Solarization of Optical Filter Glasses

Ralf Biertümpfel*; Axel Engel*, Steffen Reichel*
* SCHOTT AG, Hattenbergstraße 10, D-55122 Mainz, Germany
mailto:Ralf.Biertuempfel@schott.com

Solarization is the effect of reduction in transmission due to strong UV-radiation mainly known from polymers. Most optical filter glasses are not sensitive to solarization. However, some show a significant decrease in transmission. Detailed measurement data for those sensitive glasses are presented. Unlike polymers solarization in glasses can be observed within short time and the effect is reversible by heating the glass to high temperatures.

1 Nomenclature

d	thickness of the glass
τ	transmittance
τ_i	internal transmittance

2 Introduction

Solarization - the change in transmission due to strong UV light – is an undesired reaction in several optical materials. However this effect is more dominant in plastic materials and although the majority of glasses are inert to solarization, there are some glasses that are sensitive to UV radiation. The solarization effect is very much dependent on the compounds of the glass and the effect is different for any glass type. The functionality of optical filter glass (also called “color glass”) relies on the stability of transmission spectrum in order to filter the desired wavelength. Therefore the transmission spectrum needs to stay unchanged despite UV light illumination or its dependency needs to be known beforehand [1].

Extensive investigations at several optical filter glasses regarding solarization were performed by SCHOTT. This paper provides guideline for the effect of solarization in optical filter glass. An overview for several optical filter glasses and its dependency on solarization is given.

3 Experimental setup

A mercury high-pressure gas-discharge lamp made by Philips was used as a source of UV radiation. The spectrum of the HOK-4/120 lamp is depicted in figure 1 [2]. The peak of maximum intensity is at 364 nm (UVA).

The lamp was positioned above the samples at a distance of 70 mm. This results in a power density of about ~ 25 mW/cm².

4 Saturation after a short time

Only optical filter glasses that show a significant effect of solarization have been analyzed.

The glasses were exposed to the UV light for a short duration and then analyzed; after that the procedure was repeated in order to measure the effect of saturation.

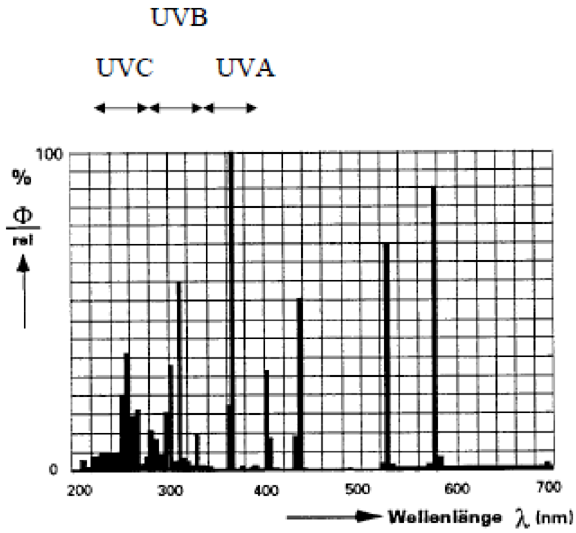

Fig. 1 *Spectrum of a Philips HOK-4/120 mercury high-pressure lamp according [2].*

Between a total of 15 hours and a total of 21 hours of exposition an increase of solarization could not be detected. Therefore, a total time of exposition of 15 hours is sufficient to describe the maximum effect of solarization.

The figures 2 and 3 present the results of the transmittance measurements after different times of exposition for BG25 and BG3 optical filter glass.

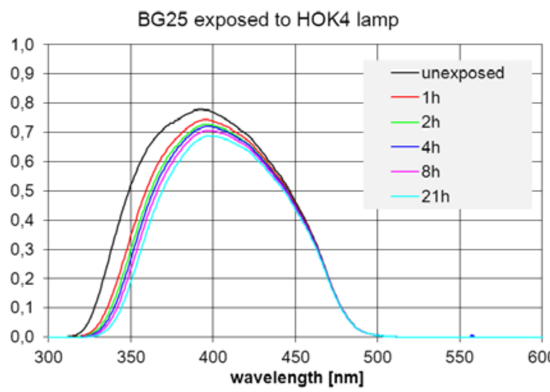

Fig. 2 *Spectral transmittance of BG25 glass before and after different times of exposition to UV radiation.*

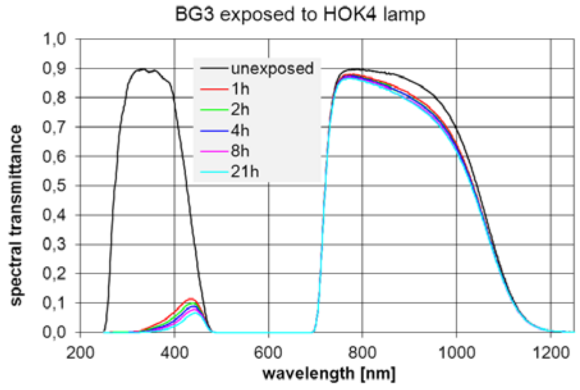

Fig. 3 *Spectral transmittance of BG3 glass before and after different times of exposition to UV radiation.*

The figures 4 and 5 depict the solarization effect of 4 types of KG glasses and 3 types of UG glasses after a duration of 15 hours of irradiation.

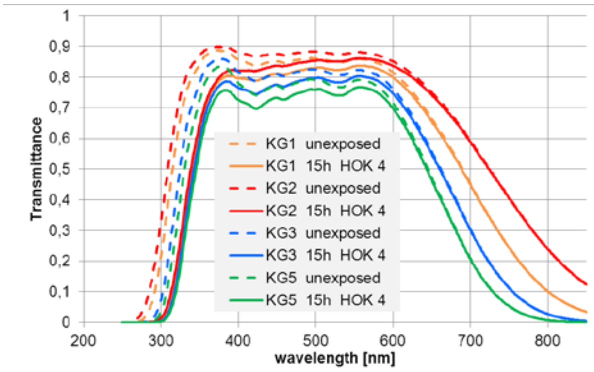

Fig. 4 *Spectral transmittance of different KG glasses before and after 15 hours of exposition to UV radiation.*

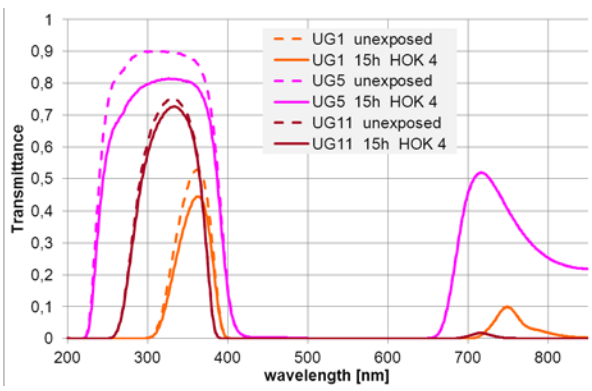

Fig. 5 *Spectral transmittance of different UG glasses before and after 15 hours of exposition to UV radiation.*

5 Reversing of the solarization effect

The effect of solarization is reversible: By heating the glass to sufficient high temperatures the solarization may be cured. In figures 6 and 7 this is shown for the filter glasses UG5 and BG25: The green curves depict the spectral transmittance of the glasses after 21 hours of UV irradiation. Then the glasses were heated to 300°C for a duration of 24 hours, afterwards the spectral transmittance was measured again. This is shown in the graph of the red crosses. The red crosses overlay the black curve which shows the transmittance of the unexposed glass, thus, the solarization effect is nearly fully annealed.

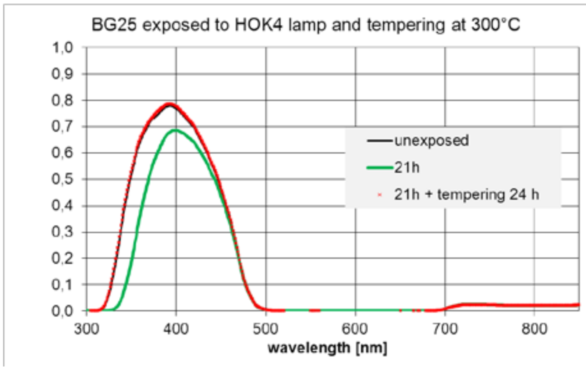

Fig. 6 *Spectral transmittance of BG25 glass before and after 21 hours of exposition to UV radiation and after reheating the exposed glass for 24 h.*

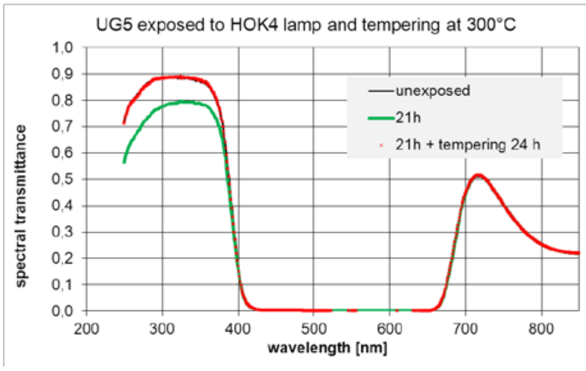

Fig. 7 *Spectral transmittance of UG5 glass before and after 21 hours of exposition to UV radiation and after reheating the exposed glass for 24 h.*

References:

[1] Reichel, S. and Biertümpfel, R.: Choosing the Correct Optical Filter for Your Application, Short Course SC1013 Photonics West 2011, San Francisco

[2] From Philips data sheet for HOK4/120 lamp (Philips UV curing lamp).