5° specular reflectance accessory (relative) (P/N 134-0101)



Specifications

Sample size	φ25 to φ100 mm
Measuring wavelength range	240 to 2,600 nm

Prism measurement accessory (P/N 134-0110)



Used for measuring the transmittance and reflectance of various prisms at incident angle 45°.

Specifications

Incident angle	45°
Sample size	16 to 60 mm cube
Measurement point	Center
Wavelength range	240 to 2,600 nm

Small prism measurement accessory (P/N 134-0111)



Used for measuring the transmittance and reflectance of small prisms.

Specifications

Incident angle	45°
Sample size	5 to 6 mm cube 7 to 20 mm cube
Wavelength range	240 to 2,600 nm

Transmittance measurement system for micro samples

(P/N 1J0-0204)



Transmission measurements are taken to evaluate optical components such as micro lenses and micro filters.

Specifications

Sample size	φ5 to φ20 mm
Sample thickness	0.2 to 3 mm
100%T line flatness	±1.0%T or below (240 to 850 nm slit 6 nm, 300 nm/min) ±1.5%T or below (850 to 2,000 nm slit : Auto, PbS Gain: 2 750 nm/min)

Variable-angle absolute reflectance measurement system for micro samples

(P/N 1J0-0206)



This accessory unit can measure the absolute reflectance of a sample with an integrating sphere installed as an extension of the sample beam, to carry out baseline correction, move the integrating-sphere unit on a turnover stage at the time of measurement, and trap the reflected light from the sample.

Specifications

Incident angle	20° to 60°
Sample size	Micro sample holder 1 : φ3.5 to 10 mm, 3 mm or less thickness Micro sample holder 2 : φ10 to 26 mm, 3 mm or less thickness Standard sample holder : φ26 to 90 mm, 5 mm or less thickness
Wavelength range	340 to 2,000 nm

Top-mount transmittance /reflectance measurement unit (P/N 134-0107)

Top-mount transmittance /reflectance measurement unit (P/N 134-0108)



Optical path is switched so that the transmittance and reflectance of a large sample are measurable.

Specifications

Incident angle	134-0107: Transmittance... 0° Reflectance... 5° (relative) 134-0108: Transmittance... 0° Reflectance... 12° (absolute)
Sample size	50×50 to 300×300 mm, φ6 inch, φ8 inch
Wavelength range	240 to 2,600 nm

In addition, holders for a variety of samples (such as photo mask) are available.

Polarizer holder (Polarizer is not included)

(P/N 132-0325)



Variable angle absolute reflectance accessory

(P/N 134-0115)



Absolute reflectance and transmittance are measurable at a desired angle with the detector (full-sphere integrating sphere) and sample stage rotating independently of each other.

Specifications

Incident angle	20° to 60°
Sample size	Flat plate: 30×30 to 90×90 mm Prism: Max. 85 mm cube (※)
Wavelength range	340 to 2,000 nm

※The custom holder is necessary

Variable angle reflectance accessory (relative)

(P/N 134-0118)

Using mirror reflection of a sample, relative reflectance is measured with respect to the standard reflection plate (aluminum-evaporated mirror).

Specifications

Incident angle	20° to 60°
Sample size	25×25 to 50×100 mm
Wavelength range	240 to 2,600 nm

Variable angle absolute reflectance accessory (10° to 60°) (P/N 134-0116)

Variable angle absolute reflectance accessory (15° to 65°) (P/N 134-0117)



Absolute reflectance of a sample is measured by the V-N method with the mirror relocated to the specified position.

Specifications

Incident angle	P/N 134-0116: 10° to 60° (10° step) P/N 134-0117: 15° to 65° (10° step)
Sample size	8×8 to 90×100 mm
Wavelength range	240 to 2,600 nm

ø60 full-sphere integrating sphere accessory

(P/N 134-0205)



Transmittance of a solid/liquid sample is accurately measurable. Effective particularly for measurement of lens.

Specifications

Wavelength range	240 to 2,600 nm
100%T line flatness	±0.5%T (340 to 2,000 nm) ±2.0%T (other wavelengths)

High-sensitivity integrating sphere accessory

(P/N 134-0206)



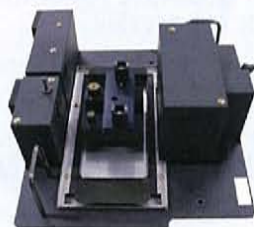
An integrating sphere having a high sensitivity in the ultraviolet region. Effective for evaluating the transmittance/reflectance of an excimer laser equipment part or like optical component to be used in the ultraviolet region.

Specifications

Wavelength range	190~2,600 nm
Detector	Full sphere (with R955 photomultiplier)
100%T line flatness	±0.5%T (195 to 2,600 nm) ±2.0%T (190 to 195 nm)

Measurement system for liquid samples

(P/N 134-0219)



This accessory provides a wide wavelength range (185 to 3,300 nm) and a large measurement range by changing the integrating sphere into optical measurement through use of the detector's normal incidence, which can measure the absorption/transmission of a wide range of samples.

Specifications

Wavelength range	185 to 3,300 nm
Corresponding cell	10 mm rectangular cell (prepared separately)

Large lens measurement unit

(P/N 134-0203)



Used for measuring the transmittance of a large lens with a V-bench.

Specifications

Sample size	φ50 to φ200 mm Length 300 mm max.
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Glass filter holder

(P/N 134-0207)



Used for transmittance/absorbance measurement of such a solid sheet sample as a glass filter.

Specifications

Sample thickness	0.5 to 5 mm
Sample size	12×12 to 55×100 mm

Film holder

(P/N 134-0208)

Convenient for measurement of film-shaped samples.

Specifications

Film frame	Width 25 mm, height 30 to 55 mm
Beam aperture	Width 10 mm, height 20 mm

Rectangular cell holder

(P/N 134-0209)

Mounts a 10 mm rectangular cell for measuring the transmittance/absorbance of a liquid sample.

UV Solutions Program

(Windows® XP Professional)

P/N 2J1-0310	UV Solutions Program	(Standard Software)
P/N 2J1-0312	Report Generator Program	for UV Solutions
P/N 2J1-0313	UV Navigation Program	for UV Solutions

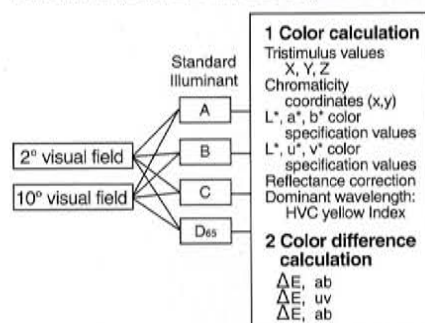
Option package

(P/N 2J1-0311)

Color Analysis

To define a color of light or any object, it is helpful to provide conventions concerning light sources, objects and eyes. CIE standard illuminants for measurement is specified in JIS Z 8720, and CIE 1931 standard colorimetric system is specified in JIS Z 8701. The color analysis program is designed for diffuse reflectance measurement of a solid sample surface, making it possible to carry out high-accuracy color measurement analysis. Its measurement method conforms to JIS Z 8722.

A photometric value ranging from 780 to 380 nm is measured, and calculations are performed on tristimulus values (X, Y, Z), psychometric lightness values (L*, L), psychometric chromaticity indices (a*, b*, a, b), and chromaticity coordinates (x, y). With input of tristimulus values (X, Y, Z) of a standard sample, color difference is performed (Eab, ΔE*uv, ΔE*ab).



Application Measurement

Conforming to the test method for sheet glass transmittance and reflectance, specified in the JIS (Japanese Industrial Standards).

1 Visible Transmittance (Reflectance) Measurement Program

Spectral transmittance τ_v and spectral reflectance ρ_v of sheet glass are measured in the visible wavelength range. Using these measured values, visible light transmittance τ_v and visible light reflectance ρ_v based on relative luminous efficiency of CIE light adaptation are automatically calculated with respect to the standard light Des specified by CIE.

(CIE: Commission International de l'Eclairage)

$$\tau_v = \frac{\sum_{\lambda=380}^{780} \Delta\lambda \cdot V(\lambda) \cdot \tau(\lambda)}{\sum_{\lambda=380}^{780} \Delta\lambda \cdot V(\lambda)} \quad \rho_v = \frac{\sum_{\lambda=380}^{780} \Delta\lambda \cdot V(\lambda) \cdot \rho(\lambda)}{\sum_{\lambda=380}^{780} \Delta\lambda \cdot V(\lambda)}$$

Δλ: Spectral distribution of standard illuminant Des
Vλ: Spectral luminous efficiency of CIE light adaptation.

2 Solar Radiation Transmittance (Reflectance) Measurement Program

As for the radiant flux of the solar radiation incident on sheet glass, the transmitted radiant flux (reflected radiant flux) is measured, and solar radiation transmittance τ_e and solar radiation reflectance ρ_e are automatically calculated.

$$\tau_e = \sum_{\lambda=300}^{2100} E_{\lambda} \cdot \Delta\lambda \cdot \tau(\lambda) \quad \rho_e = \sum_{\lambda=300}^{2100} E_{\lambda} \cdot \Delta\lambda \cdot \rho(\lambda)$$

$\tau(\lambda)$: Spectral transmittance (measured value)
 $\rho(\lambda)$: Spectral reflectance (measured value)
 E_{λ} : Standard spectral distribution of directly irradiated relative solar radiation value

3 Sum-of-Products Calculation Program

The above-mentioned visible light transmittance (reflectance) and solar radiation transmittance (reflectance) conform to JIS R 3106. This program is formulated as a general form for calculation of these values. For each wavelength, a measured value is multiplied by coefficient $\alpha(\lambda)$, and a total sum value is determined for normalization. A weight factor $\alpha(\lambda)$, wavelength range, and normalization factor can be set up arbitrarily in use of this program.

$$S = \frac{\sum_{\lambda_1}^{\lambda_2} \alpha(\lambda) \cdot \tau(\lambda)}{\sum_{\lambda_1}^{\lambda_2} \alpha(\lambda)} = \frac{1}{K} \frac{\sum_{\lambda_1}^{\lambda_2} \alpha(\lambda) \cdot \tau(\lambda)}{\sum_{\lambda_1}^{\lambda_2} \alpha(\lambda)}$$

Where, $K = \sum_{\lambda_1}^{\lambda_2} \alpha(\lambda)$

4 Weight Factor Input Program

With this program, a correction value (weight factor) for each wavelength interval Δλ can be input in a wavelength range of λ₁ to λ₂. Using the input values, the sum-of-products program is carried out. Up to five wavelength intervals can be assigned individually, and up to 500 data points can be specified.

5 Spectrum Correction Program

A photometric value at each wavelength is multiplied by correction coefficient $R_o(\lambda)$, and the result of multiplication is displayed and recorded in graph. A correction count value can be specified arbitrarily by the user. This program is particularly useful for absolute reflectance spectral measurement.

$R(\lambda) = r(\lambda) \cdot R_o(\lambda)$
 $R(\lambda)$: Corrected data
 $r(\lambda)$: Measured data (%)
 $R_o(\lambda)$: Correction coefficient data

6 Correction Coefficient Input Program

This program is designed for input of correction coefficient data. Up to 500 points can be specified.

7 Film Thickness Calculation Program

In use with the reflectance accessory, this program allows the following measurements:

- A thickness of a filmy object is calculated according to the measured interference spectrum. The results of calculation are displayed on the CRT monitor and output onto the printer for recording.
- Photometric values of measured interference spectral peaks and valleys can be printed out automatically.
- A difference between standard film thickness and measured film thickness is calculated, and the resultant data can be displayed on the CRT monitor and output onto the printer for recording.

$$d = \frac{N-1}{2 \sqrt{n^2 - \sin^2 \theta}} \times \frac{1}{\frac{1}{\lambda_1} - \frac{1}{\lambda_2}} \times 10^{-3}$$

d: Film thickness (μm)
... Value to be calculated
N: Number of interference peaks
... Counted automatically
n: Reflection factor
... Manually entered value
θ: Angle of incidence
... Manually entered value
λ₁: First peak wavelength in spectrum (nm)
λ₂: Last peak wavelength in spectrum (nm)

Specifications

Wavelength range	175 to 2,600 nm
Monochromator	Prism-grating or grating-grating type Double monochromator Pre-monochromator: Littrow monochromator using diffraction grating or prism Main monochromator: Diffraction grating monochromator (2 diffraction gratings switchable) Czerny-Turner monochromator
Detector	Photomultiplier (UV-VIS): Cooling type, PbS (NIR) Ø60 mm integrating sphere: Inner face coated with BaSO ₄ or Spectralon Incident angle on reflective sample: 10° on both standard and reference sides
Sample compartment	Equipped at head of table-top section, capable of accommodating very large samples Inner dimensions: 480 (W) × 470 (D) × 200 (H) mm (standard type) 680 (W) × 470 (D) × 300 (H) mm (large type) Optical path length: 200 mm
Wavelength indication	In 0.01 nm step
Slit width indication	Ultraviolet and visible region: Automatic control and switching in 0.01 nm step from 0.01 to 2.4 nm (Switching in 0.02 nm step from 2.4 to 8.0 nm) Near infrared region: Automatic control and switching in 0.1 nm step from 0.1 to 20.0 nm
Wavelength accuracy	Ultraviolet and visible region: ±0.2 nm Near infrared region: ±1.0 nm Automatic wavelength calibration function incorporated
Wavelength/Wavelength setting repeatability	Ultraviolet and visible region: ±0.1 nm Near infrared region: ±0.5 nm
Wavelength scan speed	Automatic control scan plus 0.3 (0.75), 3 (7.5), 15 (37.5), 30 (75), 60 (150), 120 (300), 300 (750), 600 (1,500), 1,200 (3,000) and 2,400 (6,000) nm/min * The parenthesized values correspond to wavelength scan speeds in the near infrared region. G to λ: 3,600 (9,000) nm/min
Light source	Ultraviolet region: Deuterium lamp (mountable by one touch) Visible and near infrared region: 50 W halogen lamp (long-life 1,000 h)
Light source switching	Automatic changeover interlinked with wavelength Wavelength freely selectable within 325 to 370 nm
Photometric system	Double beam direct ratio photometry (Negative absorbance or over-100% transmittance/reflectance measurable due to Hitachi's original differential feedback system) Ultraviolet and visible region: Negative voltage control and slit control system Near infrared region: Slit control and fixed slit system
Photometric mode	Absorbance (Abs), transmittance (%T), reflectance (%R) Energy on reference side (E(R))/sample side (E(S))
Photometric range	Absorbance: -2 to +5.0 Abs (in 0.001 Abs step) Transmittance/reflectance: 0 to 999.99 (in 0.01% step)
Photometric accuracy	±0.002 Abs (0 to 0.5 Abs), ±0.004 Abs (0.5 to 1.0 Abs), ±0.3%T Qualified according to NIST SRM 930
Photometric repeatability	±0.001 Abs (0 to 0.5 Abs), ±0.002 Abs (0.5 to 1.0 Abs), ±0.1%T Qualified according to NIST SRM 930
Response	Automatic setting of optimum level interlinked with slit width and wavelength scan speed
Baseline memory	3 channels (system baseline: 1 ch, user baseline: 2 ch)
Baseline flatness	< ±0.002 Abs (240 to 850 nm, slit 6 nm) < ±0.004 Abs (850 to 2,200 nm, slit automatically controlled) < (0.008 Abs (2,200 to 2,600 nm, slit automatically controlled)
Baseline stability	Within 0.0004 Abs/h (at 340 nm), 2 hours after power-on
Data processing section	PC with OS Windows® XP Professional
Operating temperature	15 to 35°C
Operating humidity	45 to 80% (condensation unallowable, within 70% at 30°C or higher)
Power consumption	100, 115, 220, 230, 240 V AC, 50/60 Hz, 500 VA
Physical size (spectrophotometer main unit)	730 (W) × 800 (D) × 880 (H) mm (standard sample compartment type) 930 (W) × 800 (D) × 980 (H) mm (large sample compartment type)
Weight	120 kg

Functions

	Wavelength/time series measurement functions and processing functions	Quantitative calculation functions
Spectrophotometer control	- Wavelength drive (Go To λ) 100%T adjustment (auto zero) - Automatic wavelength calibration	
Measurement conditions	- Measurement condition setting - Condition readout - Condition saving (Number of files, file rewriting/deletion: Arbitrary) - Automatic start function (Measurement conditions are automatically set up when the power switch is turned on.)	- Calibration curve condition setting (first to third order, polygonal line) - Standard data setting (20 std, 20 points in average)
Measurement execution	- Spectral/time-series measurement Repetitive spectral measurement - S/N user-selectable function (Sampling interval setting) - Baseline measurement: 3 ch (System baseline: 1 ch, user baseline: 2 ch)	Calibration curve re-measurement
Recording/display	- Sample name - Comment input - Ruled-line recording ON/OFF - Measurement condition recording ON/OFF - Spectral/time-series recording/display - Spectral data readout - Spectral data saving	- Calibration curve recording/display - Data deletion - Data readout - Data saving - Data list printing
Data processing	- Scale change (numeric value input, cursor input) - Spectrum trace - Smoothing - Data printout - Graph axis conversion Abscissa: nm, kcm⁻¹, eV, THz Ordinate: Abs, %T, %R, E(S), E(R), ε, log ε - Spectral calculation (4-rule arithmetic calculation /coefficient calculation) - Differentiation (first to fourth order) - Area calculation - Data resetting - Rate calculation (only for time-series measurement) - Spectrum selection	- Calibration curve trace - Data printing - Sample data deletion - Statistical calculation - Coefficient-of-determination calculation
Others	- File conversion (ASCII/JCAMP) - Lamp ON time control - Display format setting - Cell length conversion - Data export to Microsoft® Excel - Graph copying - Windows meta-file saving - Print preview function	

* Microsoft, Windows, Microsoft Excel, Microsoft Word and Windows XP are registered trademarks, trademarks or trade names of Microsoft Corp., USA, while other company names and product names are those of respective companies.

CE labeled model is available.

NOTICE: For proper operation, follow the instruction manual when using the instrument.

Specifications in this catalog are subject to change with or without notice, as Hitachi High-Technologies Corporation continues to develop the latest technologies and products for our customers.

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