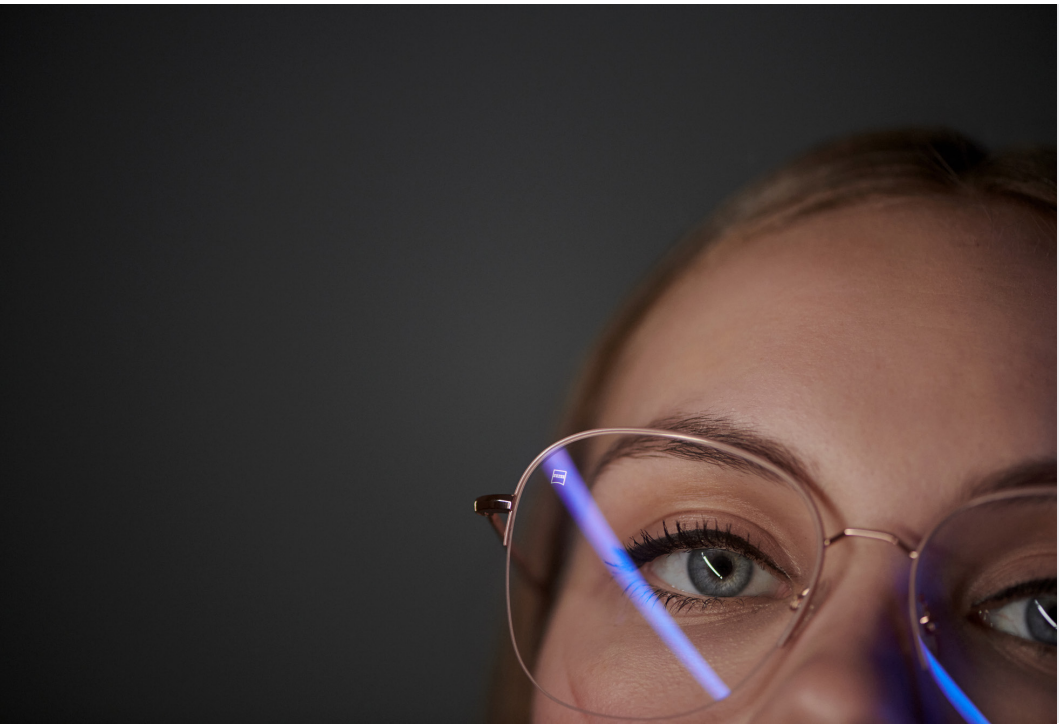
ZEISS BlueGuard Lenses

Easy on the eyes. More protection, less reflection.



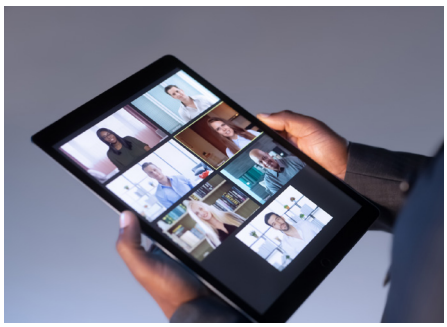
ZEISS BlueGuard Lenses are the latest in blue light protection, providing comfortable vision and excellent clarity and aesthetics, while blocking up to 40% of potentially harmful and irritating blue light and providing full UV protection.

Seeing beyond

ZEISS BlueGuard Lenses

An in-material blue light blocking lens with less reflections, outstanding clarity and excellent transmission.

- ZEISS BlueGuard Lenses are designed to address digital eye strain by blocking blue light.
- Blocking up to 40% of potentially harmful blue light.
- Reducing up to 50% of digital blue light reflections compared to common blue light coatings.
- Excellent clarity with 97.8% of luminous transmittance.
- 90% of wearers are very satisfied with the clarity of ZEISS BlueGuard Lenses.
- Provides combined protection - UV protection up to 400nm, and Blue Light protection in the range of 400-455nm.
- Benefical blue light (>455nm) which plays a roll for our sleep wake cycle is not blocked.



ZEISS BlueGuard Lenses are the latest in blue light protection from ZEISS. Now that we're spending more time in front of screens, increasing our exposure, we need a better blue light solution to overcome the drawbacks inherent in many typical blue light lenses. ZEISS BlueGuard is an in-material blue light lens solution, blocking up to 40% of potentially harmful blue light between 400 to 455nm, but allowing to pass the beneficial blue light between 455 to 500nm. By blocking light in the material, ZEISS BlueGuard reduces digital blue light reflections by 50% compared to common blue light coatings.[10]

New Online Digital Lifestyle

The coronavirus pandemic has accelerated a change to a more digital lifestyle. Effecting how we work, learn and socialize, in doing so generating increased exposure to digital blue light. Since the pandemic began, worldwide smartphone usage has increased by 70%, while laptop usage has increased by 40%.[1] A recent peer-reviewed article showed that 94% of participants had increased their screen time during lockdown and on average, screen time almost doubled from 4.8 to 8.6 hours per day.[2]

Blue light can have Positive and Negative Effects

Our vision evolved with natural light from the sun, the most intense blue light source. Now modern life has introduced new diverse artificial light sources. LEDs and digital devices have increased our daily exposure to artificial and digital blue light. Typically, the human eye can see light and color in the wavelength range between 380 and 780nm, the so called visible light spectrum.
A sub section of visible light range is blue light (Figure 1), between 380 and 500nm.

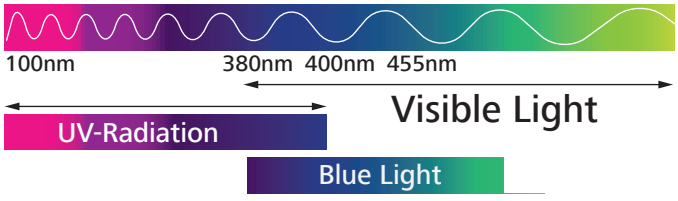


Figure 1 Part of the electro-magnetic light spectrum.

Blue light can have both, positive and negative impacts. Blue light is essential for our alertness and mood, well-being and the sleep-wake cycle. At the same time it is potentially harmful to our eyes and can cause Digital Eye Strain.
Modern LED displays are a new challenge to our eyes - having their peak intensity in the blue light region. This is in contrast to old incandescent lighting, and perhaps most importantly the sun – the light source that our eyes have evolved with. This means our eyes are now getting relatively more blue light exposure when compared to other wavelengths (Figure 2).

Blue light can be potentially harmful to our eyes. High-energy visible light (HEV)in wavelengths between 380 and 450nm can

cause damage to the retina nerve tissue at the back of our eye. Unlike UV radiation, blue light reaches the retina and interacts with cells (macular pigment epithelium) and photoreceptors. One study found blue light can be more damaging to the retina than other spectral colors.[3]

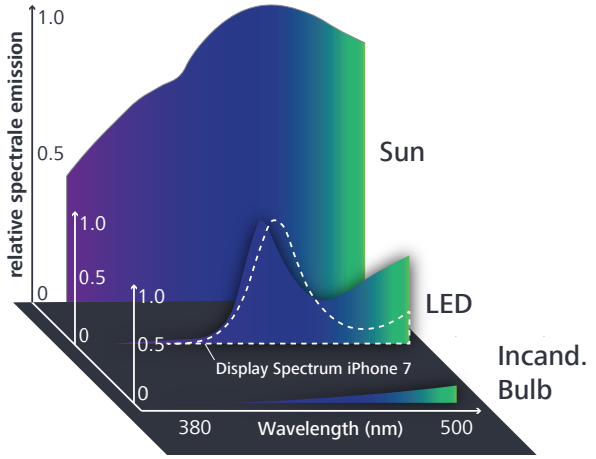


Figure 2 Blue light emission of different light sources.

The latest report into blue light by the International organization for Standardization (ISO/TR20772:2018) concludes that the blue light up to 455nm is not as the greatest phototoxic risk for the retinal pigment epithelium. ISO suggests minimizing blue light up to 455nm and maximizing longer wavelengths to avoid interfering with the sleep-wake cycle and other blue light triggered processes. ZEISS BlueGuard Lenses were designed to block blue light in the region 400nm and 455nm, but to allow the beneficial longer wavelengths to pass.

More than two-thirds of adults in the US who regularly use digital devices experience DES.[4]

Many of us have already experienced Digital Eye Strain (DES) or at least its symptoms, including glare, discomfort, blurred vision, pain in or around the eyes, dryness and eye fatigue.[5],[6]
These symptoms can be the result of increased usage of digital devices, and intense time in front of screens.

Digital Eye Strain can be linked to Blue Light

It is well accepted that DES is caused by a close working distance in front of screens. But blue light itself can also cause blurry vision and eye discomfort which are symptoms of DES.[7]
The two main mechanisms with which blue light can cause DES are (i) wavelength-dependent light scatter, the same reason why the sky appears blue, and (ii) longitudinal chromatic aberration.[8],[9]
Blue light scatter occurs in the ocular media as shown in Figure 3. This effect causes increases visual noise in the retina, which can cause dazzle, reduced contrast and can contribute to eye strain.
Longitudinal chromatic aberration, is the effect of higher refraction angles, giving different colors slightly different focal points, resulting in an image that can look blurry because different colours have different focal points creating a challenge for our eye (Figure 3).

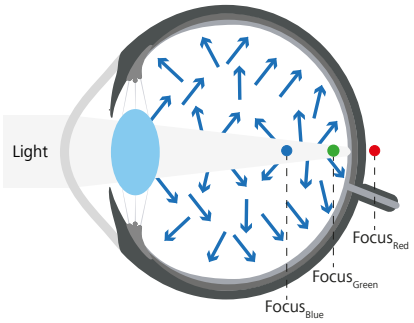


Figure 3 Schematic visualization of blue light scatter and the different color related focus points in the eye.

BlueGuard Lenses block up to 40% of potentially harmful blue light. [10]

ZEISS quantifies how much a lens blocks of potentially harmful blue light using the blue-violet block (BVB) formula.
It measures the percentage of potentially harmful blue light being blocked by a lens between 400 and 455nm.
Using the BVB formula, ZEISS BlueGuard Lenses block up to 40% of potentially harmful blue light across all BlueGuard materials from 1.50 to 1.74 index.[10]

$$Blue\ Violet\ Block = 100 - \frac{\int_{400}^{455} T(\lambda)d(\lambda)}{\int_{400}^{455} d(\lambda)}$$

UV and Blue Light Protection combined into one lens

UV is harmful to the human eye and surrounding tissues. Ultraviolet radiation ranges from 100 to 400nm.
In addition to partially blocking potentially harmful blue light, ZEISS BlueGuard Lenses also provide full UV protection, blocking harmful UV radiation up to 400nm based on the innovation first started with ZEISS UVProtect materials. UV Protection to 400nm, the benchmark for sunglasses, is therefore standard for ZEISS clear and ZEISS BlueGuard lenses to ensure the best possible protection for our eyes.

Because ZEISS BlueGuard Lenses block in-material, reflections are minimized by up to 50%.[11]

Have you ever seen annoying blue/violet reflections on a lens, especially during video calls? Blue light coatings produce annoying blue and violet reflections because this is their mechanism to reduce blue light transmittance. Because ZEISS BlueGuard Lenses block blue light in the material, no blue light reflective coating is required to reduce blue transmittance, meaning visible reflections of digital blue light are reduced by up to 50%.[11]
But how can we quantify digital blue light reflections?
Based on digital blue reflectance (DBRLED), ZEISS BlueGuard Lenses produce up to 50% less digital blue light reflection compared to ZEISS DuraVision BlueProtect coating.

$$DBR_{LED} = \frac{\int_{380}^{500} R(\lambda).L(\lambda).LED(\lambda).d(\lambda)}{\int_{380}^{500} d(\lambda)}$$

The DBR metric calculates the quantity of digital blue light reflected from the lens front surface. Blue light ranges from 380-500nm, and it is in this range that modern most device displays have their predominant spectral peak. For the calculation DBR uses as weighting the display spectrum for the world's most popular smartphone.[12]
The reduction is noticeable to wearers and observers, a ZEISS survey found that 72% of participants felt ZEISS BlueGuard Lenses showed less intense reflections than ZEISS DuraVision BlueProtect – a blue light coating solution.[13]

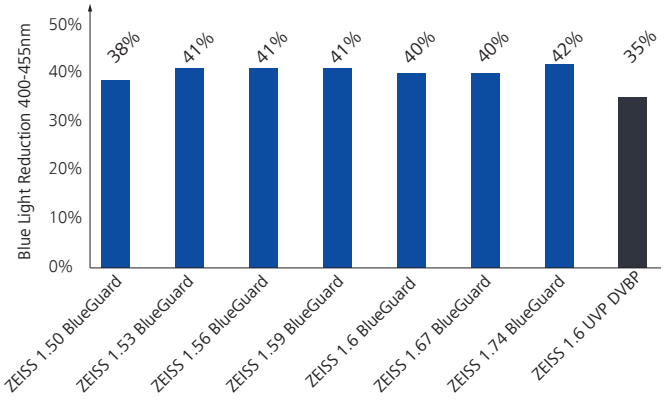


Figure 4 ZEISS BlueGuard (blue bars) blue light protection of available lens index materials calculated by the BVB metric. Black bar illustrates a ZEISS 1.6 UVProtect DuraVision BlueProtect (UVP DVBP) as a comparison lens.

Outstanding Clarity and High Transmission with up to 97.8% luminous transmittance[10]

We all want to see our world as clear as possible, but previous generation in-material blue light lenses have shown noticeable discolorations from grey/blue color additives. The additives have been used to offset the yellowness of the lens that can come from some blue light absorbers and can reduce lens transmittance and give lenses a grey or bluish hue.
ZEISS engineers have found the best balance between clarity and transmission. As a result, 90% of wearers are very satisfied with the clarity of ZEISS BlueGuard Lenses.[13]

Combining protection, comfort and aesthetics

ZEISS BlueGuard Lenses provide an optimal balance between blocking potentially harmful blue light, allowing good blue light to pass, minimizing reflections and providing excellent clarity.

And what about the difference of ZEISS BlueGuard lenses and ZEISS DuraVision BlueProtect. The biggest difference between ZEISS BlueGuard Lenses and ZEISS DuraVision BlueProtect is the blue blocking approach – absorption vs. reflection. ZEISS BlueGuard Lenses absorb blue light while ZEISS DuraVision BlueProtect reflects blue light. ZEISS BlueGuard Lenses deliver more protection with less reflection and better clarity.

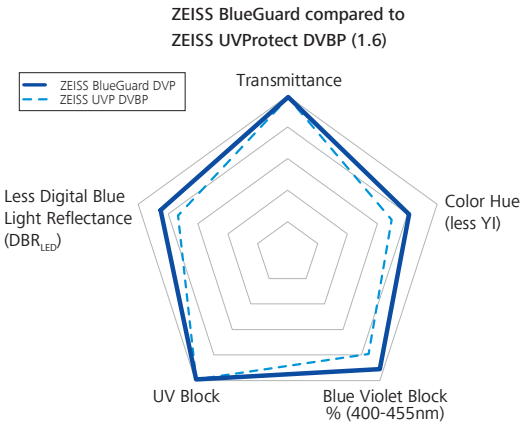
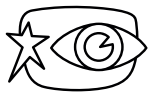
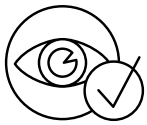


Figure 5 Overview of ZEISS BlueGuard and ZEISS DuraVision BlueProtect coating of 1.6 lens material.

- **More Protection:** Blocks up to 40% of potentially harmful blue light1 and offers full UV protection to 400nm.



- **Less reflection:** Looks good on- and offline, with up to 50% less annoying reflections of digital blue light for excellent clarity.



- **Easy on the eyes:** Designed to address digital eye strain in an increasingly digital world.

References

[1] *Watson A. (2020). In-home media consumption due to the coronavirus outbreak among internet users worldwide as of March 2020, by country. www.statista.com, URL https://www.statista.com/statistics/1106498/home-media-consumption-coronavirus-worldwide-by-country/*

[2] *Bahkir F. A., Grandee S.S. (2020). Impact of the Covid-19 lockdown on digital device-related ocular health. Indian Journal of Ophtalmology, 2378-2383.*

[3] *Behar-Cohen F., Martinsons C. (2011). Light-emitting diodes (LED) for domestic lighting: Any risks for the eye? Progress in Retinal and Eye Research, Volume 30, Issue 3, 239-257.*

[4] *The Vision Council, 2016 Digital Eye Strain Report*

[5] *Sheppard A.L., Wolffsohn J.S. (2018). Digital eye strain: prevalence, measurement and amelioration BMJ Open Ophthalmology, BMJ Journals*

[6] *Coles-Brennan C., Sulley A., Young G. (2019). Management of Digital Eyestrain. Clin Exp Optom, 102(1):18-29.*

[7] *Rosenfield M. (2011). Computer vision syndrome: a review of ocular causes and potential treatments. Ophtalmic Physiol Opt., (5):502-15.*

[8] *Rucker F. J., Osorio. D. "The effects of longitudinal chromatic aberration and a shift in the peak of the middle-wavelength sensitive cone fundamental on cone contrast." Vision research, Volume 48, Issue 19, 1929-1939.*

[9] *Cozza F., et al. (2019) The effects of two longpass filters on visual performance. J Optom. Journal of Optometry, Volume 13, Issue 2, 102-112.*

[10] *Inhouse measurements and calculations based on the BVB (Blue-Violet-Block) metric. Analyses by Technology and Innovation, ZEISS Vision Care, DE 2020*

[11] *Inhouse measurements and calculations based on the DBRLED (Digital Blue Light Reflection) metric. Analyses by Technology and Innovation, ZEISS Vision Care, DE 2020*

[12] *FoxBusiness (2020). What is the most popular smartphone in the world right now. https://www.foxbusiness.com/technology/most-popular-smartphone-world*

[13] *Quantitative survey with N=100 consumers (spectacle lens wearers) in Germany in September 2020*

ZEISS Vision Care
Turnstraße 27
73430 Aalen, Germany

Contact
Email: SciTechComVIS@zeiss.com
www.zeiss.de/vision

EN_20_200_0518I