






WORKSHOP/TRAINING SESSION FOR STAKEHOLDERS AND END-USERS FROM INDUSTRY - 26TH NOVEMBER 2018

INDUSTRIALLY USED MEASUREMENT TECHNIQUES – INFLUENCE OF MULTIPLE-REFLECTIONS WHEN USING INTEGRATING SPHERES OR TIR100-2

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Date : 26 November 2018

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Multiple reflections with TIR100-2

The coating of the hemisphere is not specular → multiple reflexions are generated between the sample surface and the hemisphere.

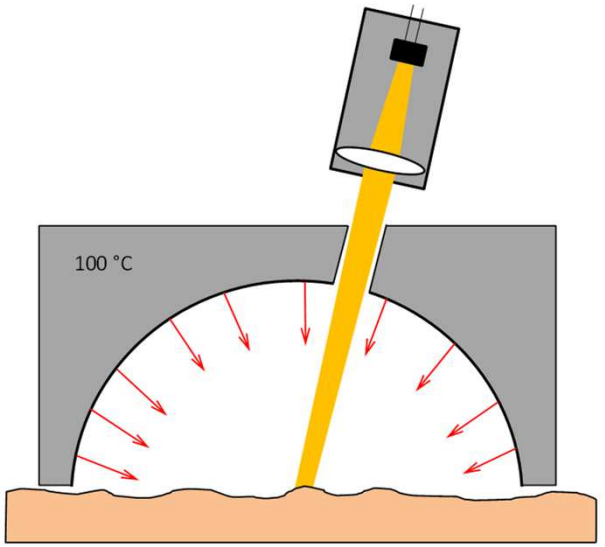
The hemisphere and the sample surface constitute a “closed” cavity.

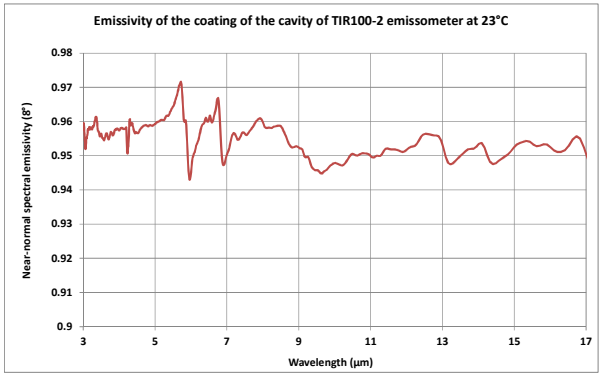
The “average reflectance” of the cavity walls depends on the reflectance of the sample surface.

The instrument is calibrated only for 2 levels of reflectance (a high level and a low level).

When a sample with a reflectance different from the reflectance of one of the reference sample used for calibration is in place, the “multiple reflections” error is not corrected by the calibration at only 2 levels of reflectance.

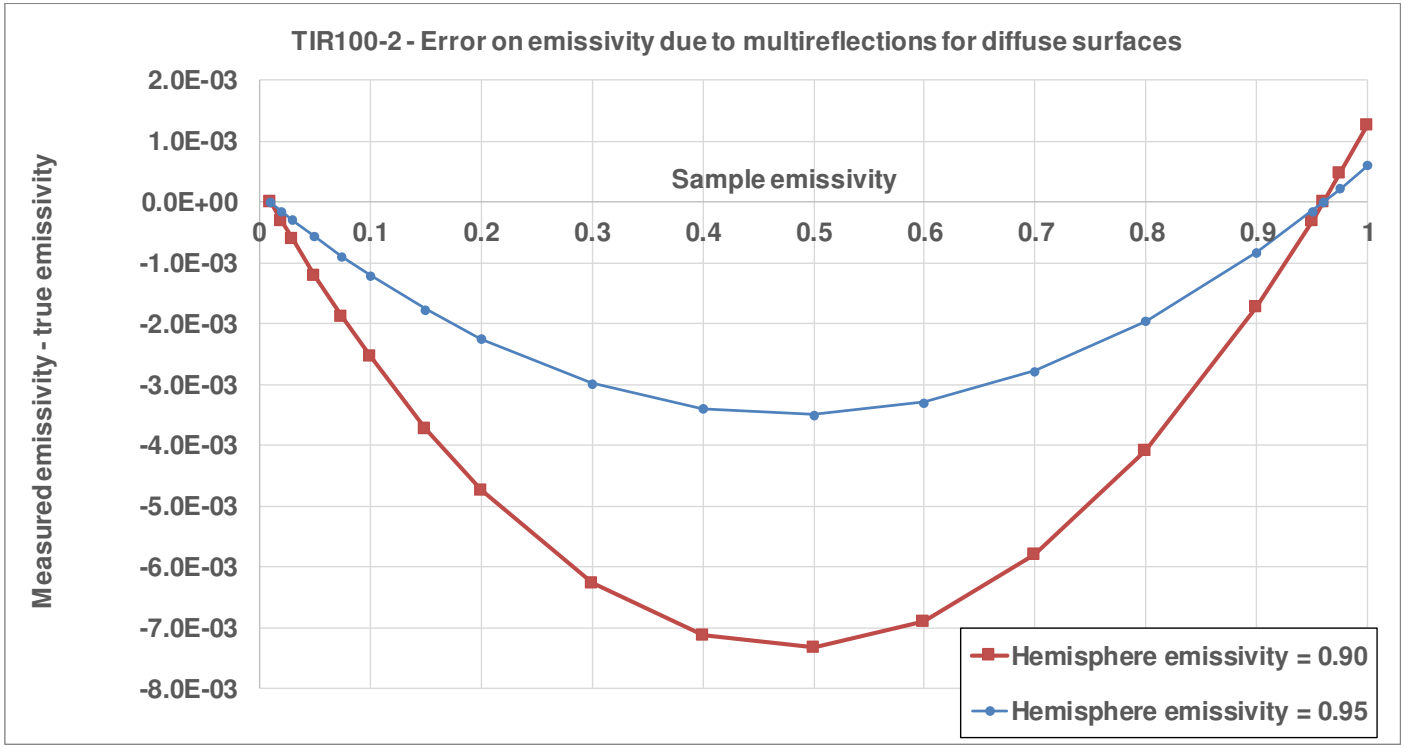
Multiple reflections have been modelled assuming that the surfaces (hemisphere and sample) are Lambertian (perfectly diffuse at emission and reflection).





Multiple reflections with TIR100-2

Modelling of multiple reflections was performed using the radiosity method.



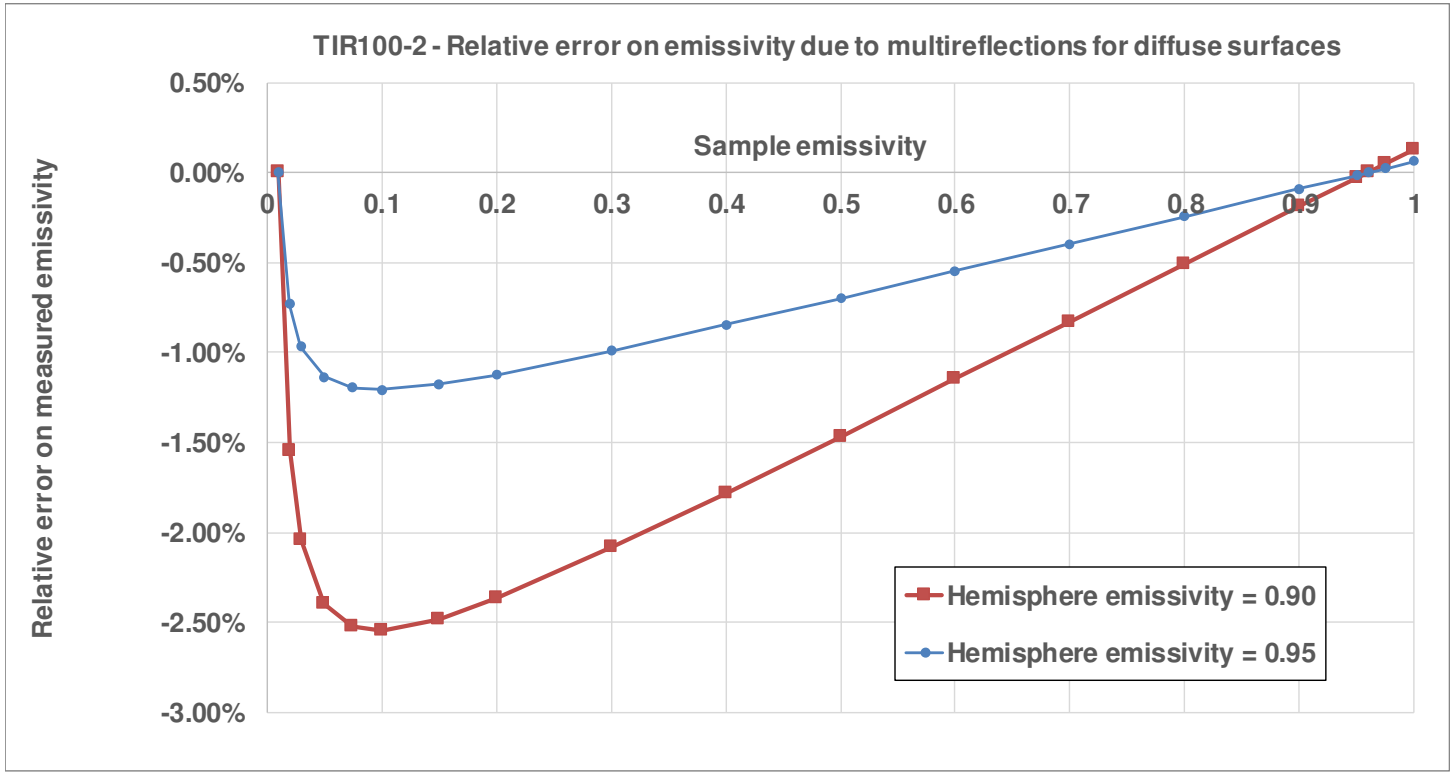
The error is maximum at mid-distance from the calibration points.

The maximum error is less than 0.01 (still to be validated).

An intermediate level of emissivity for calibration is may be not necessary.

Multiple reflections with TIR100-2

Modelling of multiple reflections was performed using the radiosity method.



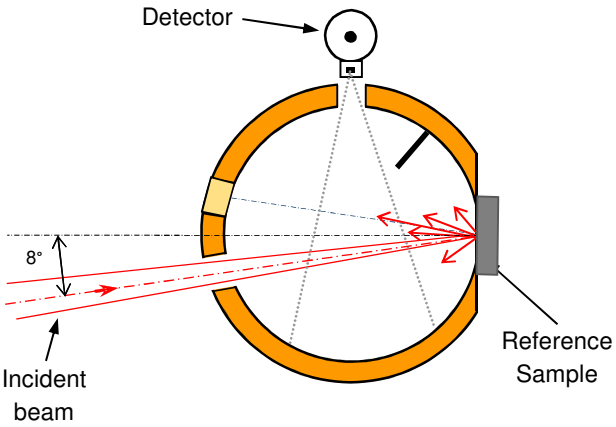
The relative error is maximum for low emissivities.

Multiple reflections with integrating spheres

Usually infrared integrating spheres are used in “single beam” configuration.

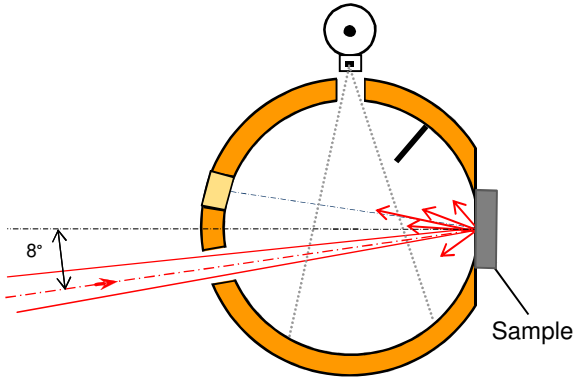
Multiple reflexions are generated between the sample surface and the integrating sphere. The “average reflectance” of the cavity walls depends on the reflectance of the sample surface.

The radiance of the sphere wall and thus the signal measured by the detector are affected by multiple reflections.



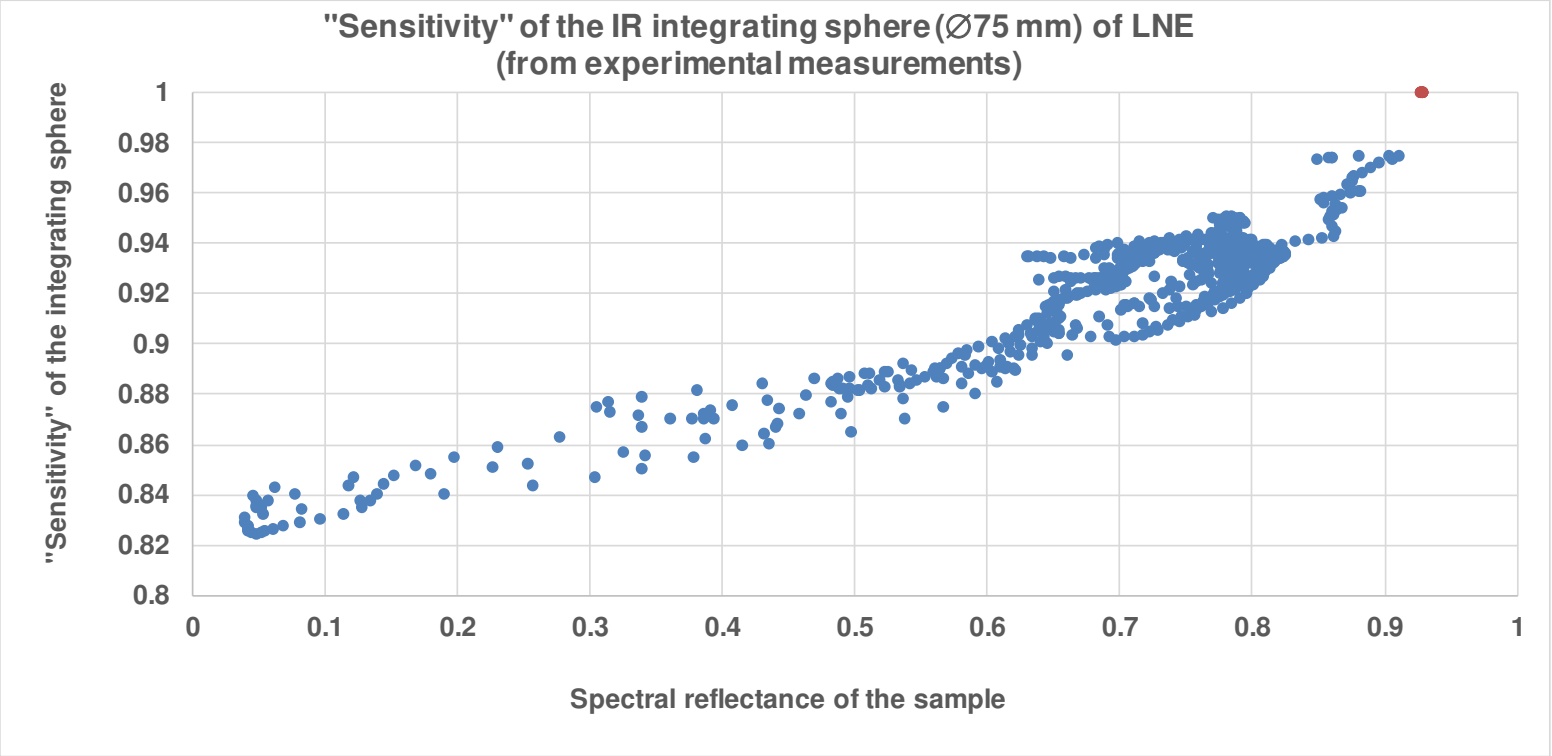
Usually, the instrument is calibrated implicitly for 2 levels of reflectance (a high level and the “zero level”).

When a sample with a reflectance different from the reflectance of the reference sample is in place, the “multiple reflections” error is not corrected by the calibration at only 2 levels of reflectance.



Multiple reflections with integrating spheres

Example of variations of sensitivity of an integrating sphere from LNE.

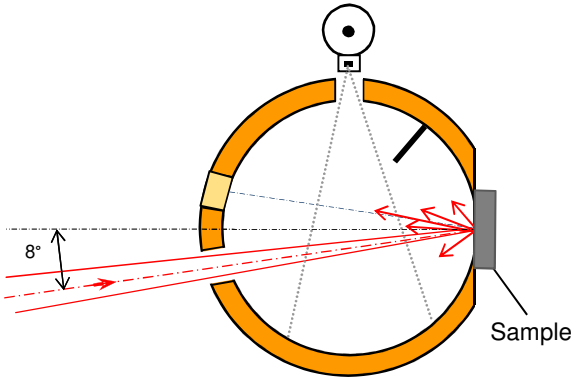


The variation of the sensitivity of an integrating in function of the sample reflectance sphere is significant and must be corrected.

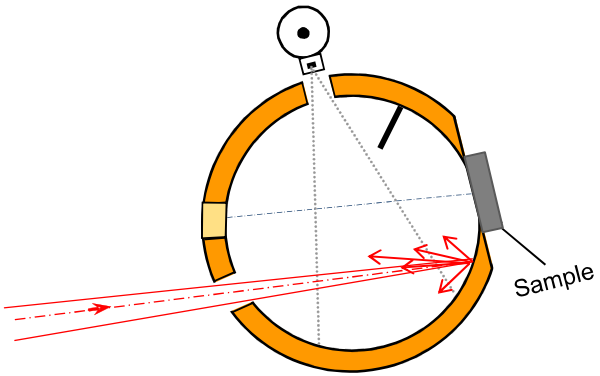
Multiple reflections with integrating spheres

Correction of variations of sensitivity of an integrating sphere.

Usually integrating spheres associated to UV-Vis-PIR sprectrometers function in “double beam” configuration. The principle consist to perform signal measurements with the incident beam impacting a fixed part of the integrating sphere. The ratios of those signals obtained with the sample in test and with the reference sample allows the correction of sensitivity and of intensity of the light source. This procedure is applied at LNE by rotating the integrating sphere.



Configuration “measurement of the sample signal”



Configuration “measurement of the substitution signal

$$\rho_{sample} = \frac{U_{sample} \Big/ U_{substitution\ sample}}{U_{reference\ sample} \Big/ U_{substitution\ reference\ sample}} \cdot \rho_{reference\ sample}$$

Conclusions :

Integrating sphere :

- **The substitution error can be significant and must be corrected.**

Questions ?