REPORT

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UVC exposure (254 nm) of UV sensitive material at different irradiation levels

(1 appendix)

RISE Research Institutes of Sweden has evaluated the colour shift for UV sensitive material using two different irradiance levels at 254 nm. The results show that the change in colour after a certain UV exposure (dose) is very similar for the irradiance levels 90 and 760 µW/cm^2 respectively.

Identification

Object	Yellow samples of an UV-sensitive material, denoted “1”.
Object state	Upon arrival the samples had no visual damage and were without any colour changes.
Location	Borås, Sweden
Measurement date	Nov 08, 2017

Measurement methods and procedures

The samples were exposed by UV-radiation at 254 nm wavelength using a UVP Trans-illuminator equipped with fluorescent UVC-tubes using two different irradiation levels (90 and 760 µW/cm^2 respectively). The irradiation level at the sample plane was determined by a calibrated silicon detector with a precision aperture in front of the detector’s photosensitive surface. An aperture was used to limit the exposure to a well-defined spot of about ∅ 20 mm on the samples.

At certain times corresponding to exposures of 10000, 25000, 50000, 75000 and 100000 µJ/cm^2, the exposure was briefly paused and the colour of the exposed area was measured using a PR-735 spectrophotometer. Also, a picture of the sample was taken. The measurements and pictures were taken with the sample placed in a light both using D65 illumination with high colour rendering index (> 95).

Based on the colour coordinates in CIE 1976 L* a* b* colour space, the total colour difference ΔE* relative to a non-exposed sample was determined as:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

where ΔL*, Δa* and Δb* are the differences between the individual coordinates. Typically the human eye is is capable of detecting a colour change when ΔE* is 1-2 or higher.

Measurement conditions

Ambient temperature	23 ±2 °C
Sample temperature (during exposure)	30 ±5 °C
Exposure wavelength	254 ±2 nm

Results

The results only refer to the object specified in this document.

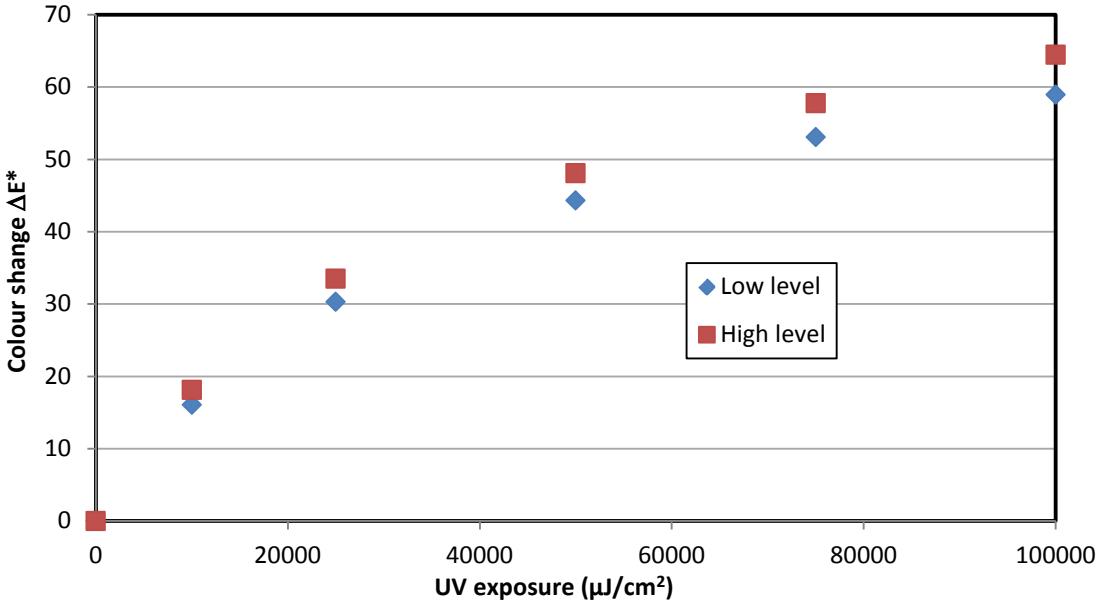
Table 1. Exposure with low irradiance (90 µW/cm^2).

Exposure µJ/cm^2	CIE 1976 L*a*b* colour coordinates L*	a*	b*	Colour difference ΔE*
0	82,2	-4,0	52,4	0,0
10000	77,8	6,3	40,9	16,0
25000	73,2	14,2	30,0	30,2
50000	69,4	21,3	18,4	44,3
75000	67,8	25,4	10,7	53,0
100000	66,4	27,8	5,4	58,9

Table 2. Exposure with high irradiance (760 µW/cm^2)

Exposure µJ/cm^2	CIE 1976 L*a*b* colour coordinates L*	a*	b*	Colour difference ΔE*
0	83,0	-4,8	52,5	0,0
10000	77,9	7,1	39,8	18,1
25000	73,5	16,0	28,0	33,5
50000	69,6	23,5	16,0	48,1
75000	66,3	28,0	8,0	57,7
100000	65,1	31,0	2,0	64,4

The results for ΔE* for the two irradiation levels are presented in the diagram below.



Pictures of the exposed samples are shown in the appendix.

The uncertainty is estimated to ±8 % of the reported exposure levels. The relative uncertainty for L*, a* and b* is ±2.

Comment: No absolute uncertainty is given for L*, a* and b* as the measurement geometry is not well defined (detection about 15° normal to the sample surface, illumination close to diffuse).

Equipment

Reference silicon detector 10×10 mm, inv.no. 500963
UVP Transilluminator 254 nm, no. 95-0153-02
Current amplifier Keithley 427, inv.no. 603159
Precision aperture ∅ 8 mm, inv.no. 502607
Spectrophotometer PR-735, inv.no.901491
Light booth True Color TC-60
Nikon D7000 digital camera

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Performed by

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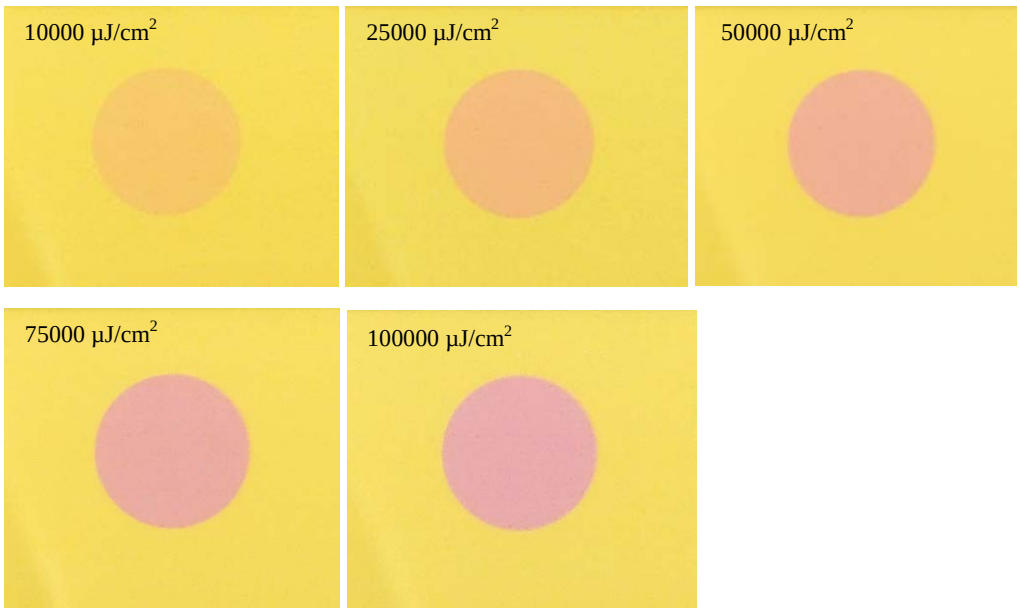
Appendix

Pictures of the UV-exposured samples

Appendix 1

Pictures of the UV-exposured samples

Low irradiance level (90 µW/cm^2):



High irradiance level (760 µW/cm^2):