HSL – HUMAN SUN LIGHTING

Innovative lighting technology

Lighting to protect vision

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Better light changes everything

Lighting today is not only an end in itself to provide lighting, but is also used for interior design, emotional relaxation and other purposes. It thereby helps in all aspects of our daily lives. We are, unfortunately, not fully aware of the risk of damaging our eyesight by using poor lighting or too much lighting.

Since the invention of artificial light, the lighting industry has focused on energy savings and the efficient production of light. So while the lighting industry has focussed on lighting efficiency and energy efficiency, the health and care of our eyesight has been neglected.

As lighting is basically designed to provide the human eye with light to be able to identify an object, the selection of a lighting system with better quality must be placed above the economic values or efficiency.

Good and healthy lighting can enrich our everyday activities and make our life more vibrant.

The Lumi Green products improve lighting with artificial light.

The lighting is similar to daylight and has a continuous wavelength just like sunlight which protects eyesight and can help to improve the quality of life.

![Visible Light Spectrum](image)
1. The important role of the retina (cones and rod cells) in vision

The retina of the human eye consists of more than 120 million rod cells and 92 million cone cells.

Up until the 20th Century, the cone cells played the most important part. For this reason the wavelengths of RGB (red, green, blue) were perceived as the most important components in the theory of human vision.

In 1996, image compression algorithms used for computer graphics were based on counter-colour theories as opposed to being based on RGB. In 1999 the Max Planck Research Institute in Germany discovered the rod-cone process which resulted in both the rod cells and also the cone cells being extremely important in 21st Century vision theory.

- Rod cells, a type of photo-receptor on the retina of the eye, are simulated by light over a wide range of intensities and are responsible for the perception of the brightness of the light.

- Cone cells are responsible for colour perception, there are three different pigments (namely S-cones, M-cones and L-cones) which are sensible to the wavelength of the light corresponding to light with shorter wavelengths (blue), average wavelengths (green) and longer wavelengths (red).
2. Cone cells are very sensitive to blue-green wavelengths of 498 nm.

The blue-green wavelengths contain the largest proportion of sunlight’s energy and light with blue-green wavelengths supports the activity of the rhodopsin in the rod cells.

Rhodopsin: a biological pigment found in the rod cells of the retina is a G-protein coupled receptor (GPCR).

“Aronia (chokeberry)”: helps with the production of rhodopsin.

Rhodopsin in the rod cells is stimulated by light. It transfers the signals to the optic nerve and thereby makes it possible to see. In addition, when rhodopsin is exposed to light, there is immediate photo-bleaching. In humans, it is regenerated fully in approximately 45 minutes, in the elderly, photo-bleaching and regeneration is reduced however. Rhodopsin absorbs blue-green wavelengths of 498 nm better than other wavelengths. Anthocyan pigments in fruits, such as “Aronia” and “blueberries”, helps in the reproduction of rhodopsin and supports the protection of vision.

<table>
<thead>
<tr>
<th>Color</th>
<th>Wavelength λ in nm</th>
<th>Retina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultraviolet</td>
<td>&lt;380</td>
<td></td>
</tr>
<tr>
<td>Violet</td>
<td>380–435</td>
<td></td>
</tr>
<tr>
<td>Blue</td>
<td>436–480</td>
<td>Blue cones</td>
</tr>
<tr>
<td>greenish-blue</td>
<td>481–490</td>
<td></td>
</tr>
<tr>
<td>Blush-green</td>
<td>491–500</td>
<td>Rods</td>
</tr>
<tr>
<td>Green</td>
<td>501–560</td>
<td>Green cones</td>
</tr>
<tr>
<td>Yellowish-green</td>
<td>561–580</td>
<td></td>
</tr>
<tr>
<td>Yellow</td>
<td>581–595</td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td>596–650</td>
<td></td>
</tr>
<tr>
<td>Red</td>
<td>651–780</td>
<td>Red cones</td>
</tr>
<tr>
<td>Near Infrared</td>
<td>&gt;780</td>
<td></td>
</tr>
</tbody>
</table>
3. The Lumi Green bulbs to protect vision generate sufficient blue-green wavelengths to which the rod cells are very sensitive and thereby support the rhodopsin activity and protect vision.

In addition, sufficient red wavelengths are generated in the Lumi Green bulbs to protect vision. These are necessary to perceive the true colour red and to generate clear colour lighting.

Sadly, the majority of LED lamps on the market favour blue and yellow wavelengths which are not suitable for the vision process. They cause optical discomfort in humans and also cause difficulty in distinguishing colours due to the lack of sufficient red wavelengths.

<table>
<thead>
<tr>
<th>Comparison of light spectra</th>
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<tbody>
<tr>
<td>Sunlight</td>
</tr>
<tr>
<td>Correct lighting to protect vision</td>
</tr>
<tr>
<td>Standard LED light</td>
</tr>
</tbody>
</table>

- ✓ The energy of the blue-green wavelengths is the largest.
- ✓ In addition, red wavelengths have more energy than blue wavelengths.
- ✓ The energy of the blue-green wavelengths is amplified to the level of natural sunlight.
- ✓ There is plenty of energy available in the red and blue wavelengths.
- ✓ The energy of the blue-green wavelengths is very low.
- ✓ There is plenty of energy from the blue wavelengths, but very little energy from the red wavelengths.

The human eye only detects this spectrum of light.
4. Lighting with full-spectrum natural light very close to sunlight

Advantages of lighting with natural light

- It helps against depression and melancholy
- Improves work concentration, e.g. reduces distractions, improves school performance
- Increases work efficiency, reduces cortisol (stress hormone) level
- Increases turnover in shops due to longer stays in the sales areas
- Protects vision, reduces eye fatigue
- Prevention for skin allergy

Results of a survey conducted by the US NLPIP (Natural Light Product Information Program) Lighting Research Center Survey (2003)

Question: How does natural light help with different activities? (Questions were asked by lighting specialists.)

Answer: (Multiple answers)

- Improves mood: 72%
- Helps concentration at work: 70%
- Makes colour perception better: 90%
- Improves clarity of objects: 75%
- Increases work efficiency: 71%
- Improves performance: 58%
- Helps to treat season-related moods: 60%
- Increases turnover: 63%
- Improves plant growth: 62%

✔ Note: These questions were based on fluorescent lamps with flicker and CRI 90. As the lighting from Lumi Green has over CRI 95 and is closer to natural sunlight, more positive answers are expected.
4.2 Comfortable lighting even after long hours of use.

- Reduction of eye fatigue

The patented lamps from Lumi Green to protect vision support rhodopsin activity and reduce eye fatigue.

Comparative results from clinical tests between fluorescent lamps and Lumi Green lighting

- Time required for eye fatigue: 35 minutes for fluorescent lamps compared with 1 hour for lighting with Lumi Green bulbs

4.3 Flicker-free lighting

Flickering permanently irritates our eyes and brain and can cause epilepsy, headache, anxiety and damage vision.

The patented bulbs from Lumi Green to protect vision do not produce electromagnetic waves which can trigger nausea, headaches, fatigue, dizziness and skin irritations. In addition, they do not contain any substances which are hazardous to health such as lead or mercury.