

The versatile Diffuse Reflectance accessory, provides accurate, convenient analysis of the most difficult samples.

## Diffuse Reflectance UV-Vis Accessory

An integrating sphere for easy, accurate analysis of any sample.



The Diffuse Reflectance accessory (DRA-EV-600), for use with the Evolution™ 600 UV-Vis spectrophotometer, is a valuable tool used to characterize a variety of materials. The accessory provides sample mounting configurations for performing both reflectance and transmission measurements. With this accessory, you can easily measure a myriad of materials from solids to liquids.

The upward-looking, horizontal reflectance port provides extensive mounting flexibility for repeatable sample positioning. With the reflectance port located above the plane of the instrument, sample size is nearly unlimited.

To obtain the highest possible reflectivity and wavelength range, the accessory utilizes an integrating sphere that is coated with Spectralon®, a highly Lambertian thermoplastic material. Spectralon maintains greater than

99% reflectance from 400 nm to 900 nm and greater than 95% reflectance from 250 nm to 900 nm. Moreover, Spectralon is a nearly perfect diffuser, chemically inert to most compounds, and maintains its high reflectance properties under harsh environmental conditions such as high humidity.

### Compliance to Industry Standards

The design of the integrating sphere provides a very low port fraction of 3.6%. Usually this low port fraction is only available on much larger and more expensive integrating spheres. The low port fraction of the integrating sphere easily complies with the CIE color requirement of less than 10% port fraction and also complies with the more rigorous  $\leq 4\%$  port fraction requirement for Haze measurements (ASTM D-1003).



## High Performance and Accuracy for Color Measurements

The absolute accuracy of the Diffuse Reflectance accessory/ Evolution 600 system for CIE color measurements is exemplified in Tables 1 – 4. The tables compare values from a calibrated standard against values measured using the Diffuse Reflectance accessory with the Evolution 600 spectrophotometer. Values for Tristimulus and CIELAB are compared using 2° and 10° observer angles with A and D65 illuminants. The values in black are the values from calibrated standards, and the values in blue are the actual measured values measured with the Diffuse Reflectance accessory.

Colorimetric Method		2° Observer Illuminant A	2° Observer Illuminant D65	10° Observer Illuminant A	10° Observer Illuminant D65
Tristimulus values	X	96.327 95.8	71.972 71.5	96.877 96.4	71.135 70.7
	Y	81.398 81.2	74.129 74.0	79.329 79.1	69.906 69.7
	Z	5.786 5.3	16.267 14.7	5.397 4.9	15.573 14.0
CIELAB	L*	92.31 92.2	88.98 88.9	91.38 91.3	86.95 86.8
	a*	11.76 11.5	3.27 2.7	14.76 14.6	10.58 10.2
	b*	77.56 80.5	74.87 78.2	78.09 81.3	72.39 75.8

Table 1: Colorimetric data for yellow standard

Colorimetric Method		2° Observer Illuminant A	2° Observer Illuminant D65	10° Observer Illuminant A	10° Observer Illuminant D65
Tristimulus values	X	44.08 43.6	28.31 27.9	42.05 41.6	26.41 26.0
	Y	23.95 23.5	17.72 17.3	23.64 23.2	17.17 16.8
	Z	2.97 2.8	9.11 8.4	2.94 2.7	8.99 8.3
CIELAB	L*	56.04 55.6	49.15 48.7	55.73 55.3	48.48 48.0
	a*	58.29 58.8	53.12 53.8	52.47 53.0	48.60 49.3
	b*	36.77 38.3	24.87 26.3	36.25 37.8	23.67 25.1

Table 2: Colorimetric data for red standard

Colorimetric Method		2° Observer Illuminant A	2° Observer Illuminant D65	10° Observer Illuminant A	10° Observer Illuminant D65
Tristimulus values	X	28.04 27.9	25.16 25.0	28.91 28.8	25.57 25.5
	Y	31.52 31.6	33.98 34.1	31.55 31.6	33.83 33.9
	Z	9.67 9.6	27.82 27.4	9.25 9.2	26.66 26.2
CIELAB	L*	62.94 63.0	64.95 65.0	62.97 63.0	64.82 64.9
	a*	-23.09 -23.6	-29.55 -28.5	-21.21 -21.7	-25.36 -26.0
	b*	6.57 7.0	22.14 13.2	8.05 8.6	13.62 14.3

Table 3: Colorimetric data for green standard

Colorimetric Method		2° Observer Illuminant A	2° Observer Illuminant D65	10° Observer Illuminant A	10° Observer Illuminant D65
Tristimulus values	X	20.73 20.3	23.79 23.6	20.86 20.5	23.86 23.6
	Y	20.39 20.1	23.98 23.8	21.58 21.4	26.56 26.4
	Z	21.60 21.6	67.31 67.1	21.61 21.6	66.68 66.5
CIELAB	L*	52.27 52.0	56.07 55.8	53.58 53.3	58.57 58.4
	a*	-7.46 -7.9	4.51 4.5	-13.67 -14.0	-5.72 -5.7
	b*	-51.62 -52.0	-46.12 -46.5	-50.01 -50.4	-42.10 -42.4

Table 4: Colorimetric data for blue standard

The Diffuse Reflectance accessory provides excellent performance and photometric accuracy for color measurements, as demonstrated in Figure 1. Two overlapping spectral plots are shown. The trace in blue represents the expected values from a calibrated Labsphere Blue Color standard. The red trace gives the spectral scan of the Labsphere Blue Color standard using the Diffuse Reflectance accessory.

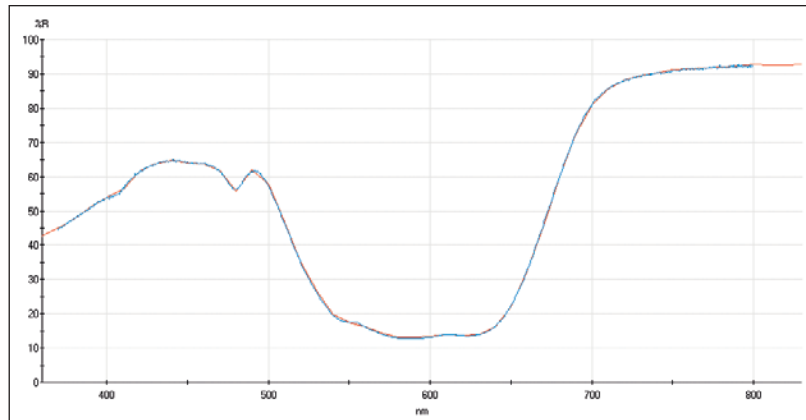


Figure 1

### Horizontal Sample Mounting for Reflectance Measurements

The horizontal sample mounting configuration for reflectance measurements provides considerable flexibility for diffuse and specular reflectance measurements of a variety of materials. Unlike vertical type arrangements that use force to mount a sample, the upward looking configuration of the Diffuse Reflectance accessory uses gravity to hold the sample in place. No pressure from mounting clips is exerted on the sample, thus maintaining the integrity of the sample surface. A protective Mylar® film on the top sphere surface further guarantees this integrity and ensures that delicate samples will not be scratched.

Since only gravity holds the sample in place, the most delicate samples can be measured in this configuration. This potentially eliminates the need to alter or destroy your sample in order to make a measurement. Even the color spectrum of a Peruvian butterfly wing can be measured without the slightest damage to its fragile wings.

To make reflectance measurements of relatively small samples simply place the sample on the reflectance port, drop the top light shield cover in place, and perform the measurements from the appropriate system software. Because the reflectance sample port is situated above the top plane of the spectrophotometer, you can also measure very large solid samples. Simply position the sample so that it lays flat on the sample reflectance port. If the sample is flat against the reflectance port, the sample itself should provide sufficient light shielding from room light. If the large sample is not flat against the port, a black cloth may be necessary to block room light. Irregular-shaped samples, such as geological specimens, are also easy to measure with the Diffuse Reflectance accessory, as shown in Figure 2.



Very delicate samples can be measured using the horizontal reflectance port. Even the fragile wings of a Peruvian butterfly can be measured without damaging the sample.

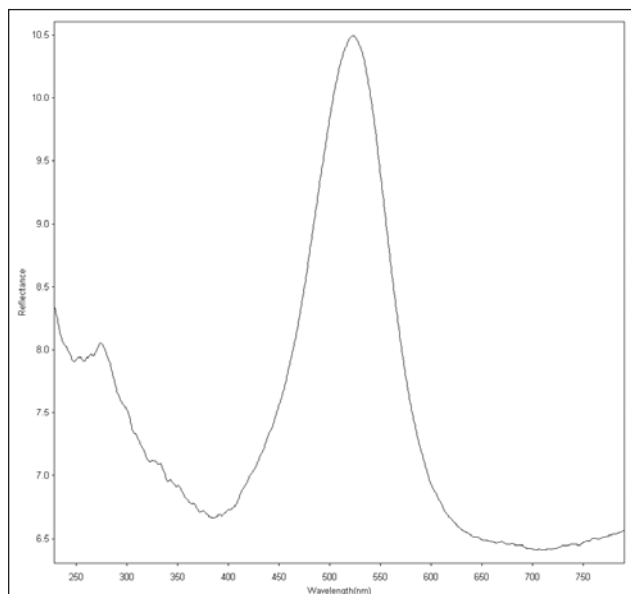


Figure 2: Easily mount irregular samples such as geological specimens. This spectrum shows a reflectance scan of the mineral Malachite ( $\text{Cu}_2\text{CO}_3(\text{OH})_2$ ).

## Eliminate Scattering Effects

The Diffuse Reflectance accessory is Haze compliant and is a very valuable tool for eliminating the scattering effect from materials such as plastic films or turbid liquids. This is demonstrated in Figure 3. Shown in red is the spectrum from a wavelength scan of a plastic film mounted in the sample compartment of an Evolution 600 spectrophotometer. The spectrum shown in black is a wavelength scan of the same sample mounted at the transmittance port of the integrating sphere. The scattering effect is eliminated in the scan performed on the integrating sphere. This enables an accurate calculation of the peak value because the sloping baseline from the scattering sample is eliminated.

## Sample Mounting Accessories

Two optional accessories are available for the Diffuse Reflectance accessory for measurements of powders and crystals and for measurements of liquids.

The powder cell holder is designed to minimize the amount of powder required for measurement by incorporating an aluminum insert backed with a spring. This insert takes up the majority of the sample holder cavity and presses the powder firmly against the quartz window. A second powder cell holder containing a Spectralon reference is used for collecting a 100%R baseline.

A liquid cell holder is available for the measurement of turbid or scattering liquid samples. When a liquid sample is placed at the transmission port, the sphere acts as a very efficient collector of forward scattered light from the turbid liquid. Applications for this type of measurement can vary from the measurement of the protection factor of sunscreen lotions to the analysis of Cytochrome samples from cell lysates.

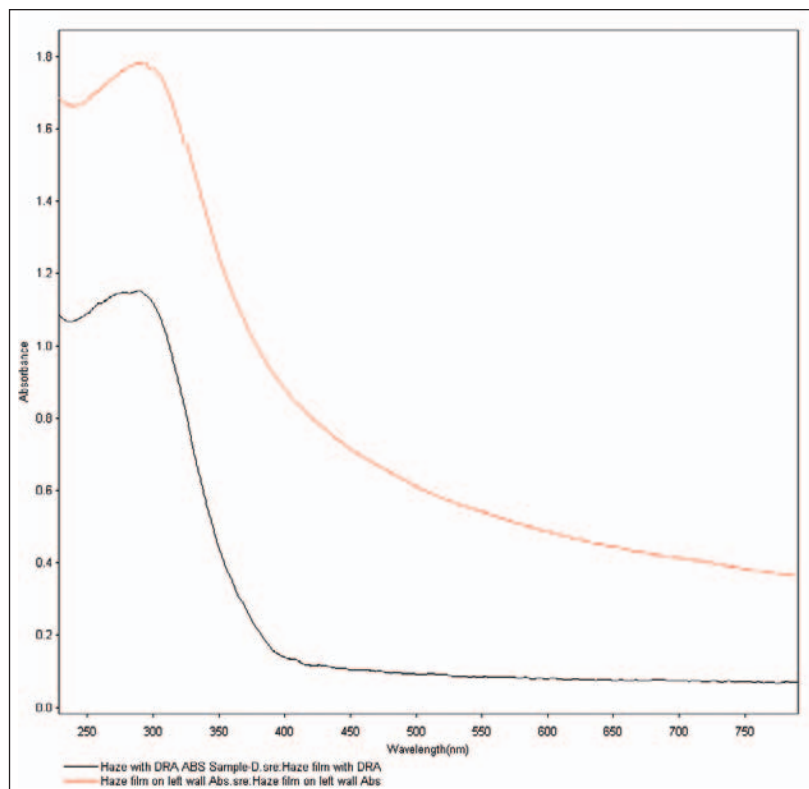


Figure 3

## Specifications

### Double Beam Integrating Sphere with built-in PMT detector

Sphere Diameter	75 mm
Sample Illumination	8° hemispherical
Port to Surface Area Ratio	3.6%
Wavelength Range	~220 nm to 900 nm
Minimum Sample Size (reflectance)	0.563 in (14.3 mm)
Minimum Sample Size (transmittance)	< 1 in (<25.4 mm)
Reflectance Measurements	Horizontal upward illumination mounting
Specular Included/Excluded	Selectable CIE Color compliance
Haze Compliance	ASTM 1003-1995

## Product Information

Product	Part Number
DRA-EV-600 Diffuse Reflectance Accessory	222-219000
Powder Cell Holder	222-223000
Cuvette Holder	222-222900
Spectralon Diffuse Color Standards	222-219700
Spectralon Diffuse Standards (2 – 99%)	222-219800
Software	
VL ColorCalc Advanced	869-124400
VL ColorCalc Basic	869-124300
VL MaterialsCalc	869-124500

©2007 Thermo Fisher Scientific Inc. All rights reserved. Mylar is a registered trademark of E.I. Du Pont de Nemours Corporation. Spectralon is a registered trademark of Labsphere, Inc. All other trademarks are the property of Thermo Fisher Scientific Inc. and its subsidiaries. Specifications, terms and pricing are subject to change. Not all products are available in all countries. Please consult your local sales representative for details.



Thermo Electron Scientific Instruments LLC,  
Madison, WI USA is ISO Certified.

PS51248\_E 04/07M

**Australia** +61 2 8844 9500  
**Austria** +43 1 333 50340  
**Belgium** +32 2 482 30 30  
**Canada** +1 800 532 4752  
**China** +86 10 5850 3588  
**Denmark** +45 70 23 62 60

**France** +33 1 60 92 48 00  
**Germany** +49 6103 408 1014  
**India** +91 22 6742 9434  
**Italy** +39 02 950 591  
**Japan** +81 45 453 9100  
**Latin America** +1 608 276 5659

**Netherlands** +31 76 587 98 88  
**South Africa** +27 11 570 1840  
**Spain** +34 91 657 4930  
**Sweden/Norway/Finland**  
+46 8 556 468 00  
**Switzerland** +41 61 48784 00

**UK** +44 1442 233555  
**USA** +1 800 532 4752

[www.thermo.com](http://www.thermo.com)

**Thermo**  
SCIENTIFIC