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THORLABS

IS200-4 - September 22, 2021

Item # IS200-4 was discontinued on September 22, 2021. For informational purposes, this is a copy of the website content at that time and is valid only for the stated product.

Ø2" INTEGRATING SPHERES

- Made of Durable, Highly Reflective Bulk Material
- Available With and Without Photodiode
- 3 and 4 Port Versions with Adapters for Fiber and Photodiode

IS200 Series

FC & SMA Fiber Adapters, Port Plugs & SM05PD Adapter Included

Directly Compatible with SM05 Lens Tubes and 30 mm Cage Systems

OVERVIEW

Features

- Ø2" Integrating Sphere in Black Anodized Aluminum Housing
- Operating Range: 250 - 2500 nm (Unless Limited by the Detector)
- Equipped with 3 or 4 Ø1/2" Ports for Easy Coupling of Light (Depending on Model)
- Recessed Ø3 mm Detector Port Allows Direct Connection of Any of Our SM05PD Photodiodes
- Directly Compatible with SM05 (0.535"-40) Lens Tubes and Our 30 mm Cage Systems
- Durable White High Reflectance Sphere Material
- Metric and Imperial Threads for Post Mounting
- Included Accessories
  - Reflective-Coated Port Plugs (One per Port) SM05CP2C
  - FC Fiber Adapter
  - SMA Fiber Adapter
  - SM05 Adapter (SM05L05) for Mounting SM05PD Series Photodiodes

Compatible Mounted Photodiodes		
Sensor Type	**Wavelength Range**	**Photodiodes**
GaP	150 - 550 nm	SM05PD7A
Si	200 - 1100 nm	SM05PD2A SM05PD2B
Si	350 - 1100 nm	SM05PD1A SM05PD1B
InGaAs	800 - 1700 nm	SM05PD5A
	900 - 1700 nm	SM05PD4A
Ge	800 - 1800 nm	SM05PD6A

Functionality

The IS200 Integrating Sphere is a general purpose integrating sphere enabling high sensitivity measurements of optical signals. An integrating sphere evenly spreads the incoming light by multiple reflections over the entire sphere surface. This makes it the ideal instrument for many applications such as laser power, flux, reflectance and radiance measurements. The input and output ports can be equipped with fiber adapters or closed with the coated port plugs (included); the detector port is recessed to avoid direct light exposure from the incidental light to the active area of the photodiode. The sphere is manufactured from PTFE based bulk material that has high reflectance in the 250 - 2500 nm wavelength range (see *Specs* tab for details) and is resistant to heat, humidity, and high levels of radiation. This reflective surface provides a specific roughness and diffusive reflection properties and should not be cleaned using solvents, as this could damage the inner surface. We only recommend using compressed air for cleaning the inner surface of the integrating spheres. The sphere is compatible with

Thorlabs' SM05 (0.535"-40) thread standard as well as our 30 mm cage systems, thereby enabling easy integration into existing setups.

Our IS200 Integrating Spheres are available with either a mounted Si photodiode (350 - 1100 nm), mounted InGaAs photodiode (900 - 1700 nm) or without a detector. When purchasing an Integrating Sphere without a built-in detector, the sphere's operating range is limited by the reflectance wavelength range of 250 - 2500 nm (see the *Specs* tab). When purchasing the sphere with no detector, any of our SM05PD series photodiodes can be mounted to the Ø3 mm detector port using the SM05 threading of the included SM05 Adapter (SM05L05).

Replacement items for the included adapters and port caps can be ordered separately below.

Choose from 5 Models:

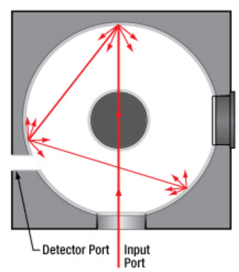
- IS200 & IS200-4**:** Ø2" Integrating Sphere with 3 or 4 Ports and without a Detector
- IS236A & IS236A-4**:** Ø2" Integrating Sphere with SM05PD1B Si Detector (350 to 1100 nm) and 3 or 4 Ports
- IS210C: Ø2" Integrating Sphere with Anode-Grounded Version of the SM05PD4A InGaAs Detector (900 to 1700 nm) and 3 Ports

For our integrating spheres we offer a calibration service upon request. Please contact your nearest sales office for more information.

Top Views

Click to Enlarge
Integrating Sphere with Photodiode and 3 Ports
(IS236A & IS210C)

Click to Enlarge
Integrating Sphere with Photodiode and 4 Ports
(IS236A-4)

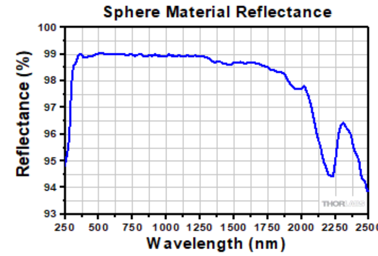


Click to Enlarge
Integrating Sphere Design
(Side View)

SPECS

Item #	IS200	IS200-4	IS236A	IS236A-4	IS210C
Detector Type	No Detector		Si		InGaAs
Detector	-		SM05PD1B		Anode-Grounded SM05PD4A
Detector Wavelength	-		350 - 1100 nm		900 - 1700 nm
Sphere Reflectance	~99% @ 350 to 1500 nm; >95% @ 250 to 2500 nm				
Sphere Diameter	2"				
Port Diameter	0.5"				
Ports	3 at 0°, 90°, and Top	4 at 0°, 90°, 180°, and Top	3 at 0°, 90°, and Top	4 at 0°, 90°, 180°, and Top	3 at 0°, 90°, and Top
Photodiode Port	Ø3 mm for SM05PD				
Thermal Stability	Up to 250°C				
Laser Damage	2 kW/cm^2, 7 J/cm^2				

Threshold	
Dimensions	61 mm x 61 mm x 65 mm (2.4" x 2.4" x 2.56")
Weight	0.35 kg (0.77 lb)



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Integrating Sphere Material Reflectance

INSIGHTS

Insights into Best Lab Practices

Scroll down to read about things to consider when building integrating spheres into setups and analyzing data results.

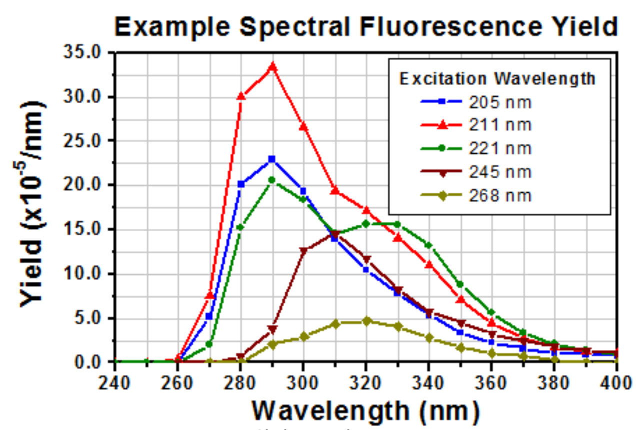
- Ultraviolet and Blue Fluorescence Emitted by Integrating Spheres
- Sample Substitution Errors

Click here for more insights into lab practices and equipment.

Ultraviolet and Blue Fluorescence Emitted by Integrating Spheres

A material of choice for coating the light-diffusing cavities of integrating spheres is polytetrafluoroethylene (PTFE). This material, which is white in appearance, is favored for reasons including its high, flat reflectance over a wide range of wavelengths (see the Specs tab for details) and chemical inertness.

However, it should be noted that integrating spheres coated with both PTFE and barium sulfate, which is an alternative coating with lower reflectance, emit low levels of ultraviolet (UV) and blue fluorescence when irradiated by UV light. [1-3]



Click to Enlarge
Figure 1: Typical yields at each wavelength are around four orders of magnitude lower than the excitation wavelength. [4]

The spectral fluorescence yield relates the intensity of the fluorescence emitted within the integrating sphere with the intensity of the excitation wavelength. The yield is calculated by dividing the wavelength-dependent, total fluorescence excited over the entire interior surface of the sphere by the intensity of the light excitation.

Data were kindly provided by Dr. Ping-Shine Shaw, Physics Laboratory, National Institute of Standards and Technology, Gaithersburg, MD 20899, USA.

Hydrocarbons in the PTFE Fluoresce

It is not the PTFE that fluoresces. The sources of the UV and blue fluorescence are hydrocarbons in the PTFE. Low levels of hydrocarbon impurities are present in the raw coating material, and pollution sources deposit additional hydrocarbon contaminants in the PTFE material of the integrating sphere during its use and storage. [1]

Fluorescence Wavelength Bands and Strength

Researchers at the National Institute of Standards and Technology (NIST) have investigated the fluorescence excited by illuminating PTFE-coated integrating spheres. The total fluorescence output by the integrating sphere was measured with respect to fluorescence wavelength and excitation wavelength. The maximum fluorescence was approximately four orders of magnitude lower than the intensity of the exciting radiation.

The UV and blue fluorescence from PTFE is primarily excited by incident wavelengths in a 200 nm to 300 nm absorption band. The fluorescence is emitted in the 250 nm to 400 nm wavelength range, as shown by Figure 1. These data indicate that increasing the excitation wavelength decreases the fluorescence emitted at lower wavelengths and changes the shape of the fluorescence spectrum.

As the levels of hydrocarbon contaminants in the PFTE increase, fluorescence increases. A related effect is a decrease of the light output by the integrating sphere over the absorption band wavelengths, due to more light from this spectral region being absorbed. [1, 3]

Impact on Applications

The UV and blue fluorescence from the PTFE has negligible effect on many applications, since the intensity of the fluorescence is low and primarily excited by incident wavelengths <300 nm. Applications sensitive to this fluorescence include long-term measurements of UV radiation throughput, UV source calibration, establishing UV reflectance standards, and performing some UV remote sensing tasks. [1]

Minimizing Fluorescence Effects

Minimizing and stabilizing the fluorescence levels requires isolating the integrating sphere from all sources of hydrocarbons, including gasoline- and diesel-burning engine exhaust and organic solvents, such as naphthalene and toluene. It should be noted that, while hydrocarbon contamination can be minimized and reduced, it cannot be eliminated. [1]

Since the history of each integrating sphere's exposure to hydrocarbon contaminants is unique, it is not possible to predict the response of a particular sphere to incident radiation. When an application is negatively impacted by the fluorescence, calibration of the integrating sphere is recommended. A calibration procedure described in [4] requires a light source with a well-known spectrum that extends across the wavelength region of interest, such as a deuterium lamp or synchrotron radiation, a monochromator, a detector, and the integrating sphere.

References

[1] Ping-Shine Shaw, Zhigang Li, Uwe Arp, and Keith R. Lykke, "Ultraviolet characterization of integrating spheres," *Appl.Opt.* **46**, 5119-5128 (2007).

[2] Jan Valenta, "Photoluminescence of the integrating sphere walls, its influence on the absolute quantum yield measurements and correction methods," *AIP Advances* **8**, 102123 (2018).

[3] Robert D. Saunders and William R. Ott, "Spectral irradiance measurements: effect of UV-produced fluorescence in integrating spheres," *Appl. Opt.* **15**, 827-828 (1976).

[4] Ping-Shine Shaw, Uwe Arp, and Keith R. Lykke, "Measurement of the ultraviolet-induced fluorescence yield from integrating spheres," *Metrologia* **46**, S191 - S196 (2009).

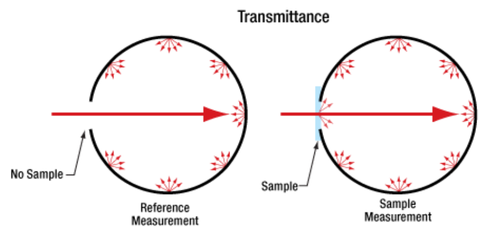
Sample Substitution Errors

Absolute transmittance and absolute diffuse reflectance spectra of optical samples can be found using integrating spheres. These spectra are found by performing spectral measurements of both the sample of interest and a reference.

Measurement of a reference is needed since this provides the spectrum of the illuminating light source. Obtaining the reference scan allows the spectrum of the light source to be subtracted from the sample measurement.

The light source reference measurement is made with no sample in place for transmittance data and with a highly reflective white standard reference sample in place for reflectance measurements.

Sample substitution errors incurred while acquiring the sample and reference measurement sets can negatively effect the accuracy of the corrected sample spectrum, unless the chosen experimental technique is immune to these errors.



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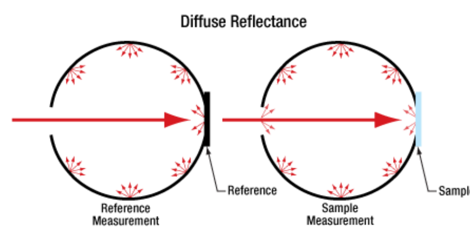

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Figure 2: Measuring diffuse sample transmittance and reflectance as shown above can result in a distorted sample spectrum due to sample substitution error. The problem is that the reflectivity over the sample area is different during the reference and sample measurements.

Conditions Leading to Sample Substitution Errors

An integrating sphere's optical performance depends on the reflectance at each point on its entire inner surface. Often, a section of the sphere's inner wall is replaced by the sample when its transmittance and diffuse reflectance spectra are measured (Figure 2). However, modifying a section of the inner wall alters the performance of the integrating sphere.

Sample substitution errors are a concern when the measurement procedure involves physically changing one sample installed within the sphere for another. For example, when measuring diffuse reflectance (Figure 2, bottom), a first measurement might be made with the standard reference sample mounted inside the sphere. Next, this sample would be removed and replaced by the sample of interest, and a second measurement would be acquired. Both data sets would then be used to calculate the corrected absolute diffuse reflectance spectrum of the sample.

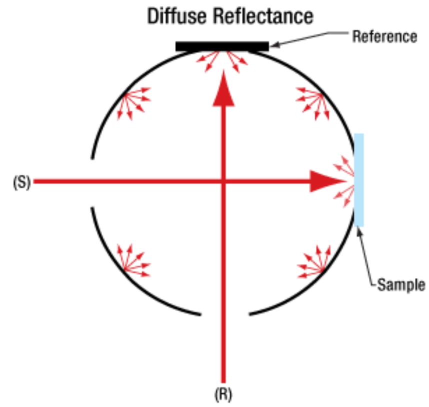

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Figure 3: The above configuration is not susceptible to sample substitution error, since the interior of the sphere is the same for reference and sample measurements. During the reference measurement the light travels along (R), and no light is incident along (S). The opposite is true when a sample measurement is made.

This procedure would result in a distorted absolute sample spectrum. Since the sample of interest and the standard reference have different absorption and scattering properties, exchanging them alters the reflectivity of the integrating sphere over the samples' surface areas. Due to the average reflectivity of the integrating sphere being different for the two measurements, they are not perfectly compatible.

Solution Option: Install Sample and Reference Together
One experimental technique that avoids sample substitution errors acquires measurement data when both sample and reference are installed inside the integrating sphere at the same time. This approach requires an integrating sphere large enough to accomodate the two, as additional ports.

The light source is located external to the integrating sphere, and measurements of the sample and standard reference are acquired sequentially. The specular reflection from the sample, or the transmitted beam, is often routed out of the sphere, so that only the diffuse light is detected. Since the inner surface of the sphere is identical for both measurements, sample substitution errors are not a concern.

Alternate Solution Option: Make Measurements from Sample and Reference Ports
If it is not possible to install both sample and standard references in the integrating sphere at the same time, it is necessary to exchange the installed sample. If this must be done, sample substitution errors can be removed by following the procedure detailed in [1].

This procedure requires a total of four measurements. When the standard sample is installed, measurements are made from two different ports. One has a field of view that includes the sample and the other does not. The sample of interest is then subsituted in and the measurements are repeated. Performing the calculations described in [1] using these measurements removes the sample substitution errors.

References
[1] Luka Vidovic and Boris Majaron, "Elimination of single-beam substitution error in diffuse reflectance measurements using an integrating sphere," *J. Biomed.Opt.* **19**, 027006 (2014).

Integrating Spheres

Shipping List for Ø2" Integrating Sphere Kits			
Item #	**Included Integrating Sphere**	**Included Photodiode (Item #)**	**Included Port Accessories (Item #; Also Available Below)**
IS200	3-Port Sphere	None	FC/PC Fiber Adapter (SM05FC) SMA Fiber Adapter (SM05SMA) Ø1/2" Lens Tube for Mounting SM05PD Series Photodiodes (SM05L05) Reflective End Cap, One per Port (SM05CP2C)
IS200-4	4-Port Sphere	None	
IS236A	3-Port Sphere	Si Detector, 350 - 1100 nm (SM05PD1B)	
IS236A-4	4-Port Sphere	Si Detector, 350 - 1100 nm (SM05PD1B)	
IS210C	3-Port Sphere	InGaAs Detector, 900 - 1700 nm (Anode-Grounded SM05PD4A)	

Part Number	Description	Price	Availability
IS200	**Ø2" Integrating Sphere, No Sensor, 3 Ports**	**$1,101.60**	**Today**

IS200-4	Ø2" Integrating Sphere, No Sensor, 4 Ports	$1,128.65	Lead Time
IS236A	Ø2" Integrating Sphere, Si Sensor, 3 Ports	$1,151.38	Today
IS236A-4	Ø2" Integrating Sphere, Si Sensor, 4 Ports	$1,173.02	Lead Time
IS210C	Ø2" Integrating Sphere, InGaAs Sensor, 3 Ports	$1,327.76	5-8 Days

Integrating Sphere Accessories

These items are included with the integrating spheres above (depending on the ordered module). Refer to the table above for details. They are also available here as replacement items or if you need additional ones.

The SM05FC and SM05SMA are adapters to connect FC- or SMA-terminated fiber patch cables to a port, respectively; the SM05L05 allows any of our SM05PD photodiodes to be mounted to a port; the SM05CP2C is a reflective cap to close unused ports.

Part Number	Description	Price	Availability
SM05FC	FC/PC Fiber Adapter Plate with External SM05 (0.535"-40) Threads, Wide Key (2.2 mm)	$26.52	Today
SM05SMA	SMA Fiber Adapter Plate with External SM05 (0.535"-40) Threads	$30.30	Today
SM05L05	SM05 Lens Tube, 0.50" Thread Depth, One Retaining Ring Included	$14.52	5-8 Days
SM05CP2C	Customer Inspired! End Cap Coated with 1 mm Thick Reflective Sphere Material	$30.30	Today