

# Diffuse Reflectance Accessories (DRAs)

for the Cary 4000, 5000, 6000i, or 7000 UV-Vis-NIR spectrophotometers



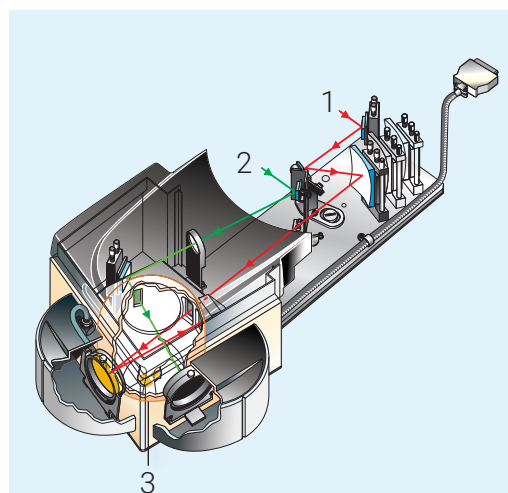
## Measure reflectance, transmittance or absorbance

Integrating spheres are versatile accessories that accommodate a wide variety of sample types, and allow for various measurement modes. The integrating sphere is hollow and its internal surface is a non-selective diffuse reflector. The geometry of the integrating sphere is designed to collect the majority of reflected or transmitted radiation (without directional preference), presenting an integrated signal to the detector.

Agilent has a range of external and internal DRAs for the Cary 4000, 5000, 6000i, or 7000 instruments. The three external and three internal DRAs are designed to perform reflectance, transmittance, or absorbance measurements of diffuse, specular, or mixed samples.

## Features

- **Variety:** The internal and external DRAs can be used with all Agilent high end UV-Vis and UV-Vis-NIR instruments, so you can choose the DRA option that best suits your needs.
- **Flexibility:** Reflectance and transmittance mounting options are provided as standard. Other options are available for powders and small samples, including variable angle center mount attachments for solids and solutions.
- **Ease of use:** A thoughtfully designed lock down lever saves time, with no tools required to install accessories.



**Optical diagram of the Cary DRA accessories**

1. Sample beam
2. Reference beam
3. Integrating sphere

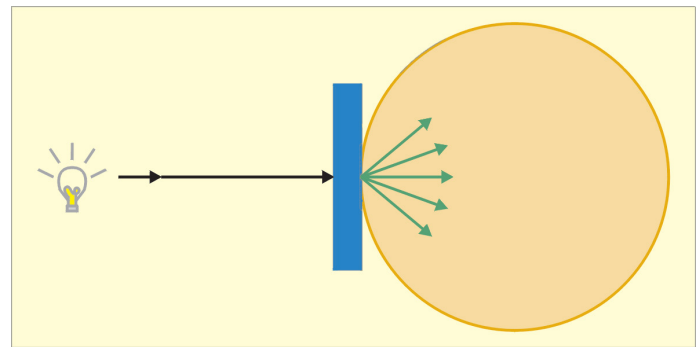
Reflection consists of two components: specular and diffuse. Specular reflectance is the mirror-like reflection off a sample surface. Diffuse reflectance occurs when the surface reflects light in many different directions, giving the surface a matte finish.

Traditionally, the accessory used to measure diffuse reflectance is the integrating sphere. Applications include characterizing solar materials, color measurement and characterization, and obtaining reflectance spectra of a painted surface. Samples which distort the beam of the instrument, such as a lens, can also be studied with the DRA.

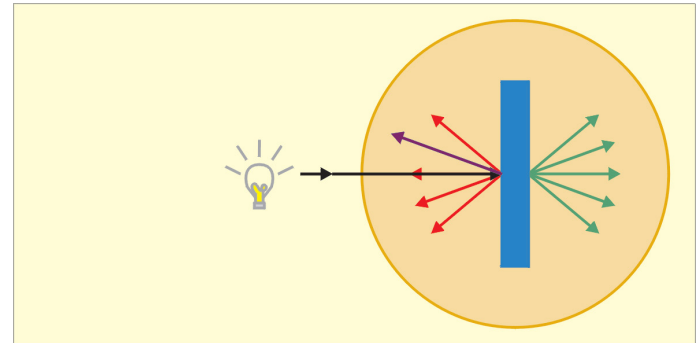
Integrating spheres are ideal for measuring the transmission of turbid, translucent or almost opaque materials where many standard techniques prove inadequate due to loss of light and sample scattering effects.

Reflectance measurements are made by mounting a sample on the sphere wall, ensuring efficient collection of a high proportion of diffusely reflected radiation. Although commonly referred to as a diffuse reflectance accessory (DRA), options are available to exclude or include the specular component of the reflected radiation, providing the choice of either diffuse only or total reflectance modes.

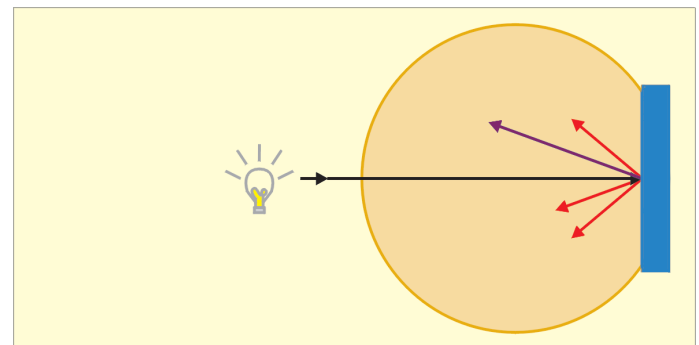
The functionality of a DRA is not limited to reflectance measurements. Integrating spheres can also be used to measure transmittance by mounting the sample at the entrance port or the center of the sphere. The center mount, augmented by rotational control over the sample axis, complements the straight diffuse measurement mode.



Transmission



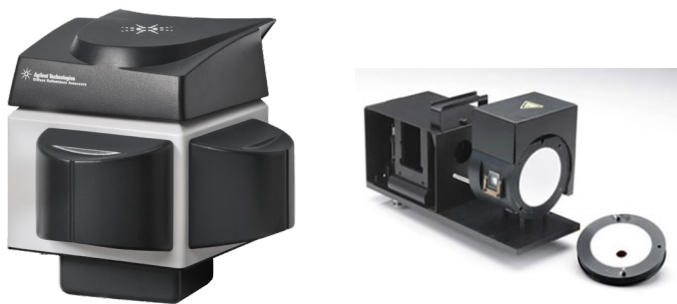
Center



Reflection

Figure 1. Schematics showing transmitted and reflected light. Diffuse reflection (red), specular reflection (purple) and diffuse transmission (green). Incident light is shown in black and the sample is shown in blue.

## Choosing an external or internal DRA



The DRAs are available in either an external or an internal version. The external version (shown on the left, above) mounts in the instrument sample compartment, but extends beyond the instrument footprint. The internal version (shown on the right, above) fits completely inside the instrument sample compartment.

External DRA	Internal DRA
Unlimited sample size in reflectance mode	Max sample size limited to sample compartment dimensions
Center mounting options available as clip, jaw or cuvette	Small efficient size resulting in high signal to noise and greater dynamic range
Variable angle measurements for center and transmission positions	
Access to reference beam for cuvette holder	
150 mm sphere	110 mm sphere
Port to sphere area ratio: <5%	Port to sphere area ratio: <3%

### Measurement capabilities

The external DRA can perform more measurement types than the internal version, with the use of optional accessories. The table below conveys the different measurement types each DRA can be used for.

	Internal DRA	External DRA
Total %R (Specular + Diffuse)	✓	✓
Diffuse %R (Specular excluded)	✓	✓
Transmission %T	✓	✓
Cuvette Holder (optional)	✓	✓
Solid Sample Holder	✓	✓
Powder Cell Holder (optional)	✓	✓
Mount for Polarizer/Depolarizer (optional)	✓*	✓
Transmission (Variable Angle) (optional)	☒	✓
Transflectance (Center Mount) (optional)	☒	✓
Small Spot Kit (SSK) (optional)	☒	✓
Aperture Kit (optional)	☒	✓

\*Standard

## DRA detectors

As well as selecting an internal or external DRA, three different detectors are available.

1. DRA-900 (PMT version): With exceptionally low photometric noise, wide photometric range and good linearity the DRA-900 is ideal for research and reference work
2. DRA-2500 (PMT/PbS version): The PbS NIR detector is peltier cooled and optimized in real time. This provides the highest photometric linear range of any commercial PbS instrument.
3. DRA-1800 (PMT/InGaAs version): This PMT/InGaAs DRA uses a high performance narrow band InGaAs detector for improved NIR resolution and sensitivity.

## Applications

Consider the following application requirements when deciding between an internal and external DRA.

### Powders

Routine QA/QC analysis of powders is more efficient with the internal DRA using disposable cuvettes and the cell holder mounted in the reflection position (shown in Figure 1). The internal DRA also better accommodates low volumes of powders. If the samples are large and/or highly granular, the increased volume of the external DRA powder cell makes it the preferred choice.

### Absorbance

Center mounting (shown in Figure 1) is only offered with the external DRA. This permits simultaneous measurement of reflectance and transmittance, a requirement of solar and life science applications.

### Small samples

The external DRA has an optional Small Spot kit which reduces the beam size using a condensing lens and permits the measurement of samples down to approximately 5 mm. By focusing the beam down, minimal light is lost providing better signal to noise for small sample sizes.

### Large samples

The maximum internal DRA sample size (%T or %R) is limited by the physical space inside the sample compartment and extended sample compartment. The maximum sample size for the external DRA %R port is unlimited.

### Kinetics

Highly scattering kinetic studies which incorporate buffers that change with time require access to the reference beam to correct for this effect. The external DRA has a cuvette mount for the reference beam, making it suitable for this type of study.

## Specifications

Wavelength range (nm)			
	DRA-900	DRA-2500	DRA-1800
Cary 4000	200-900	200-900*	200-900*
Cary 5000	200-900	200-2500	200-1800
Cary 6000i	200-900	200-1800*	200-1800
Detectors			
UV-Vis	PMT	PMT	PMT
NIR	n/a	Peltier cooled PbSmart	Peltier cooled InGaAs

\*Grey shaded cells indicate full wavelength capability of the DRA is limited by the spectrophotometer itself. On this basis the configuration is not recommended however the configuration is still supported.

Measurement geometry	Internal DRA	External DRAs
Specular included	3° 20' deg/d	8 deg/d
Specular excluded	0 deg/d	8 deg/d
Transmittance	0 deg/d	0 deg/d

## Additional Accessories

<b>Required</b>	Extended sample compartment (internal DRA only)
<b>Optional</b>	Sample holders, polarizer/depolarizer, small spot kit, double aperture, aperture kit, variable angle %T holder, Edwards attachment, powder mounts

For more information:

[www.agilent.com/chem/uv](http://www.agilent.com/chem/uv)

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