UVP APPLICATION BULLETIN

Bulletin A-I 12 — **The Source for Ultraviolet ... ULTRA-VIOLET PRODUCTS, INC.**

SOLARIZATION

INTRODUCTION

When optical components are exposed to ultra-violet radiation they undergo changes that reduce their ability to transmit UV light. This phenomenon is called solarization. All components are subject to this loss in transmittance, but it is particularly a problem in those few elements that lose the ability to transmit UV rapidly.

To understand how solarization affects the different types of lamps, it is necessary to know the optical components used in their manufacture.

The optical components are the parts of the lamp that make up the optical path for the light coming from the central arc, and can be broken down by function into three groups. These are: glass envelopes, phosphor coatings, and filters. See Figure 1.

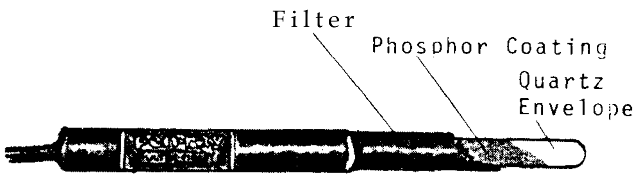


FIGURE 1: OPTICAL COMPONENTS OF AN ULTRAVIOLET LAMP

ENVELOPE SOLARIZATION

The glass envelope houses the gas used to generate the light. Solarization causes the glass to lose its ability to transmit this light and the intensity is reduced. Typical solarization rates for the most commonly used envelopes are given in Table 1.

Glass Type	% Loss
Fused Quartz	Less than 1%/100 hours
VYCOR"	1%/100 hours
Schott UV Glass	10%/100 hours

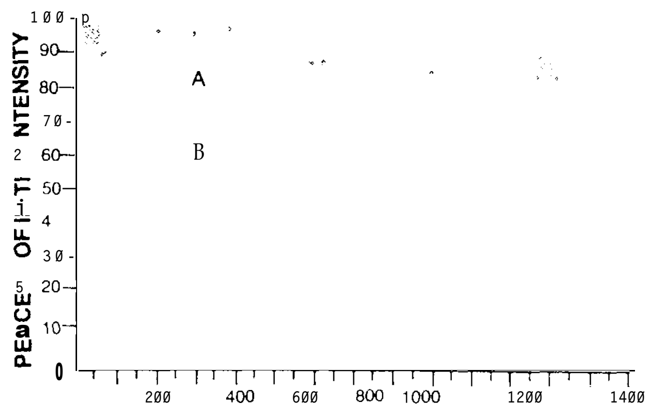
TABLE 1

It shouldbe noted that solarization affects the short wave transmission much more than the long wave, and the visible transmission is hardly affected at all. This means that a Schott-type lamp might aopear as bright as new after 100 hours, but its short wave UV output is down by 10%.

PHOSPHOR DEGRADATION

Many applications require wavelengths other than those emitted by mercury. To get these wavelengths a phosphor coating is used which absorbs the 254 or 366nm light and re-emits it at the longer waveiength that is needed.

When a phosphor solarizes it loses its ability to shift the light's wavelength. There are many different phosphors which degrade at different rates. Two examples are given in Figure 2. This data was taken using PEN-RAY@ lamps in which the phosphor was deposited on a fused quartz envelope, so that less than 1% per 100 hours of the intensity loss is due to the envelope.



TIME (hours)

FIGURE 2: A- 410nm PEN-RAY
B- 285nm PEN-RAY

FILTER SOLARIZATION

The two most important filters used for UV transmission are the long wave BLAK-RAY® filter and the short wave MINERALIGHT® filter. The BLAK-RAY® filter is a band pass filter. It is often used in conjunction with a phosphor which converts the 254nm light to 366nm to enhance the long wave intensity. The band pass filter absorbs unwanted visible and short wave UV light. This filter's solarization is comparable to that of fused quartz and for most applications need not be considered.

Short wave MINERALIGHT" filters solarize rapidly. This cobalt glass filter transmits both long and short wave UV, but effectively blocks out unwanted visible light. The intensity loss due to solarization is plotted in Figure 3. The vertical axis gives the output of a filtered lamp in percent of its initial intensity. The horizontal axis is the time the lamp was on. The intensity of the surface of the filter was 20,000 μW/cm². As you can see, the intensity drops to about 25% in 10 hours, where the output becomes fairly stable, with a slowly downward trend.

Due to the technical difficulty of manufacturing these filters, solarization rates vary from sheet to sheet and the data in Figure 3 should only be considered an approximation.

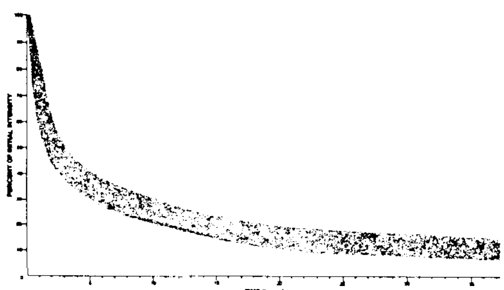


FIGURE 3: TRANSMITTANCE VERSUS TIME FOR SHORT WAVE FILTER GLASS. E = 20,000 μW/cm²

APPLICATION NOTES

Table 2 lists some UV lamps and their expected intensities after 100 hours. The values were derived using the information from the previous sections and represent losses due to solarization only. They are given in % of initial filtered lamp intensity. Similar lamps, such as the M-14 and the MS-47, have different readings because solarization depends on the amount of light or dose incident on the optical components in the given time period. See the Appendix for a more detailed discussion of dose.

The actual lifetime of a lamp is dependent on many more factors than solarization and cannot be inferred from Table 2.

UVP Lamp	Intensity After 100 Hrs. (%)
UVL-21 UVL-56 M-16 ML-49 c-71 c-90 c-91 S52-T C-62 Standard PEN-RAY® B-1 OOA	99
UVS-11 E uvs-54	90
UVSL-25	30-99*
M-15	30 SW 99 LW
UVSL-58	25-99'
MSL-48	25-SW 99-LW
c-70	20-SW 99-LW
M-14	30
uvs-11	25
uvs-54 MS-47	20
R-52 C-61	15
S-68	10

TABLE 2.

*These units have separate long wave and shor wave tubes which share the same filter, so the in tensity after 100 hours depends on the amount o short wave used.

RADIOMETER SENSITIVITY

Radiometers are the instruments used to measure the intensity of an ultraviolet source. Ultra-Violet Products manufactures three radiometers which use a total of five sensors. Filters are incorporated into the sensors to define their useful regions. As these filters solarize, the radiometers become less sensitive, and the meter will give a low reading.

The filters used in the J-221 Radiometer and the J-2602- A Sensor are of the BLAK-RAY ® filter type and solarize at a rate similar to that of fused quartz. When using these to measure sources that emit long wave, the sensitivity loss is negligible.

The J-225 Radiometer has a MINERALIGHT" filter and can lose sensitivity rapidly if i is exposed to short wave UV for extended time periods. For this reason the J-225's sensor should be uncovered only when readings are taken. The J-2601 -A and J-2603-A sensors use a special short wave filter material that solarizes more slowly than the J-225 sensor.

To correct for the measurement error caused by this phenomenon the meters are recalibrated. In this method the radiometer is adjusted to give the proper reading when compared to a standard.

To help the user determine when his meter needs recalibration, correction factors have been determined. Figure 4 shows the factor for the J-225, J-2601-A and J-2603-A curve. The horizontal axis is in dose (see Appendix), as a radiometer can be used to measure many different lamps with different intensities and time alone does not define the situation. These curves are for 254nm light only, and are not accurate when the source being measured emits other short wave radiation.

These factors can be used directly in special, high use situations, but to insure the accuracy of the measurement, the meter should be periodically recalibrated.

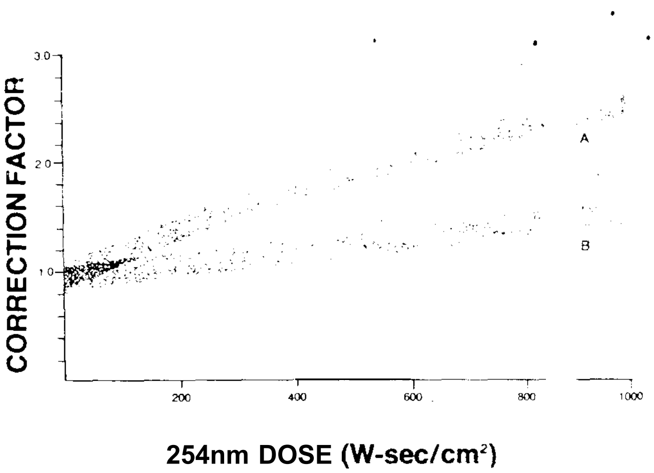


FIGURE 4. A- **CORRECTION FACTOR FOR J-225**
B-CORRECTION **FACTOR FOR**
J-2601 - A and J-2603-A

APPENDIX

An ultraviolet lamp's output is measured in irradiance (E) with the units microwatts per square centimeter ($\mu W/cm^2$) at some distance. The dose an optical component receives is the product of the irradiance and the time (t) it is being irradiated, or:

$$\text{dose} = \text{irradiance} \times \text{time} = E \times t$$
$$= \mu W\ Sec/cm^2 = \mu J/cm^2$$

Where J = joule = a unit of radiant energy.

Many publications give dose in terms of joules per square meter (J/m^2).

To convert from J/m^2 to $\mu W\ Sec/cm^2$ we have
$1\ J/M^2 = 100\ \mu J/cm^2 = 100\ \mu W\ Sec/cm^2$

Ultra-Violet Products' J-221 and J-225 Radiometers read directly in units of 100 μ W/cm', easing this conversion.

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