

# Fast and Easy Measurement of Scattering Samples with the Agilent Cary 60 UV-Vis Spectrophotometer

Characterize more samples with your Cary 60 UV-Vis using a diffuse reflectance accessory



# Ensure data accuracy of scattering samples with an internal DRA

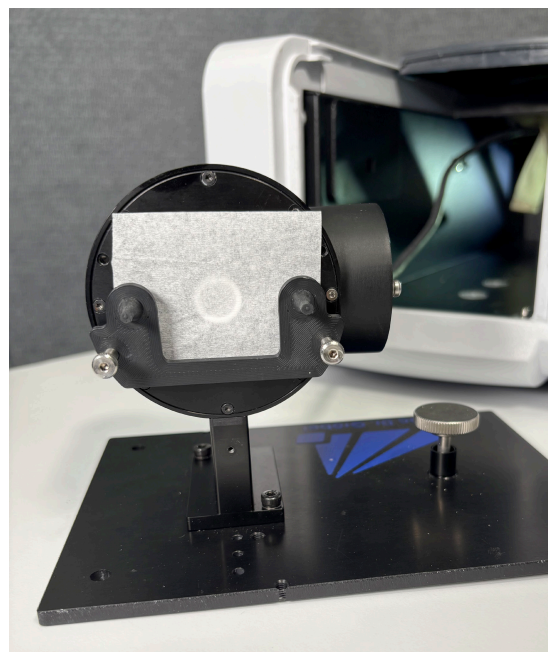
The [Agilent Cary 60 UV-Vis spectrophotometer](#) is an efficient, accurate, and flexible spectrophotometer, ideal for routine UV-Vis analysis.

Measuring samples that diffuse or scatter light in a standard transmission sample compartment can be challenging, as some of the diffused light may deviate from the direct optical path and fail to reach the detector, leading to inaccurate results. To address this issue, diffuse reflectance accessories (DRAs) are highly recommended for scattering samples.

DRAs use an integrating sphere design that enhances light collection efficiency, making them ideal for analyzing scattering samples in both reflectance and transmission modes. The DRAs also enable the measurement of total reflection and transmission, providing complete profiles for films and coatings.

Adding the Agilent Cary 60 UV-Vis DRA to the Cary 60 UV-Vis extends the system's ability to fully characterize solid and liquid samples in diffuse and total reflectance and transmission modes. The highly focused beam of the Cary 60 UV-Vis allows for accurate measurements of small samples using the DRA.

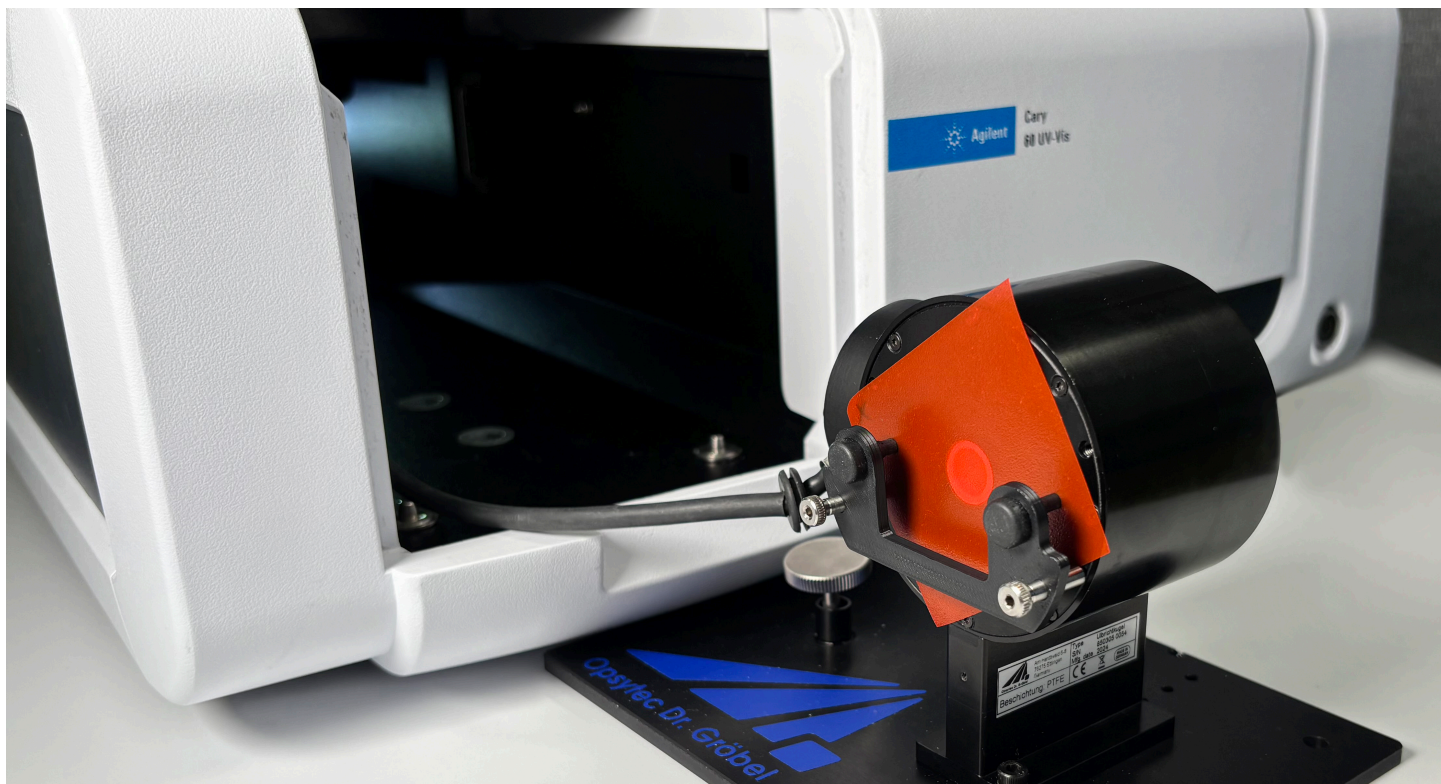
The Cary 60 UV-Vis DRA uses a 50 mm diameter integrating sphere, and since it is specifically designed to fit seamlessly inside the sample compartment of the Cary 60 UV-Vis, it can be set up in less than five minutes.



## Maximizing sampling flexibility

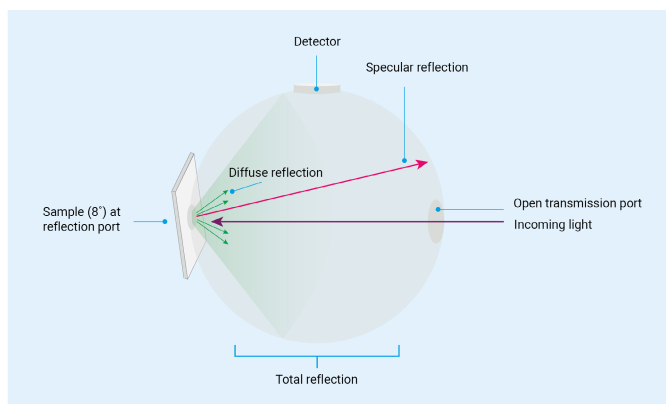
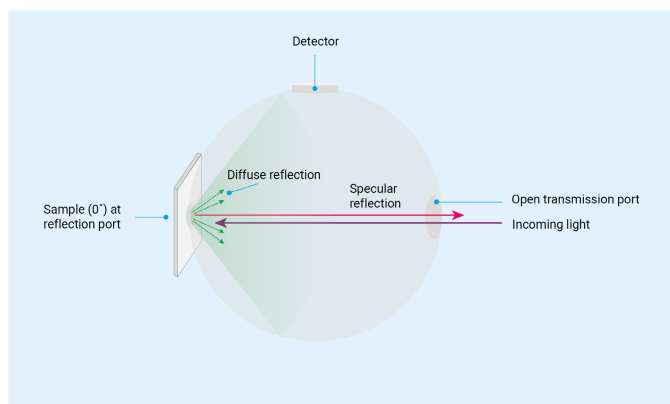
A variety of sample holders and supplemental parts are available to tailor the Cary 60 UV-Vis DRA, enabling it to accommodate different sample types and measurement modes.

<p><b>Standard clamp holders</b> Pre-installed at the DRA transmission and reflection port.</p> <p>Versatile sample holder that allows samples up to ~5 mm thickness to be clamped into position. Minimum sample size (w × h): 15 × 14 mm Maximum sample size (w × h): 200 × 85 mm</p>	
<p><b>Filter holder</b> The holder can be attached to the transmission or reflection port.</p> <p>Allows the measurement of free-standing solid samples such as glass, plastic, and optical filters. Samples slide into the V-shaped holder. Minimum sample size (w × h): 12 × 12 mm Maximum sample size (w × h): 50 × 70 mm</p>	
<p><b>Thin film holder</b> Holder can be attached to the transmission or reflection port.</p> <p>Securely holds thin and flexible samples such as films by pressing the sample against the DRA using two rubber-coated pins. Minimum sample size (w × h): 50 × 12 mm Maximum sample size (w × h): 200 × 64 mm</p>	
<p><b>Standard 10 mm cuvette holder</b> Holder can be attached to the transmission or reflection port.</p> <p>Enables the measurement of liquid samples in cuvettes. Fits 10 × 10 mm cuvettes. Requires a minimum sample volume of 1.4 mL in the cuvettes.</p>	
<p><b>28 mm Powder cell holder</b> Holder can be attached to the transmission or reflection port.</p> <p>Enables the mounting of 28 mm powder cells for reflection measurements.</p>	
<p><b>28 mm Powder cell</b> Mounts into the 28 mm powder cell holder.</p> <p>The 28 mm powder cell can be used in the internal DRA Cary 4000 to 7000 or Cary 60 DRA. It can hold volumes from approximately 0.2 to 1 mL dependent on particle size and opacity. It can easily be used with a quartz window and spring loaded plunger. We recommend having two of them, one filled with PTFE or BaSO<sub>4</sub> for the 100% baseline and one for the sample.</p>	
<p><b>Reflection port cover</b> Made from optical-grade PTFE. Used to close the reflection port for transmission measurements.</p>	
<p><b>0° and 8° port reducer</b> (6 mm aperture)</p> <p>Port reducers help reduce the port-to-sphere ratio and improve signal quality by focusing the beam more precisely on the sample. Additionally, the choice of 0° or 8° geometry allows respectively the exclusion or inclusion of specular reflection, by adjusting the light incidence angle on the sample surface.</p>	



## Reflectance measurements

Reflected light consists of two components: specular and diffuse reflection. 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. Both components can be measured using the Cary 60 UV-Vis with DRA, and the analysis can be performed on surfaces, powders or liquids.

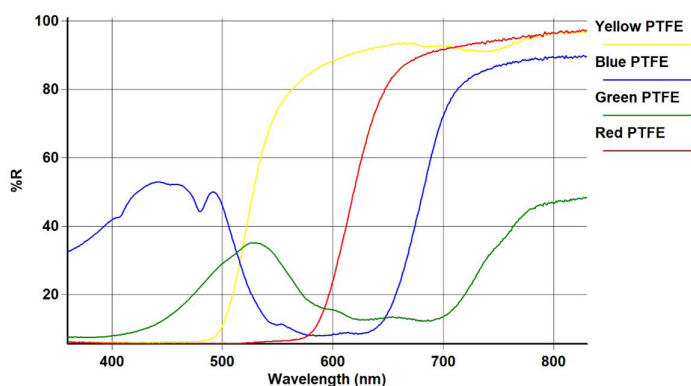
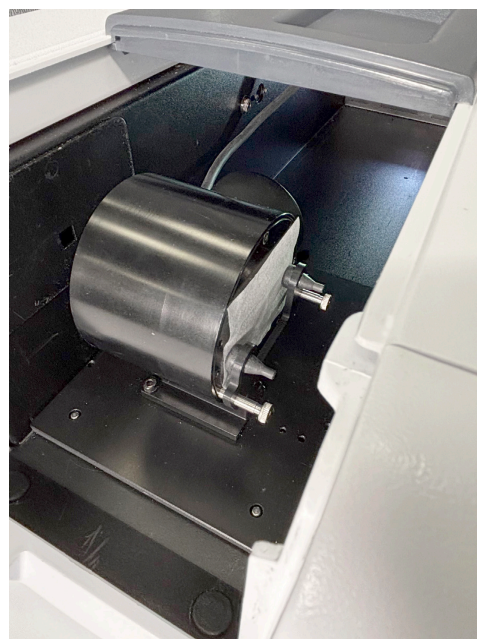


Schematic showing how reflectance measurements are performed using the Agilent Cary 60 UV-Vis DRA. The sample is mounted at the reflection port of the DRA, ensuring efficient collection of the diffusely reflected light (green). Although commonly referred to as a “diffuse reflectance accessory”, the DRA allows users to exclude or include the specular component of reflected light, providing the flexibility to choose between diffuse-only or total reflectance measurement modes.

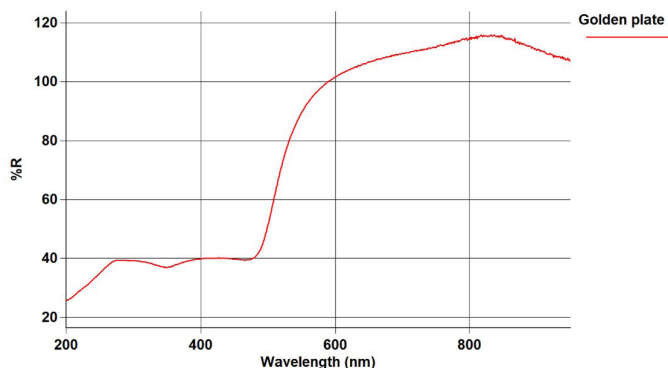
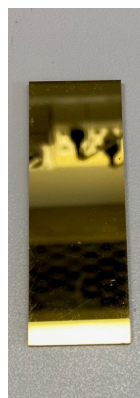


## Applications of total, diffuse, and specular reflection include:

- Solar materials characterization. Evaluating reflectance and absorption efficiency of solar panels and coatings, and measuring diffuse reflectance of photovoltaic materials.
- Color and appearance measurement using the [Agilent Cary WinUV Color software](#):
  - Analyzing color and gloss properties of textiles, paints, inks, and coatings and ensuring color consistency in pharmaceutical tablets, food products, and packaging.
  - Color matching in textiles, paint, and ink manufacturing, pharmaceuticals, and art conservation.
- Coatings and surface finish quality control. Measuring reflectance properties of protective and decorative coatings and evaluating surface roughness and texture in industrial materials.
- Optical and electronic materials. Evaluating diffuse reflectance of optical components and sensors and measuring light-scattering properties of display coatings.



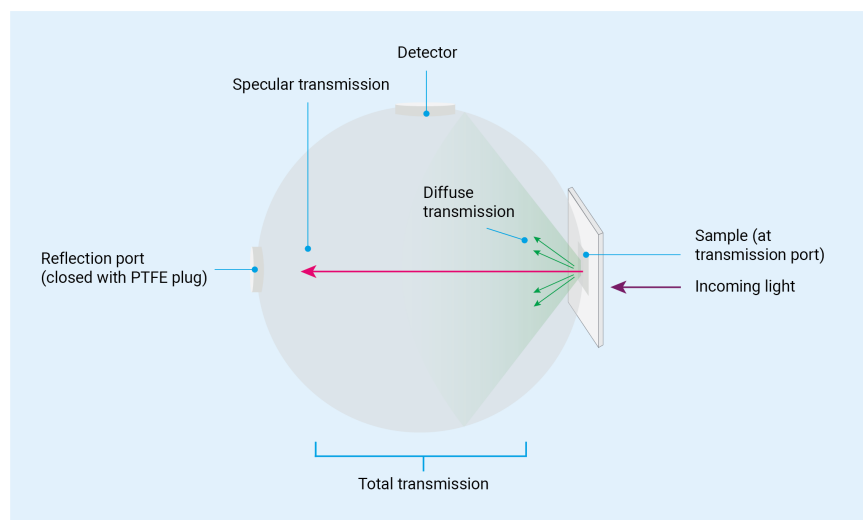
Diffuse reflection of colored PTFE diffuse color standards measured using the Agilent Cary 60 UV-Vis DRA. The standards support manufacturers in achieving consistent color reproduction of products such as textiles, papers, pharmaceuticals, paints, and inks.



Specular reflection of a gold-coated mirror measured using the Agilent Cary 60 UV-Vis DRA with the 8° port reduced holder.

# Transmission measurements

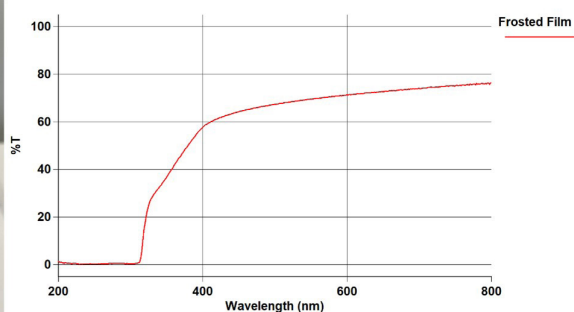
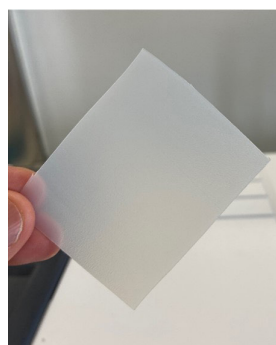
Integrating spheres are ideal for measuring the transmission of turbid, translucent, or almost opaque materials where many standard techniques prove inadequate due to loss of light and sample scattering effects. It is recommended therefore to use a DRA with an integrating sphere design to capture all the transmitted light, ensuring a more accurate analysis of the sample's transmission properties.



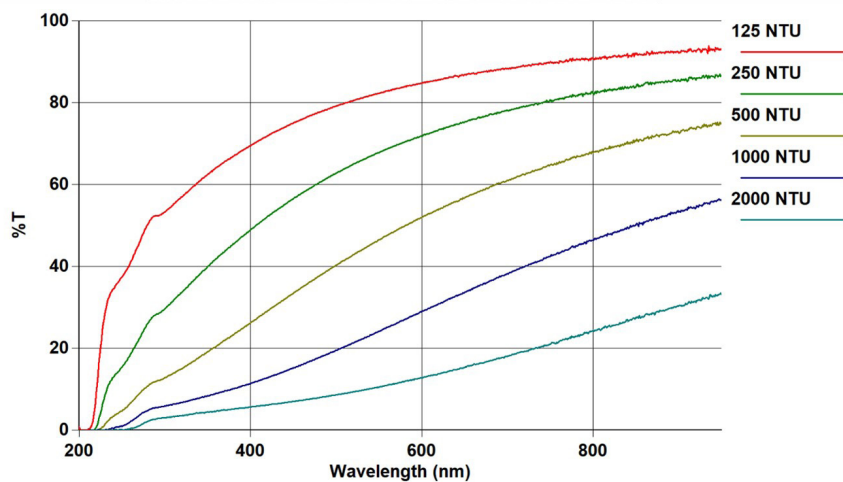
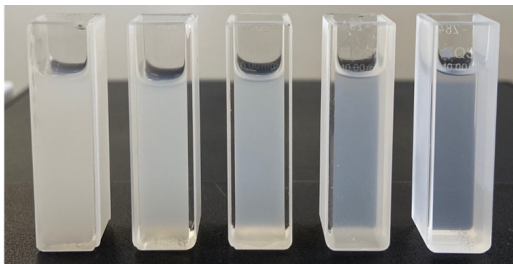
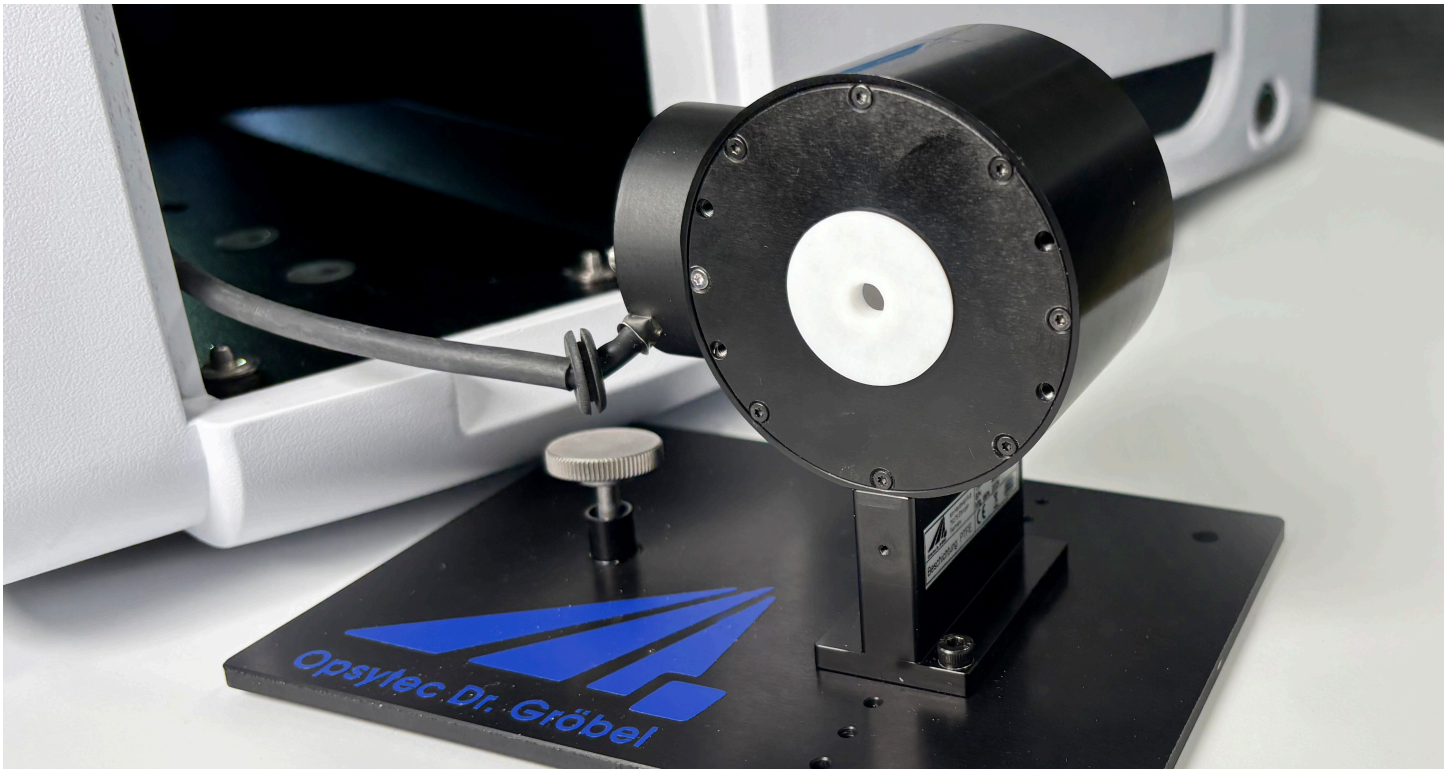
Schematic showing how diffuse/total transmission measurements are performed using the Agilent Cary 60 UV-Vis DRA. The sample is mounted at the transmission port and the reflection port is closed with the provided PTFE port cover. Solid samples can be mounted using an appropriate solid sample holder. Ensuring close and consistent contact between the sample and the wall of the DRA is essential to prevent the loss of diffusely transmitted light, particularly for thicker and strongly diffusing samples. Thin film samples can be conveniently mounted using the foil holder, while liquid samples can be measured using the 1 cm cuvette holder. It is also recommended to avoid using a port reducer for diffuse transmission measurements.

## Applications of diffuse and total transmission include:

- Optical and transparent materials characterization. Measuring light diffusion in frosted glass, plastics, and optical filters and evaluating antiglare and UV-blocking films.
- Food and beverage industry. Measuring haze and clarity in juices, beer, dairy products, and soft drinks and quality control of food packaging films for UV protection.
- Environmental and water quality monitoring. Turbidity measurement of water and monitoring suspended particles in wastewater and natural water bodies.
- Polymer and material science. Analyzing light-scattering properties of films, coatings, and composites and characterizing nanoparticles and colloidal dispersions.
- Textiles, paints, and coatings. Evaluating opacity and translucency of paints, coatings, and textile fibers.

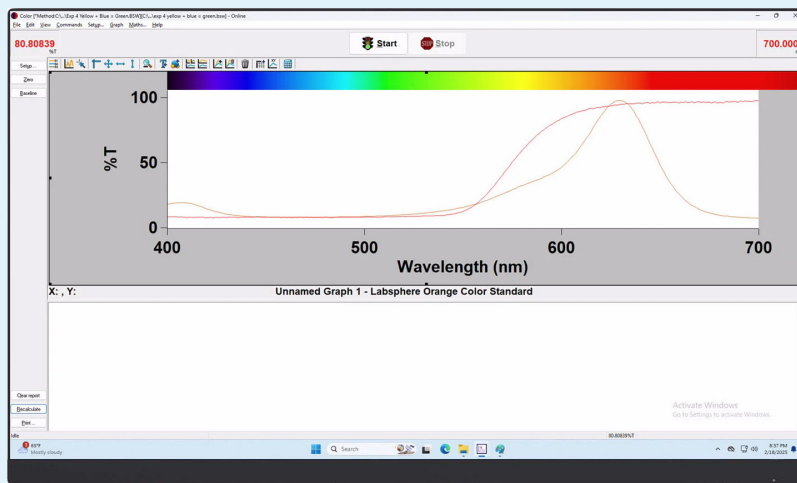


Diffuse transmission measurement of a frosted plastic packaging film designed to block UV light. The Agilent Cary 60 UV-Vis DRA ensures optimal light collection, capturing all scattered light for comprehensive characterization of the material.



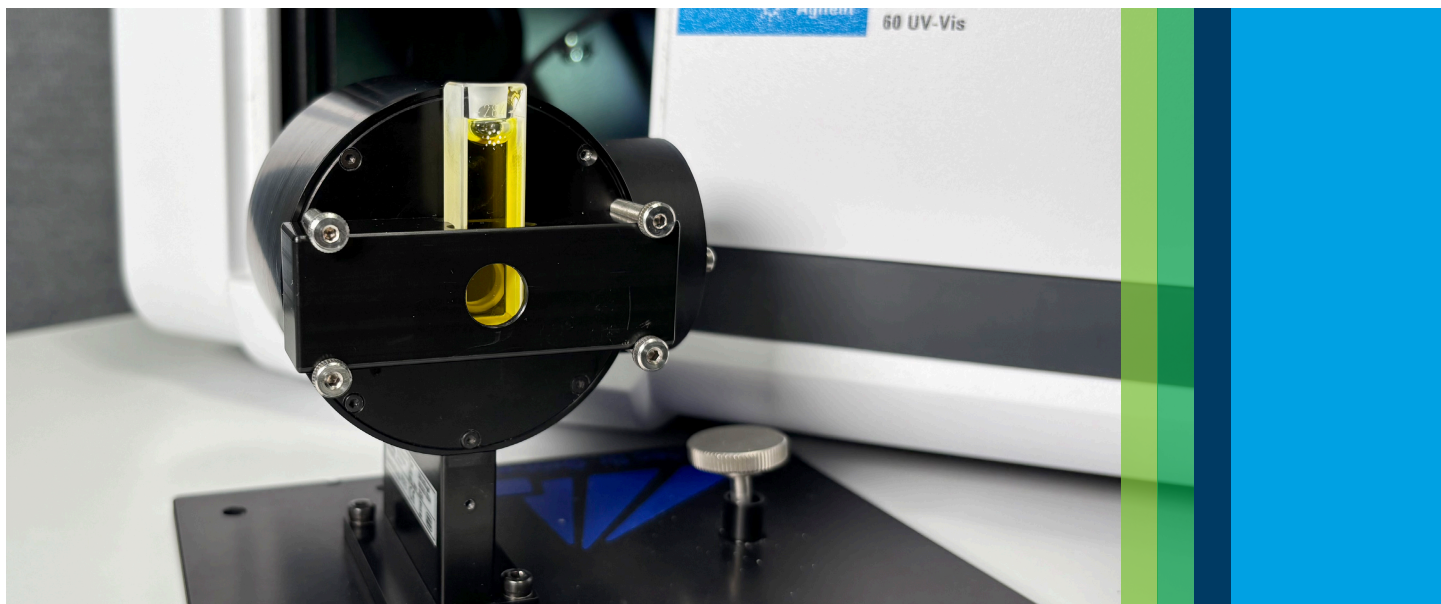
Diffuse transmission of formazin standards (125 to 2000 NTU (= Nephelometric Turbidity Unit)) measured using the Agilent Cary 60 UV-Vis DRA to assess light scattering behavior. Each measurement was performed using the standard 10 mm cuvette holder. Formazin is widely used to assess turbidity in water quality testing and to evaluate clarity of juices, beers, and dairy products, where haze formation can impact product quality.

# Cary WinUV Color software



The [Agilent Cary WinUV Color software](#) is an optional application designed for Agilent Cary UV-Vis and UV-Vis-NIR spectrophotometers, including the Cary 60 UV-Vis with the Cary 60 UV-Vis DRA. It features the same user-friendly and intuitive interface as the [Agilent Cary WinUV software](#), incorporating all major internationally recognized color calculations in a straightforward, configurable sequence. Reports are automatically generated using the chosen color coordinate system, such as chromaticity, tristimulus, and CIELAB values. This software efficiently produces routine QA/QC reports, transforming the Cary 60 UV-Vis into a versatile tool for color measurements in QA/QC and routine analyses.





## Best practices for using the Cary 60 UV-Vis DRA

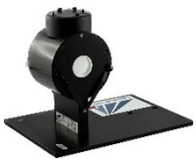


- **Maintaining a low port-to-sphere ratio:** When possible, use the 6 mm aperture to minimize light loss through the port (see Recommended setups). This helps maintain a low port-to-sphere ratio, reducing substitution errors—ensuring that the sample itself does not alter the sphere's reflectance outside the illuminated area.
- **Enhancing specular reflection measurement:** For mirror-like and smooth surfaces, use the 8° (6 mm aperture) setting to capture the specular reflection component. This setting helps prevent specularly reflected light from escaping through the transmission port, ensuring accurate data collection. For specular reflectance measurements a calibrated mirror should be used for the baseline measurement.
- **Measuring transparent smooth surfaces:** To prevent back reflections from the instrument, install a light trap at the detector opening when measuring specular reflection of transparent materials.
- **Ensuring accurate and consistent results:** To capture all scattered light effectively, always place the sample flush against the integrating sphere.
- **Maintaining sphere reflectivity:** The integrating sphere is coated with PTFE using a specialized process to ensure uniformity and optimal reflectance. To preserve its performance, avoid exposure to smoke or contaminants.
- **Keeping reference materials in optimal condition:** Regularly clean and inspect reflection reference materials to ensure they remain scratch-free and free of dust or debris.

## Recommended setups

Measurement Mode	Type of Sample	Transmission Port	Reflection Port	Baseline Mode	100% Baseline	0% Baseline
Transmission						
Total Transmission	Diffuse, glossy	0° port reducer	PTFE standard	100%	No sample at transmission port	n/a
Specular Transmission	Specular	0° or 8° port reducer	PTFE standard	100%	No sample at transmission port	n/a
Reflection						
Total Reflection	Diffuse, glossy	0° port reducer	8° port reducer	0/100%	PTFE standard at reflection port	Reflection port open (detector window blocked)
Diffuse Reflection	Diffuse, glossy	8° port reducer	0° port reducer	0/100%	PTFE standard at reflection port	Reflection port open (detector window blocked)
Specular Reflection	Specular	0° port reducer	8° port reducer	0/100%	Mirror at reflection port	Reflection port open (base instrument detector window blocked)

## Range of DRAs for flexibility and enhanced performance

Agilent offers a versatile range of diffuse reflection accessories for the Cary spectrophotometer series, designed to meet diverse application requirements.

	Cary 60 UV-Vis DRA	UV-Vis-NIR Internal DRA	UV-Vis-NIR External DRA
			
Type	Internal	Internal	External
Sphere size	50 mm	110 mm	150 mm
Compatible with	Cary 60 UV-Vis	Cary 4000 UV-Vis Cary 5000 UV-Vis-NIR Cary 6000i UV-Vis-NIR	Cary 4000 UV-Vis Cary 5000 UV-Vis-NIR Cary 6000i UV-Vis-NIR Cary 7000 UMS
Measurement types	Diffuse/total reflection Diffuse/total transmission	Diffuse/total reflection Diffuse/total transmission	Diffuse/total reflection Diffuse/total transmission

## Further information

- Cary 60 UV-Vis Spectrophotometer
- Cary WinUV Software for UV-Vis Applications
- Cary WinUV Color Software
- UV-Vis Spectroscopy & Spectrophotometer FAQ
- UV-Vis Spectrophotometer Uses & Applications

## Learn more

[www.agilent.com/chem/cary60](http://www.agilent.com/chem/cary60)

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