Characterization of new optical diffusers used in high irradiance UV radiometers

Barton, B.[1], Sperfeld, P.[1], Nowy, S.[1], Towara, A.[1], Höpe, A.[2], Teichert, S.[2], Hopfenmüller, G.[3], Baer, M.[4] and Kreuzberger, T.[4]

Abstract

Diffusers are essential components of UV radiometers used as transfer standards. They improve the insensitivity to differing radiation situations. In combination with a beam limiting aperture, a diffuser defines the irradiated area [1]. A detailed study of different properties of UV diffusers is shown.

Introduction

A suitable diffuser should meet the following requirements:

- Spectrally flat transmittance
- Temporally stable transmittance
- Insensitive to high radiation levels
- Uniform transmittance over the surface
- Good light scattering properties

Surface homogeneity

Each diffuser was irradiated by a high UV irradiance level. A silicon photodiode with an aperture of 3 mm scanned the distribution of the transmitted light right behind the diffuser.

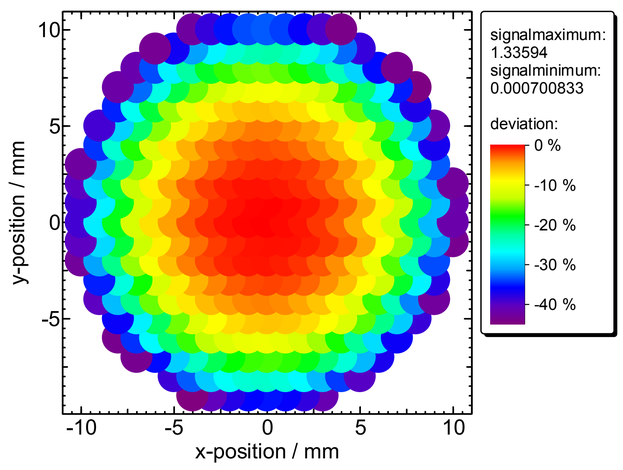

Figure 1: Homogeneity of the relative transmittance of a Primusil OQ 30-06 2 mm diffuser measured at a distance of 3 mm behind the diffuser

Cosine dependence of the angle of incident

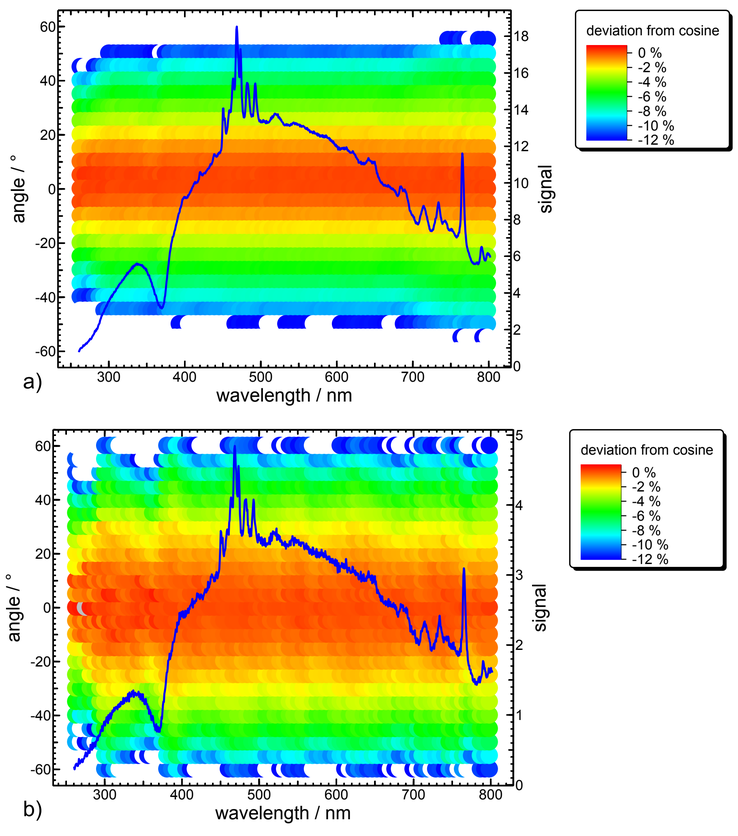

Figure 2: Deviation from cosine of a Heraeus OM100 2 mm diffuser (a) and a Primusil OQ 30-06 2 mm diffuser (b) as a function of wavelength

Spectral transmittance

The spectral regular transmittance of the investigated diffusers was determined using a Cary 5000 spectrophotometer (Varian) within the wavelength range from 230 nm to 800 nm.

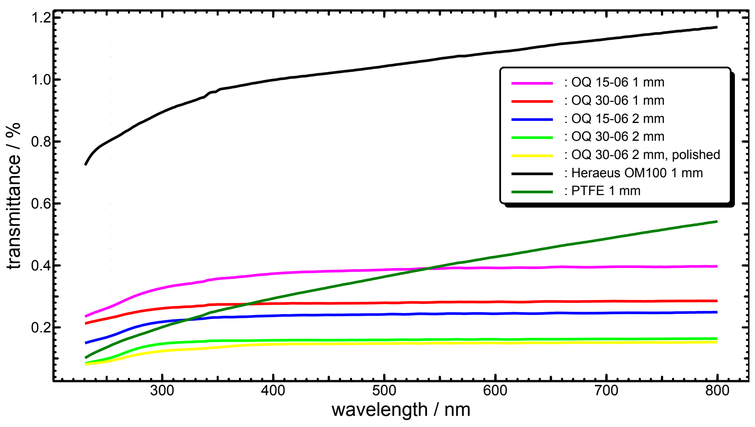

Figure 3: Transmittance of different diffusers

Figure 3 shows the detected regular transmittance of diffusers with different opacities and thicknesses. Obviously, the transmittance of Primusil diffusers in the visible spectral range is spectrally independent in contrast to the UV range where it strongly decreases. In the visible range all curves have the same characteristics. However, in the UV range the decrease of the transmittance depends on the thickness and the opacity of the diffusers. This characteristic has to be taken into account for the determination of the spectral responsivity of UV sensors.

Changes under high UV-irradiation

Different diffusers were irradiated in front of a 2 kW medium pressure Hg lamp at a distance of 20 cm. Their transmittance was measured repeatedly before and after several irradiations and rest intervals. All diffusers showed an initial increase of their transmittance in the spectral range below 450 nm. The strongest change was observed for the PTFE diffuser with a thickness of 1 mm. At 254 nm the transmittance increases by an amount of about 13 %. In general, after the first 14h of irradiation, no considerable additional changes of the transmittance were detected.

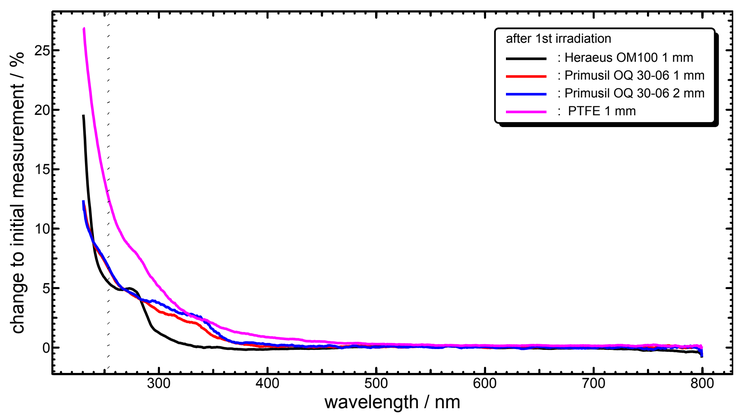

Figure 4: Change of transmittance of different diffusers after the first UV irradiation

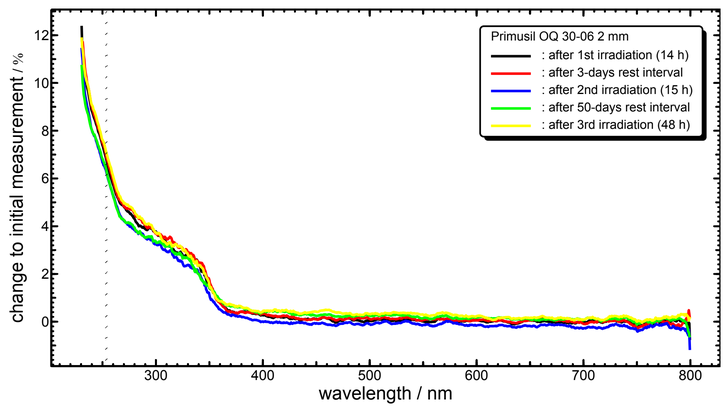

Figure 5: Change of transmission of a Primusil OQ 30-06 2 mm diffuser after several UV irradiations and rest intervals

Primusil diffusers

These new optical diffusers are made of the ultra pure opaque fused silica Primusil OQ. Extremly small gas bubbles very homogenously distributed in bulk fused silica act as scattering centres. The fused silica ensures a good transmittance of the scattered light down to the deep UV ranges.

Figure 6: Primusil OQ diffusers

Due to the exact adjustment of the quantity and size of the gas bubbles in the material, various optical diffusers with customized opacity and geometrical shape are available [2].

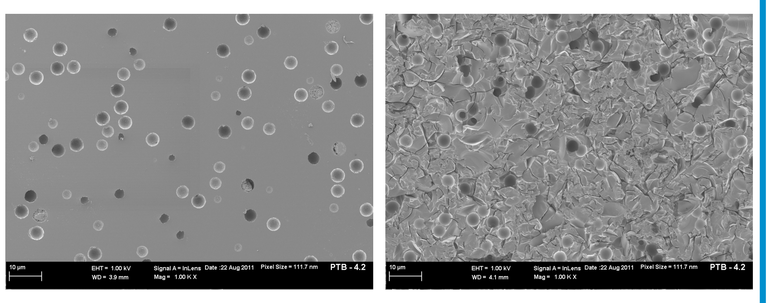

Figure 6: surface of a polished (left) and unpolished Primusil diffuser (right).

In figure 6 the surfaces of a polished and unpolished Primusil diffuser are shown. The pictures are made with a scanning electron microscope, using a 1.000 x magnification. The surface of the polished diffuser is less sensitive to pollutants and thus might be used without additional cover glasses.

References

[1] Technische Regel Arbeitsblatt W 294-3 Juni 2006, UV-Geräte zur Desinfektion in der Wasserversorgung; Teil 3: Messfenster und Sensoren zur radiometrischen Überwachung von UV-Desinfektionsgeräten; Anforderungen, Prüfung und Kalibrierung

[2] http://www.silicaglas.com/en/streuscheiben.html

Physikalisch-Technische Bundesanstalt Braunschweig und Berlin

[1]4.1 Photometry and Applied Radiometry • e-mail: bettina.barton@ptb.de

[2]4.5 Optical Technologies

[3]sglux SolGel Technologies GmbH, Berlin, Germany; [4]SGIL Silicaglas GmbH, Langewiesen, Germany