

## Effect of Input Port Adapters on the Calibration of Integrating Spheres

An integrating sphere is an instrument which collects light through its input port and through multiple diffuse reflections produces a homogeneous optical power density over its inner surface. Integrating spheres are designed to have a high reflectivity in order to ensure a large number of internal reflections to ensure good homogeneity. Still, there is power loss due to leakage out of the input and exit ports as well as absorption at each internal reflection.

At equilibrium, the power loss will equal the power input. Since the inner surface of the sphere is designed to have low absorption loss (high reflectivity), the power density on the inner surface of the sphere will be higher than the input power density.

This ratio is the so-called sphere multiplier “K”.

Theoretically, this factor is given by  $K = \rho / [1 - \rho(1 - a)]$ ,

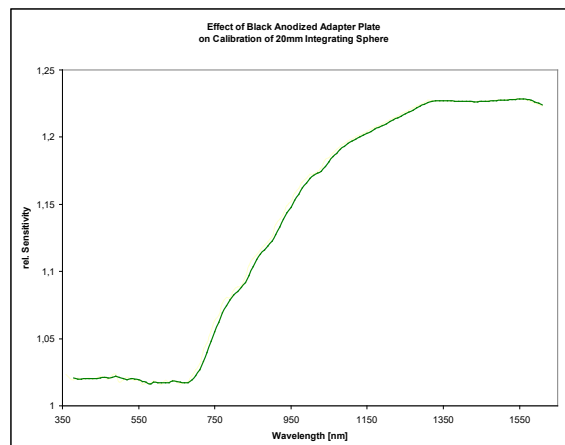
where “ $\rho$ ” is the reflectivity of the sphere inner surface and “ $a$ ” is the ratio of the total area of the input and exit ports to the total area of the sphere inner surface. Since “ $\rho$ ” has a value close to 1, the ratio “ $a$ ” has a sensitive impact on the K-value.

Consider placing a black anodized plate onto the input port of a 100mm integrating sphere with a 25mm input port. The ratio “ $a$ ” including exit ports is about 1.6% leading to a K-value of approximately 27. The black plate may reflect up to 30% in the NIR [Marschall, et al; SPIE 2014].

Placing such a plate over the input port is effectively the same as reducing the port area to 70% of the original value: 21mm which gives a K-value of approximately 31.

This means the integrating sphere will miscalibrated by about 15% when the plate is mounted. This effect is demonstrated in the following diagramme showing a measurement of a 20mm integrating sphere with a simple plate adapter mounted.

Note that in the visible range, the effect is small. The essentially metallic reflection is most noticeable in the NIR.



Artifex Engineering has addressed this issue by designing fibre port adapters which reflect so little light back into the integrating sphere that the miscalibration is less than 1% when the adapter plate is mounted. This is depicted in the following graph. Note the scale change when comparing the two graphs.

