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Fading of colours under the influence of light

Notes on the avoidance of light-induced damage to textiles and leather goods

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Fading of colours under the influence of light

With the use of discharge lamps, light-induced damage through fading of fabrics, leather and other sensitive materials was known and feared. Since the use of LED lamps, it has been assumed that due to the elimination of the high UV and infrared portions in the light the danger of light-induced damage has largely been excluded.

The present compilation explains why with long exposure times at high illuminances such as in the retail trade visible damage to material can nevertheless come about and how this can be prevented.

The following factors influence fading:

- Die lightfastness of the goods
- The illuminance
- The light source
- The exposure time / display duration
- High ambient temperature, humidity as well as air pollution

I.
The lightfastness of the goods
has the biggest influence on the fading of the goods. Distinctions are made between 8 stages, from Stage 1 = very sensitive to Stage 8 = very stable.
The clothing manufacturers make the data on the colour fastness available.

Lightfastness degrees	1	2	3	4	5	6	7	8
Permitted Exposure time for every 1000 lux of daylight	70 h	150 h	300 h	600 h	1200 h	2500 h	5000 h	10,000 h

Table 1 Lightfastness degrees and general empirical values for exposure times

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II.

Illuminance

is measured in lux. Above all in a goods presentation, high illuminances are used in a range from approx. 300 - 5000 lux which are generated by the use of spotlights with interchangeable reflectors and a beam angle of from Spot (15°) to Flood (60°).

The fading effect of a lighting unit is proportional to the illuminance. In the case of directed light considerable changes in the illuminance occur depending on the distance from the luminaire. The following values apply to a typical luminaire:

Distance [m]	**Reflector**	**1**	**2**	**3**	**4**
Illuminance [lx]	**angle**				
QR-CBC 51 50 W, halogen	24°	5,100	1,350	600	300
CDM-T 35 W*	15°	23,440	7,300	2,980	1,550
LED COB 32 W/3000 L**	15°	19,200	6,680	2,850	1,620

Table 2

Illuminances for a typical spotlight with the given lamps and reflectors. Values for other luminaires, lamps and reflectors can often be seen from the manufacturers' catalogues.

*) Assumed as typical was a new Philips high-pressure discharge lamp. Discharge lamps have a markedly higher luminous flux loss over the usual lifetime than LED lamps.

**) Measured values of a commercially available spotlight at the centre of the LED light cone. The data can deviate considerably from one another depending on the performance data of the LEDs and the reflectors of other manufacturers.

III.

The light source. Any visible light and the UV components lead to fading. Daylight intensifies the fading effect of the artificial light. This is particularly important for the shop window area because outdoors on a fine-weather day up to 100,000 lux are reached and the UV component is correspondingly high.

As artificial light depending on the type of lamp emits different degrees of UV light, there are extension factors to reach the calculated value of the daylight UV emission that is important for the comparison and the calculation of the display time.

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For the determination of the factor for a lighting system, it must be strictly noted which mixture of various light sources is present:

Shop window:	previously: daylight + halogen lamps / high-pressure discharge lamps today: daylight + LED lamps
Sales room:	previously: fluorescent lamps + high-pressure discharge lamps + daylight today: LED lamps + daylight

LIGHT SOURCE / FILTER	Extension factor
Daylight through the shop windowpane The UV radiation is filtered for the most part through the shop window-pane.	1.5
Metal halide lamps (CDM-T) - Spot -with UV-blocking filter have a comparable effect to daylight in the shop window.	1.5
Fluorescent lamps	2.0
Halogen lamps and metal halide lamps -Flood- with UV blocking filter have a similarly strong fading effect.	2.5
LED light Very low UV radiation	4.0

Table 3

Source: Manufacturer data

Calculation of the exposure time
formula:

A Permitted exposure time ***** **Extension factor** = exposure time in hours
(from Table 1) (from Table 3)

B Exposure time in hours ***** 1000 lux **/** actual illuminance
(at 1000 lux)
= **permitted** exposure time in hours

Example of the calculation of the exposure time:

- The permitted exposure for the lightfastness degree 2 amounts to 150 hours (at 1000 lux daylight).

Lighting is carried out with fluorescent lamps = factor 2 Result: 150 hours * 2 = 300 hours at 1000 lux)

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- The actual illuminance amounts to 500 lux.
  This results in: 300 * 1000 / 500 = 600 hours of permitted exposure time

In this example, the goods can be on display for 600 hours or, with 10 hours of exposure time per day, for approx. 60 days.

Example of the calculation of the exposure time in the case of LED lighting:

- The permitted exposure time for the lightfastness degree 2 amounts to 150 hours (at 1000 lux daylight).

- The lighting is carried out with LED lamps = factor 4
  This results in: 150 hours * 4 = 600 hours (at 1000 lux)

- The actual illuminance amounts to 4,500 lux.
  This results in: 600 * 1000 / 4,600 = 130.4 hours of permitted exposure time

The goods can be on display for 130 hours or, with an exposure time of 10 hours per day, for approx. 13 days.

As an average value with the spotlights used, a largely safe exposure time of < 10 days can be assumed. For between 10 and 15 days the goods should be checked by means of random samples. With an exposure time of > 15 days reallocation from bright light fields to shadow fields is advisable.

Please note: these data are empirical values which in specific cases are repeatedly not reached, but are also exceeded. High-quality goods that are exposed to high illuminances, must, to be on the safe side be checked (at least by random samples) on a daily basis.

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IV. Measures against fading

1. Obtain information from the manufacturer about the colourfastness of the goods. It has the biggest influence on fading.

   If light-induced damage is found unusually quickly, the cause is in many cases to be found in changes in the material quality, the colour quality or in changed distances of the lighting fixtures from the goods.

2. Do not direct the light on the goods as a point, but instead have, above all concentrated light flow over the goods as a highlight.

3. If necessary, increase the distance between the light source and the goods.

4. An effective measure for the reduction of fading is regular replacement of the items on display. Therefore, strive for the shortest possible decoration rhythms in order to shorten the exposure times of the exhibits.

5. In the case of relatively long exposure times, reallocation from bright light fields to shadow fields is advisable.

6. All the data on the fading effect are to be seen as indications which should be checked against one's own empirical values as regards material and colours.

Remark:
For the illumination of works of art and very sensitive exhibits, special measures must be taken and the illuminances and exposure times must be reduced.

Summary
Every light source from daylight to illumination with LED luminaires produces changes in the case of relatively long exposure and consequently light-induced damage in the case of sensitive materials.

The effects and type of the damage depend upon a large number of influencing factors which are best determined in practical application such as in the retail trade by means of empirical tests. The above-mentioned measures give tips close to actual practice which serve as rough guidelines and help to avoid unnecessary damage.

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Disclaimer
The explanations, notes and data for the avoidance of damage caused by lighting were prepared on the basis of and with the evaluation of empirical data.

Even if these tips and notes are followed, in the nature of things no guarantee or certainty can be deduced that light-induced damage can be completely excluded. The authors explicitly point out that any liability for light-induced damage that occurs when the above-mentioned notes and tips are followed, such as in particular die “permitted exposure times ", is excluded.

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