

# THE CARE AND FEEDING OF INTEGRATING SPHERES

## GENERAL INFORMATION

Integrating spheres are enclosures which have highly diffuse reflecting interior surfaces. When external light enters an "I-sphere", it bounces around the reflective surfaces (at the speed of light) and is received by a detector or other receptive device such as a fiber optic. The name "integrating sphere" implies that entering light is integrated. That is, as the light flux is reflected here and there, that light becomes spatially integrated (becomes more uniform).

## ADVANTAGES

This I-sphere produced uniformity provides a number advantages in measuring light:

- ▶▶ Uniform detection even when the sample is heterogeneous
- ▶▶ Effective measurements of combined diffuse and specular reflectances
- ▶▶ A significant reduction of inaccuracies caused by any polarizing effects
- ▶▶ Absolute measurements (when the receiving I-sphere is calibrated).

## TYPES OF INTEGRATING SPHERES

Integrating spheres are being increasingly used to make optical measurements. The sizes range from the 17 mm diameter Ancal mini-sphere to spheres into which an optical engineer can walk. The criteria is whether the sphere is appropriate to do the measuring job.

Typically, a simple I-sphere can do a good job of measuring luminous flux and radiant power. A simple I-sphere is a good, spectrally neutral signal attenuator and receptor. An advanced sphere may have several ports for various functions. An I-sphere that has an internal light source for sample illumination can provide precise reflectance measurements simply by being placed upon a sample. The Ocean Optics ISP-REF Illuminated I-sphere (available at a price of \$1,679) is an excellent all around I-sphere with an internal sphere of 38 mm diameter.

There are various I-spheres available. Contact Ancal with your requirements for our suggestions on both standard I-spheres and custom I-spheres.

## THE INNER SURFACE

As can be noted, the main part of any I-sphere is its highly diffuse reflecting inner surface. The inner surface needs to be a Lambertian reflecting surface which will "scatter" light in various directions. Specifically, that means that light falling on the surface is diffusely reflected and that the intensity of reflection is proportional to the cosine of the angle of reception.

It follows that inner surfaces of I-spheres must be kept highly reflective. For commercially available I-spheres this means keeping foreign materials, dust, etc., from entering the sphere. This should not be a major chore as I-spheres can be easily closed. However, sometimes cleaning the surface of a sphere is warranted.

A sphere whose surface reflectivity is low because of dirt may be cleaned using a wash of pure detergent in distilled water followed by an alcohol rinse. **CAUTION:** Be sure that the surface is not water soluble.

Should a sphere's inner surface be damaged, it is possible to re-coat the surface. Both Avian-B coating and Avian-D coating are very good for coating inside sphere surfaces. For general use in the visible, the less expensive Avian B is recommended (B0500 coating at \$225 for coating to cover a 6 inch diameter sphere); for a coating which provides better reflectance in the far UV and in the near IR, Avian-D may be preferred.

For instructions regarding the coating procedure and for details on Avian-D, please contact Ancal.

