

UV-VIS-NIR Spectrophotometer

# SolidSpec-3700i SolidSpec-3700i DUV



# Overcome Your Limits



## Perfect for a Wide Variety of Applications

Spectral evaluation function enables unique pass/fail judgments for quality control.

## High Sensitivity and Wide Measurement Wavelength Range

High-sensitivity measurements are achieved in deep UV region below 190 nm or in near-infrared region.

Measurements are possible over a wide range, as wide as 165 to 3300 nm (using an optional product).

The grating-grating type monochromator design enables highly accurate measurements from deep UV to near-infrared regions.

## Large Sample Compartment Accommodates a Wide Variety of Samples.

Large samples up to 700 × 560 mm can be placed easily in a horizontal position for measurement.

Using an automatic X-Y stage (optional), multiple points can be measured automatically on samples sized up to 310 × 310 mm, while keeping the sample compartment purged with nitrogen.

For solid samples, the confocal optical path enables selection of either parallel or condensed light for measurements.

### UV-i Selection

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UV-1900i



UV-2600i/2700i



UV-3600i Plus

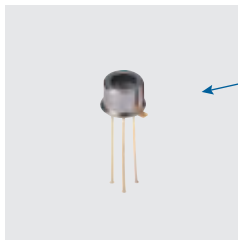


SolidSpec™-3700i

# High Sensitivity

High accuracy for transmittance and reflectance is required for the measurement of optical parts. The SolidSpec-3700i/3700i DUV have three detectors which cover the range from ultraviolet to near-infrared. The sensitivity in the near-infrared region is significantly enhanced by using both InGaAs and cooled PbS detectors. Highly accurate and highly sensitive spectra are obtainable from ultraviolet to near-infrared.

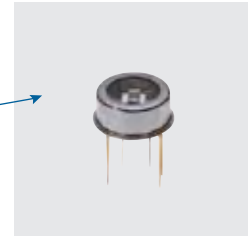
## Three Detectors



InGaAs detector



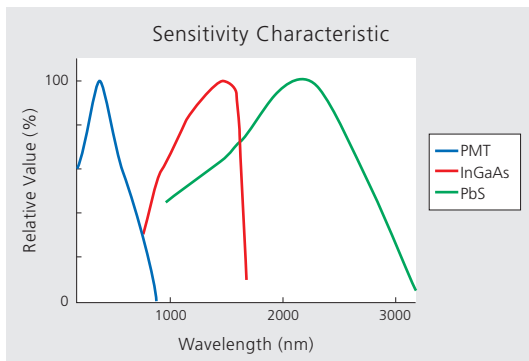
Three detectors attached to the integrating sphere



PbS detector



PMT detector



Conventional spectrophotometers have used a PMT (photomultiplier tube) for the ultraviolet and visible region and a PbS detector for the near-infrared region. However, neither detector has much sensitivity near the wavelength of 900 nm, preventing high-sensitivity measurement in this range.

The SolidSpec-3700i/3700i DUV make it possible to take high-sensitivity measurements in the switchover range by using an InGaAs detector as shown in the figure on the left.

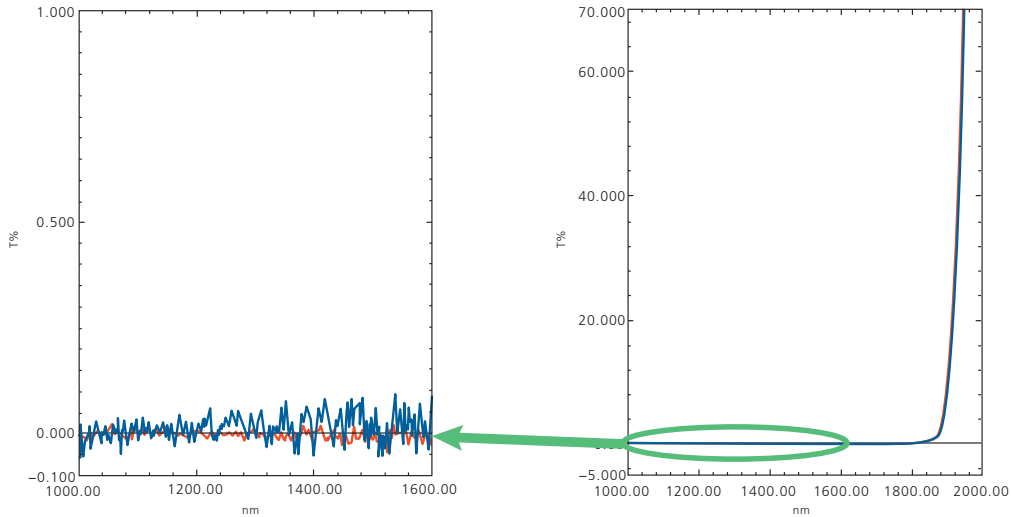
## Relationship between Detectors and Measurable Range

	165 nm	380 nm	780 nm	3300 nm
	UV	Visible	NIR	
PMT	165 to 1000 nm			
InGaAs		700 to 1800 nm		
PbS			1600 to 3300 nm	

The photomultiplier tube detector can be switched to the InGaAs detector in the range from 700 nm to 1000 nm (the default switching wavelength is 870 nm). The InGaAs detector can be switched to a PbS detector in the range from 1600 nm to 1800 nm (the default switching wavelength is 1650 nm).

## Comparison of Two-Detector and Three-Detector Models

An InGaAs detector is used, in addition to the photomultiplier tube (PMT) and cooled PbS detectors. That results in less noise than the two-detector (PMT and PbS) model, especially in the region detected by the InGaAs detector (900 to 1600 nm).

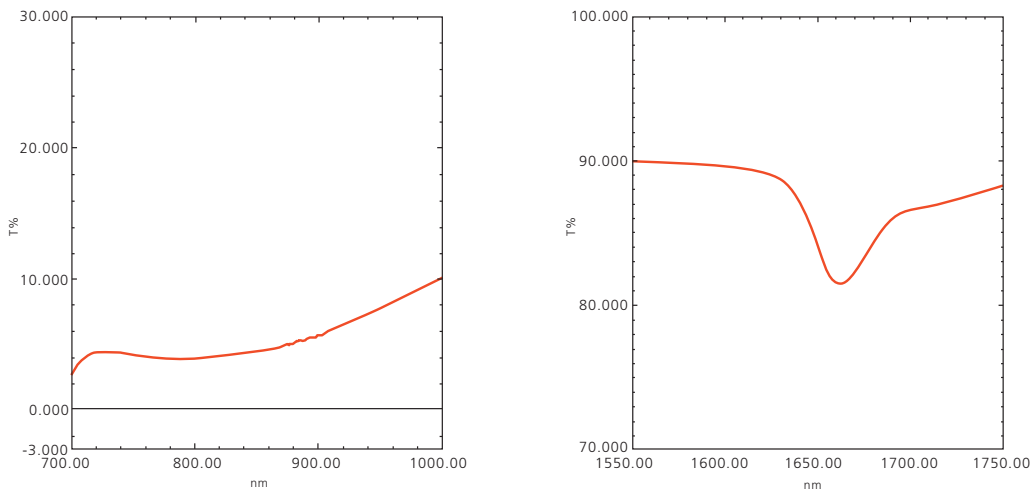


— : SolidSpec-3700i/SolidSpec-3700i DUV (InGaAs detector)  
 — : 2-detector model (PbS detector)

The spectrum above was measured with InGaAs and PbS detectors, using a sharp cut filter for near-infrared light. Increasing the sensitivity in the near-infrared region is especially beneficial for low-reflectance measurements, such as measuring anti-reflective (AR) coatings used in the optical communications field.

## High Accuracy Measurement with Minimized Detector Switchover Noise and Bump

Noise and bump caused by detector switchover are minimized to assure accurate measurement.



The transmission spectra of a color filter and polyester film are shown in the left and right figures, respectively. Noise or bump caused by the detector switchover range at 870 nm and 1650 nm are not observed.

# Wide Measurement Wavelength Range (SolidSpec-3700i DUV)

The development of precise laser machining using an ultraviolet laser such as an ArF excimer laser enhances the requirement for transmittance or reflectance measurements of optical parts in the deep ultraviolet region. The SolidSpec-3700i DUV<sup>(note 1)</sup> enables measurement in the range of 175 nm to 2600 nm<sup>(note 2)</sup> with an integrating sphere and the range of 165 nm to 3300 nm<sup>(note 3)</sup> by mounting the optional Direct Detection Unit DUV. With this additional unit, the range from deep ultraviolet to near-infrared is now measurable.

## Nitrogen Gas Purge



Oxygen molecules in the atmosphere absorb ultraviolet light under 190 nm. Nitrogen gas purging for both the optical and the sample compartment is required to remove the interfering oxygen molecules. Since the SolidSpec-3700i DUV has purge inlets for each compartment, efficient nitrogen gas purge is possible so that the time required for purging after sample replacement is reduced, and high sensitivity with lower stray light in the deep UV region is achieved.

## Integrating Sphere and Photomultiplier for the Deep Ultraviolet Region



Integrating Sphere for Deep Ultraviolet



Photomultiplier for Deep Ultraviolet

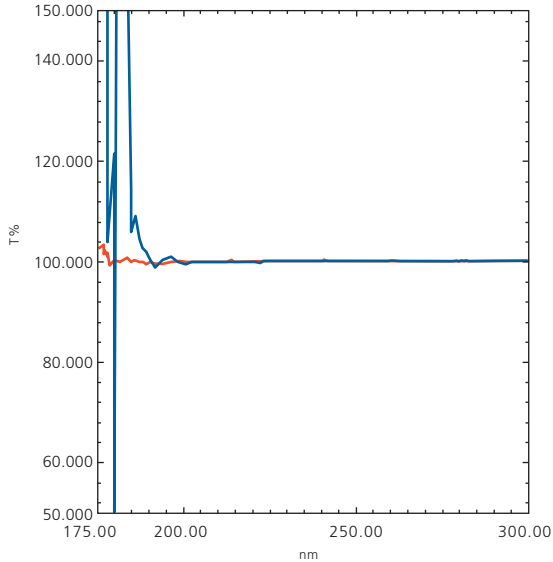
Materials which do not absorb deep ultraviolet light are required to be used as the window material for the detector and the material for the inside of the integrating sphere to enable performance in the deep ultraviolet region. The SolidSpec-3700i DUV or D<sub>2</sub> lamp uses a PMT detector with fused silica as the window material and an integrating sphere with resin that has highly reflective characteristics in the deep ultraviolet region as the inside material.

Note 1) In order to measure the range below 190 nm with the SolidSpec-3700i DUV, nitrogen gas purge is required to remove interference from oxygen molecules inside the SolidSpec-3700i DUV.

Note 2) The measurable range for SolidSpec-3700i is 240 nm to 2600 nm.

Note 3) The measurable range for SolidSpec-3700i with the optional Direct Detection Unit is 190 nm to 3300 nm.

## Integrating Sphere for Deep Ultraviolet Measurement

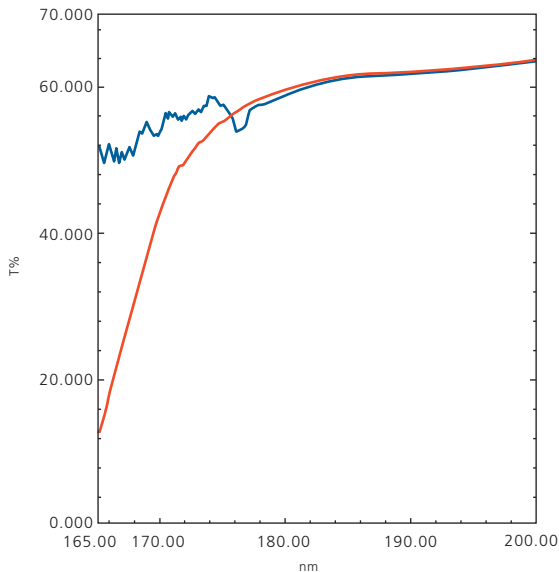


Spectra with low noise can be obtained even for wavelengths near 190 nm, which are difficult to measure accurately using a regular spectrophotometer. The ability to measure spectra in this wavelength range is especially helpful when measuring semiconductor materials used for ArF excimer lasers.

The 100% baseline spectra measured on the SolidSpec-3700i DUV with an integrating sphere for deep ultraviolet measurement and the SolidSpec-3700i with a normal integrating sphere are shown in the left figure.

- : SolidSpec-3700i DUV with an integrating sphere for the deep ultraviolet measurement
- : SolidSpec-3700i with a normal integrating sphere

## Example of Deep Ultraviolet Region measurement



Transmission Spectra of Silica Plate

In order to perform high-accuracy measurements in the deep UV region, a sufficient quantity of light and significant low stray light are required. The transmission spectrum of a silica plate measured with the Direct Detection Unit DDU-DUV (optional) is shown in the left figure. Spectra with significantly lower noise are obtainable in the ultraviolet region.

- : Transmission spectrum of Silica plate measured with nitrogen purge
- : Transmission spectrum of Silica plate measured without nitrogen purge

# Large Sample Compartment Accommodates a Wide Variety of Samples.

The SolidSpec-3700i/3700i DUV have large sample compartments which allow large samples to be measured without sample destruction. Their internal dimensions are 900W × 700D × 350H mm. A sample with a maximum size of 700W × 560D × 40H mm can be set in

the sample compartment and an entire sample area of 12 inches or 310 × 310 mm is measurable by mounting the Automatic X-Y stage (optional). The vertical optical path makes it possible to perform transmission or reflectance measurements of large samples.

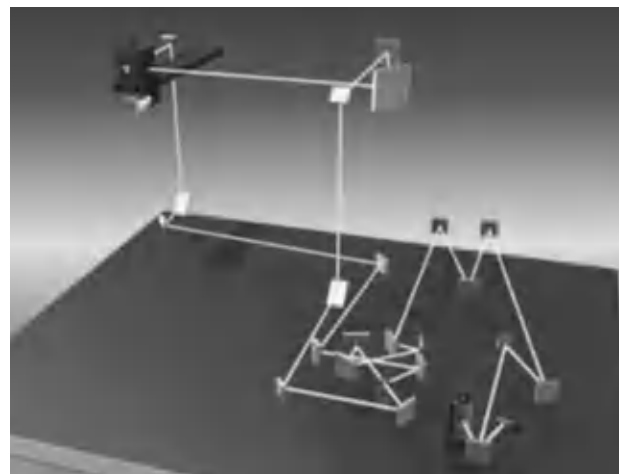
## Large Sample Compartment



Large Sample Compartment  
A sample of 700W × 560D mm is set in the sample compartment.

## Three Dimensional Optical Path

The three-dimensional optical path enables non-destructive measurement of large samples, without having to cut them smaller. In the optical path of previous models, light only traveled horizontally, but the new models include a three-dimensional optical path (U.S. patent 6583872) with light also traveling in the vertical direction. Samples can be placed horizontally, which makes it easier to place large samples.



Three Dimensional Optical Path



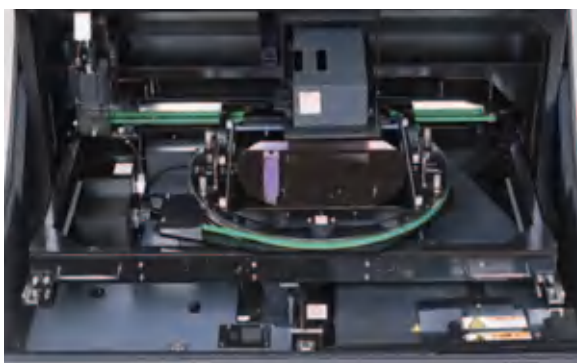
A wide variety of accessories, such as absolute specular reflectance attachments and relative specular reflectance attachments, expand the application range. Automatic measurements can be

performed with the optional Automatic X–Y Stage by inputting the intervals and the rotation angles for the sample.

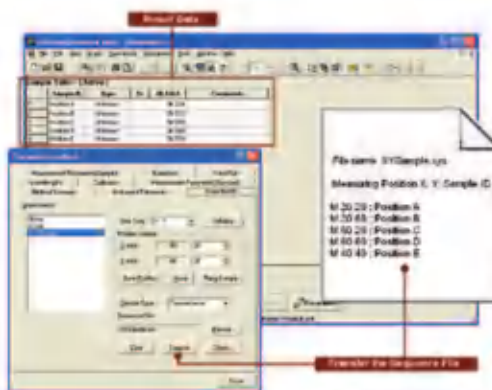
### Automatic Measurement

#### Automatic X–Y Stage (Optional)

The Automatic X–Y Stage developed for the SolidSpec-3700i/3700i DUV enables automatic measurements for the points specified in advance while maintaining the nitrogen gas purge.



12 inch Silicon Wafer on Automatic X–Y Stage



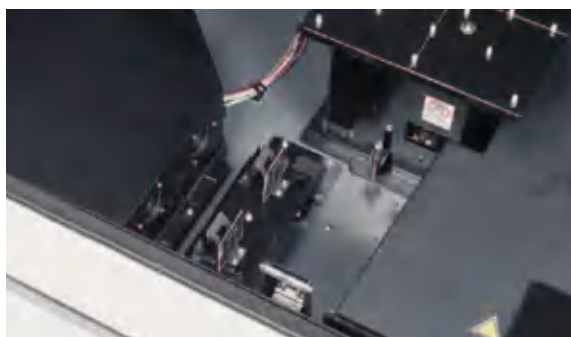
Input of Intervals and Rotation Angles

### Direct Measurement of Liquid Samples and Solid Samples without Integrating Sphere

#### Direct Detection Unit (Optional)

The SolidSpec-3700i/3700i DUV can measure samples with an integrating sphere as the standard detection system. However, some samples require measurement without using an integrating sphere. The Direct Detection Unit was created for just such instances. By

mounting the Direct Detection Unit (DDU-DUV) in the SolidSpec-3700i DUV, measurements down to 165 nm<sup>(note)</sup> are possible. Measurements with the Direct Detection Unit can be performed simply by switching a mirror.



Measurement of Film Sample with Direct Detection Unit



Measurement of Liquid Sample with Direct Detection Unit

Note) In order to measure below 190 nm with SolidSpec-3700i DUV, nitrogen gas purging is required to remove interfering oxygen molecules inside of the SolidSpec-3700i DUV. The measurable range for the SolidSpec-3700i with the optional Direct Detection Unit is 190 nm to 3300 nm.

# Standard Software: LabSolutions™ UV-Vis

Enables higher productivity and provides for a more convenient analytical environment.

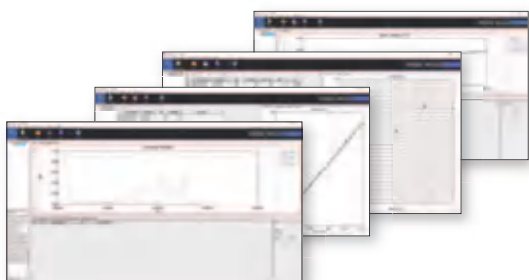


## Setting Parameters

### Smooth Operability

#### Four Measurement Modes

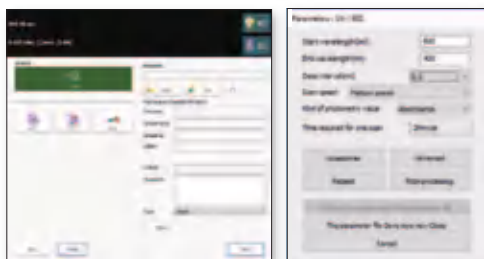
Four separate measurement modes: spectral, quantitative, photometric, time-course, automatic measurement (optional) enable measurements to be performed using intuitive operations.



Four Measurement Mode Windows

#### Instrument Control Panel

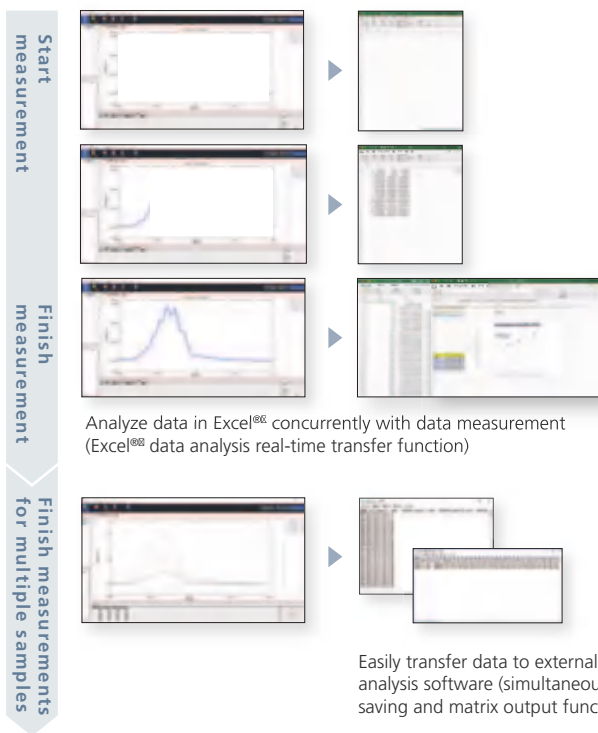
Instrument parameter settings can be specified via panels that are separate from the measurement window. The control panels include various functionality that is laid out for superior visibility. Each measurement window connects seamlessly to the corresponding parameter settings window.



## From Measurement to Data Output

### Improved Productivity of Data Analysis Operations

Data analysis and data output operations can be performed at the same time (simultaneously) as data measurement. Time spent outputting or analyzing data can also be reduced by simultaneously sending data to an Excel® spreadsheet in real time or saving data as text. The software can also automatically perform post-processing of measured data, such as processing/correcting spectra, and perform pass/fail judgments of measurement results (automatic spectral evaluation).

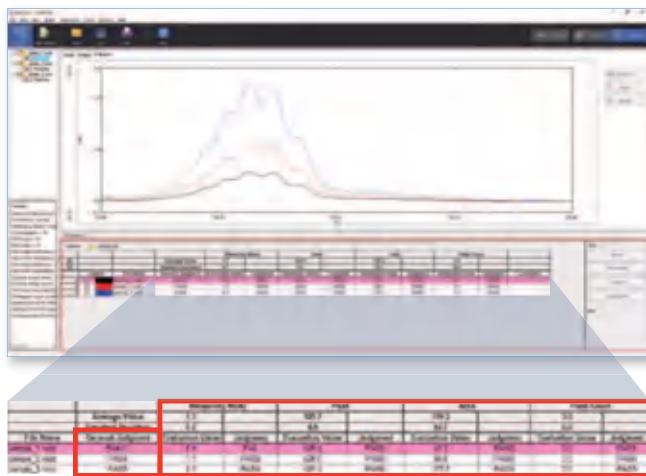




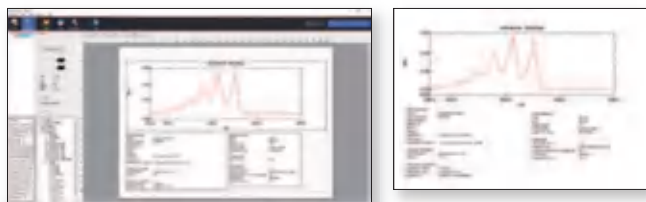
## Data Management

### Automatic Spectral Evaluation (Spectral Evaluation Function)

By specifying various evaluation criteria for measurement results, spectra judgments can be made automatically.



In the report creation window, reports can either be prepared based on a previously specified report format or freely laid out based on various parameters, data, or other elements.



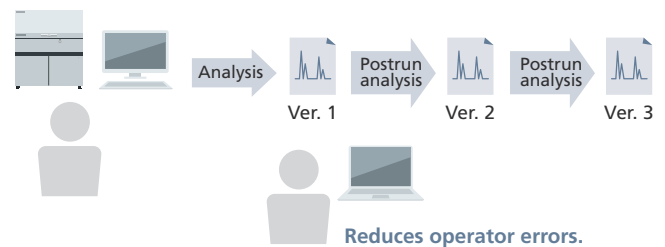
### Stronger Data Management

In addition to regular file management in folders on a PC, ideal solutions for saving data in a database with sophisticated security functionality and compliance with ER/ES-related regulations are also available.

- Optional Software
- LabSolutions DB UV-Vis
- LabSolutions CS UV-Vis

### Database Management

Managing data in a database can prevent the overwriting or deletion of analysis data. Furthermore, during postrun analysis, the data can be managed using version numbers, so there are no concerns about overwriting the data.



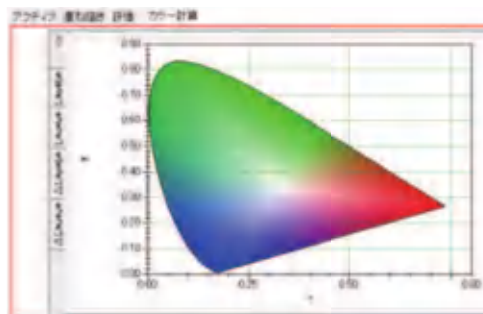
# Optional Software

Optional software adds various data analysis functions to the spectral evaluation functionality in LabSolutions UV-Vis. Pass/fail criteria can also be specified for data analysis results.

## Color Calculation Software (P/N 207-24528-91)

This software is used to calculate the color value of measured substances based on measured spectra. It can also display color diagrams, such as by plotting color coordinates in an XYZ color system or plotting CIELAB lightness index or color coordinate values.

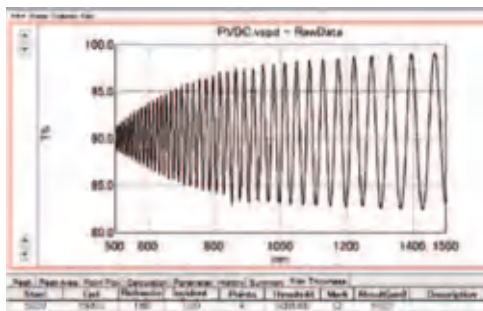
- It includes the major calculation parameters, such as the XYZ color system, CIELAB, CIELUV, Munsell color system, mentalism, yellowness, whiteness, and color difference.
- Colors relevant to JIS and ASTM standards can be calculated.\*
- Measurement illuminants, viewing angle, and other parameters can be specified for the various types of calculation.



## Film Thickness Calculation Software (P/N 207-24528-91)

This software is used to calculate film thickness from measured spectra based on the interference interval method. (Calculating the film thickness requires entering the refractive index of the sample.)

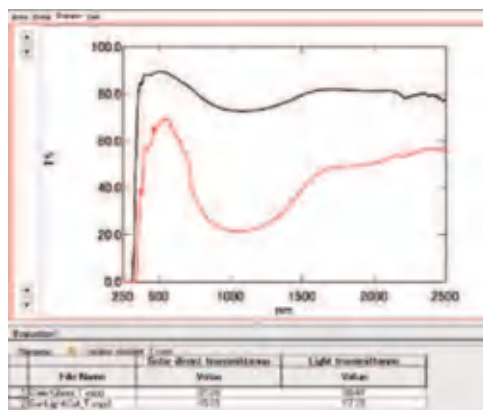
- The interference interval method calculates the film thickness based on the interval between interference peaks (or valleys). The incident angle and wavelength range for film thickness calculations and peak (or valley) detection parameters can be specified.



## Solar Radiation Calculation Software (P/N 207-25806-91)

This software is used to calculate solar transmittance/reflectance based on measured spectra.

- It includes major calculation parameters, such as visible light transmittance/reflectance, total light transmittance/reflectance, near-infrared reflectance, ultraviolet ray transmittance, CIE damage factor, and skin damage factor.
- Parameters relevant to JIS, ISO, and GB/T standards can be calculated.\*



## UPF Calculation Software (P/N 207-25806-91)

This software is used to calculate ultraviolet protection factor (UPF) values based on measured spectra.

- It can calculate UPF, UVA, UVB, and ultraviolet protection values for either UVA and UVB.
- Values relevant to JIS, DIN, BS, AATCC, AS/NZAA, or GB/T standards can be calculated.\*

\* For more details about applicable standards, contact Shimadzu.

# Guide to Selecting Accessories

In order for UV-Vis and NIR spectrophotometers to perform their full functions, it is necessary to select the appropriate accessories for the application field and sample properties. A wide variety of accessories are available to support a wide range of applications, from basic measurement such as transmission and relative/absolute reflection measurement, to multi-sample and micro-sample measurement. Please refer to the *UV-VIS Series Accessories* handbook (C101-E070) for details.

## ■ Solid Samples

Samples	Measurement Method and Conditions		Accessories	
Smooth Surface Samples*	Transmittance measurement	Less than 3 mm thick	Standard Sample Compartment + Film Holder, Cell Type Sample Holder, Glass/Film Holder for Standard Sample Compartment	
		More than 3 mm thick	Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)	
		Requires a large integrating sphere (due to ISO compliance and other reasons).	Integrating Sphere Attachment, 150 mm Dia. (ISR-1503, ISR-1503F)	
		Large sample size (over 100 mm square)	Large-Sample Compartment (MPC-2600A/603A or SolidSpec-3700i) Glass Sample Holder for MPC series/SolidSpec	
	Reflectance measurement	Relative specular reflectance measurement	Normal measurement	Specular Reflectance Measurement Attachment (5° incident angle)
			Large sample size (over 100 mm square)	SolidSpec-3700i + Large Specular Reflectance Measurement Attachment (5° incident angle)
		Absolute specular reflectance measurement	5° incident angle measurement	Absolute Specular Reflectance Attachment (ASR-3105) (Requires a Large-Sample Compartment and BIS-3100/3700/603 Sample Base Plate Integrating Sphere Set separately.)
			12°/30°/45° incident angle measurement	Absolute Specular Reflectance Attachment (ASR-3112, ASR-3130, ASR-3145) (Requires a Large-Sample Compartment, BIS-3100/3700/603 Sample Base Plate Integrating Sphere Set, and polarizer assembly separately.)
			Variable incident angle measurement	Variable Angle Measurement Unit (Requires large-sample compartment and polarizer assembly separately.)
		Relative diffuse reflectance measurement	Normal measurement	Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)
Requires a large integrating sphere (due to ISO compliance and other reasons).	Integrating Sphere Attachment, 150 mm Dia. (ISR-1503, ISR-1503F)			
Rough Surface Sample**	Transmittance measurement	Normal measurement	Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)	
		Requires a large integrating sphere (due to ISO compliance and other reasons).	Integrating Sphere Attachment, 150 mm Dia. (ISR-1503, ISR-1503F)	
		Large sample size (over 100 mm square)	Large-Sample Compartment (MPC-2600A/603A, or SolidSpec-3700i)	
	Reflectance measurement	Relative diffuse reflectance measurement	Normal measurement	Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)
			Requires a large integrating sphere (due to ISO compliance and other reasons).	Integrating Sphere Attachment, 150 mm Dia. (ISR-1503, ISR-1503F)
		Absolute diffuse reflectance measurement	Large sample size (over 100 mm square)	Large-Sample Compartment (MPC-2600A/603A, or SolidSpec-3700i)
				Consult your Shimadzu representative. (Depends on the sample. A method using conversion from the mirror reflectance, for instance, is available.)
	Large sample size (over 100 mm square)		Large-Sample Compartment (MPC-2600A/603A, or SolidSpec-3700i)	
	Small sample size (below 5 mm square)		Micro Sample Holder + Micro Beam Lens Unit	

\* Metals with a mirror-finished surface, mirrors, transparent acrylic and films, etc.

\*\* Paper, cloth, plastics, semi-transparent films, etc.

For color measurement, the Color Analysis Software or LabSolutions UV-Vis Color Calculation Software is required separately. For film thickness measurement, the Film Thickness Calculation Software is required separately.

## ■ Liquid Samples

Samples	Measurement Method and Conditions		Accessories	
Transparent Samples	Sample volume: 2.5 mL min.		Standard Sample Compartment + 10 mm Cell	
	Micro-volume measurement	1 mL min.	Semi-Micro Cell + Micro Cell Holder with Mask	
		500 µL min.	Micro Cell + Micro Cell Holder with Mask	
		50 µL min.	Super-micro Cell + Super-micro Cell Holder	
		For automatically measuring samples in multiple cells	MMC-1600 8/16 Series Micro Multi-Cell Holders and Cells	
	Samples with high absorbance, but that are difficult to dilute (short optical path measurement)		Short-Path Cell (1, 2, 5 mm) + Spacer for Short-Path Cell	
	Samples with low absorbance, but that are difficult to concentrate (long optical path measurement)		Long-Path Cell (20, 30, 50, 100 mm) + Long-Path Rectangular Cell Holder	
	For automatically measuring samples in multiple cells	Normal measurement		Multi-Cell Sample Compartment (sample volume: 2.5 mL min.)
		Small sample volumes (50 µL min.)		MMC-1600 8/16 Series Micro Multi-Cell Holders and Cells
		Requires temperature control		CPS-100 Six-Cell Thermoelectrically Temperature-Controlled Cell Positioner (sample volume: 2.5 mL min.)
	For temperature-controlled measurements (constant-temperature measurement)	Temperature-controlled with water circulation		Constant-Temperature Cell Holder + NTT-2200P Constant-Temperature Water Circulator
		Thermoelectrically temperature controlled	Normal measurement	TCC-100 Thermoelectrically Temperature-Controlled Cell Holder
			For automatically measuring samples in multiple cells	CPS-100 Six-Cell Thermoelectrically Temperature-Controlled Cell Positioner
			Tm analysis or variable temperature measurement	S-1700 Thermoelectric Single Cell Holder
	Automatically supplies sample to flow cells (automatic analysis)	Requires temperature control (constant-temperature water circulation)		160C Sipper Unit + NTT-2200P
Temperature control not necessary		160L/160T/160U Sipper Unit (Select type based on liquid volume.)		
Requires accurate control of aspiration volume.		Requires temperature control (constant-temperature water circulation)	Syringe Sipper CN + NTT-2200P (Select flow cell based on liquid volume.)	
		Temperature control not necessary	Syringe Sipper N (Select flow cell based on liquid volume.)	
For automating measurement of multiple samples		Sipper Unit or Syringe Sipper + ASC-5 Auto Sample Changer		
Suspension Samples	Absorption measurement of suspension samples	Wavelength range: 240 nm min.	Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)	
		For measuring UV region above 190 nm	SolidSpec-3700i DUV	
	Turbidity measurement	Light transmitted light turbidity measurement (commonly used measurement method)	10/50 mm Cell + Long-Path Rectangular Cell Holder (Optical path length of cell depends on test method.)	
Integrating sphere turbidity measurement		Integrating Sphere Attachment (ISR-2600, ISR-2600Plus, ISR-603)		

# Accessories

## Absolute Reflectance Attachments



This attachment enables absolute specular reflectance measurements of solid samples. It is compatible with sample sizes from 20 to 150 mm square and up to 30 mm thick. Requires a sample stage and integrating sphere set separately.

P/N	Incident Angle	Wavelength range
206-16817-58	5°	300 to 2400 nm
206-16100-58	12°	300 to 2500 nm
206-15001-58	30°	300 to 2300 nm
206-15002-58	45°	300 to 2300 nm

## Variable Angle Measurement Unit for SolidSpec-3700i (P/N 207-23470-41)



This device enables absolute reflectance measurements of solid samples, with the incident and reflection angles set to any angle. Measurement wavelength range is 250 to 2500 nm. It is compatible with sample sizes from 20 to 70 mm square and between 2 and 15 mm thick. The incident angle can be set between 5 and 70 degrees.

## Large Polarizer Assy / Polarizer Assy



These enable control of polarization characteristics of incident light on samples.

P/N	Type	Wavelength range
206-15694-40	Large type	250 to 2300 nm
206-13236-41	Type I	400 to 800 nm
206-13236-42	Type II	260 to 700 nm
206-13236-40	Type III	260 to 2300 nm

## Powdered Sample Holder (for Integrating Sphere) (P/N 206-89065-41)



This powdered sample holder is for installation in an integrating sphere.

## Micro Sample Holder (P/N 206-28055-41)



This holds small samples against the integrating sphere. It is compatible with sample sizes from 5 to 10 mm square and between 0.5 and 2 mm thick.

## Large Specular Reflectance Attachment (5° incident angle) (P/N 206-28055-41)



This attachment enables relative specular reflectance measurements of the large samples. It is compatible with samples up to 470 mm wide, 560 mm tall, or 40 mm thick.

## Automatic X-Y Stage (P/N 206-20810-58)



This accessory automatically measures multiple points. It is compatible with samples up to 310 mm in diameter, 310 mm square, or 40 mm thick.

## Accessories Dedicated for SolidSpec-3700i DUV

### Purge Box

(P/N 206-21788-58)



This unit is required for purging the direct detection unit with nitrogen. It includes a film holder and six-cell holder.

### MC-3BS Constant-Flowrate Thermal Controller

(P/N 206-28212-91)



This controller controls nitrogen flowrate during nitrogen purging.

## Compatible Accessories When Direct Detection Unit Is Added

### Direct Detection Units

(P/N 206-20264-XX)

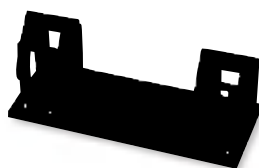


This unit enables measurements without using the integrating sphere normally used as the detector for SolidSpec systems.

P/N	Wavelength range	Available Model
-51	190 to 3300 nm	for SolidSpec -3700i
-52	165 to 3300 nm	for SolidSpec -3700i DUV

### Film Holder

(P/N 204-58909)



This holder is used to hold films, filters, and other items. It is compatible with sample sizes between a minimum W16 × H32 mm and maximum W80 × H40 mm.

### Long-Path Rectangular Cell Holder

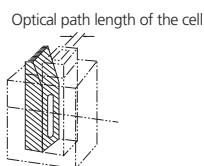
(P/N 204-23118-01)



This holds rectangular cells with an optical path length of 10, 20, 30, 50, 70, or 100 mm.

### Spacers for Short-Path Cells

(P/N 204-21473-XX)

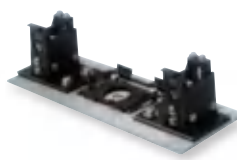


This standard cell holder is required for short optical path cells.

P/N	Available cells
-01	2 mm
-02	5 mm
-03	1 mm

### Super-micro Cell Holder

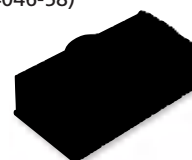
(P/N 206-14334)



This cell holder is for supermicro cells. Volumes between 50 and 200  $\mu$ L can be measured, depending on the type of black cell used.

### Specular Reflectance Attachment (5° incident angle)

(P/N 206-14046-58)



This device enables specular reflectance measurements. The angle of incidence to the sample is 5 degrees. It is compatible with sample sizes from 7 mm in diameter up to 160 × 100 mm and up to 15 mm thick.



**ANALYTICAL  
INTELLIGENCE**

- Automated support functions utilizing digital technology, such as M2M, IoT, and Artificial Intelligence (AI), that enable higher productivity and maximum reliability.
- Allows a system to monitor and diagnose itself, handle any issues during data acquisition without user input, and automatically behave as if it were operated by an expert.
- Supports the acquisition of high quality, reproducible data regardless of an operator's skill level for both routine and demanding applications.

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