Quality control for optical control of solar absorber surfaces

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Abstract

One of the most important features of solar absorbers is the optical properties of the surface acting as the interface to the solar irradiation and the ambient environment. A lot of effort was spent in the last decades for developing coatings with optimized solar absorptance and thermal emittance and reasonable durability for a collector lifetime of more than 25 years. The quality of the coating is very important for the efficiency of the collector. Therefore a high level of quality has to be guaranteed during production and quality control is needed during or after production of the absorber coatings and before manufacturing the collectors.

We developed reliable and relatively simple devices for the assessment of the solar absorptance and the thermal emittance in-situ during production of the coatings and for quality control after production. Different designs for the emittance measurements take into account the different requirements of the working temperature of the absorbers. Integrating spheres made of PTFE are used for absorptance measurements and gold-coated spheres for the emittance measurements. A special device serves for the control of the emittance of absorber tubes. The results for different selective coatings obtained with the different devices are compared to results from spectroscopic reflectance measurements carried out at Fraunhofer ISE.

The main aim of these devices is to provide tools for keeping a high standard of quality of the increasing market of solar absorbers.

1 Alphameter

We describe an easy-to-handle device for the measurement of the solar reflectance of surfaces. The solar absorptance is automatically calculated as the complimentary part, which is always the case for opaque samples.

You will get first spectral information because our instrument is using different pairs of LEDs and detectors, which are mounted at the highly reflecting (made of bulk PTFE) wall of an integrating sphere. This sphere serves as a diffuse light source, which enables measurements of the hemispherical reflectance, or the directional absorptance, respectively.

2 Emissiometer

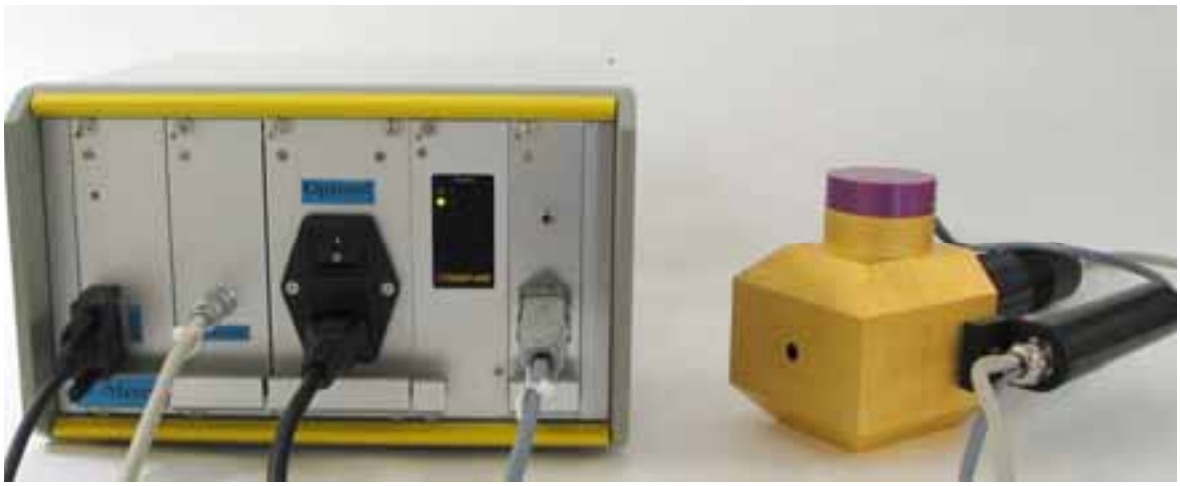
The thermal emittance of opaque samples is complementary to their infrared reflectance. Our emissiometers are therefore designed for broad-band measurements of the infrared reflectance. Glass and metal surfaces are used as high – and low-emitting standards.

Emissiometer R

This type is designed for the measurement of tubular samples with arbitrary diameter bigger than 20mm. The infrared radiation is emitted by a heated semi-cylindrical tunnel, in which the samples have to be placed axially. The reflected radiation is measured integrally in the wavelength range from 8µm to 14µm. This system could be used for heated tubes as well.

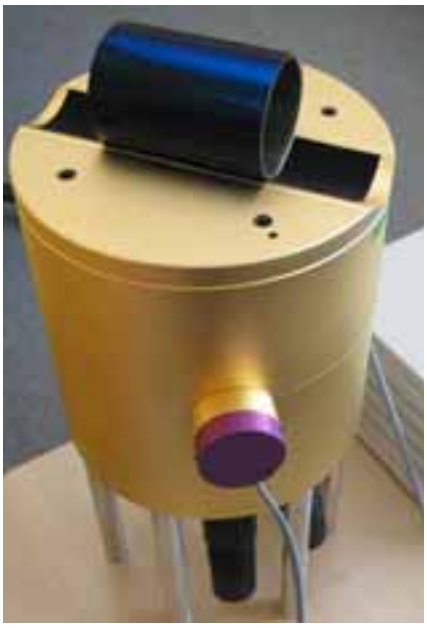
Emissiometer K1

This type is designed for measurements of plane surfaces. The diffuse infrared radiation comes through the exit hole of a diffuse-gold coated integrating sphere with a diameter of 50mm. The measured area has a diameter smaller than 10mm. The reflected radiation is measured integrally in the wavelength range from 8µm to 14µm.



Emissiometer K2

This type has an additional detector which is sensitive around a wavelength of 5.1µm for measurements of highly selective solar absorber coatings.



Emissiometer K3

This type has an additional detector which is sensitive around a wavelength of 3.9µm for measurements of highly selective solar absorber coatings for the application as medium to high temperature absorbers.

3 Absorber control

Spectrally selective coatings for solar-thermal applications are optimised for a high solar absorptance and a low thermal emittance. Optosol provides suitable measurement

devices for the quality control during production or goods receipt worldwide since many years.

Absorber control units are a combination of an alphameter and an emissiometer according to your needs and wishes. Spectral measurements can be offered on request. The used references are calibrated by Fraunhofer ISE.

4 Production control

Integrating spheres equipped with CCD and/or NIR-diode arrays allow fast measurements in the UV-VIS-NIR range. Such devices are applicable for i-line production control in coating machines, especially.