ZEISS Vision Care

UV before Blue – Take care of UV before considering blue light protection

When it comes to eye health, consumers and eye care professionals have many concerns. One is Ultraviolet Radiation (UVR) - where decades of research have shown UV rays destroy ocular structures, and can cause cancer in the skin surrounding the eye. ZEISS has designed all their UVProtect spectacle lenses to fully block the harmful effects of UVR up to 400nm, while still providing maximum clarity in visible light.
More recently, there has been a growing worry over blue light, especially from smart phones and other digital devices. To some degree, the blue light conversation has eclipsed UVR concerns. Yet the evidence against blue light is at best unclear. While the media has latched on to blue light, there is today no firm clinical evidence to suggest that blue light from digital devices poses a health risk. Blue light coatings can provide a comfort benefit from bright digital displays, which also have been linked to melanopsin levels that impact the bodies sleep pattern. Blue light blocking materials by contrast do not block the peak of the potential blue light hazard, nor the peak intensity of smartphone displays, or melanopsin response - all while compromising lens clarity.

UVR - An undisputed threat to eye health

Scientific and international regulatory bodies agree: UVR is harmful to the human eye and its surrounding tissues

Ultraviolet Radiation (UVR), otherwise known as ultraviolet light, is light that ranges from 100 to 400nm. While UVR is mostly invisible, it can nonetheless severely damage the eyes and their surrounding structures.

UVR interacts strongly with molecules in human cells. Research has shown that the effects of UVR damage accumulate over a lifetime; retinal exposure very early in life may contribute to age-related macular degeneration later on. Other effects of UVR exposure include:

- Photoaging and xerosis of the eyelids and skin surrounding the orbital region
- Skin cancers of the same regions, accounting for 5 to 10 percent of all skin cancers
- Degenerative and unsightly growths on the conjunctiva
- Acute and painful inflammation of the cornea
- Melanoma of the iris, a potentially deadly type of cancer
- Nuclear sclerosis of the lens leading to reduced vision and ultimately to cataracts that require surgery

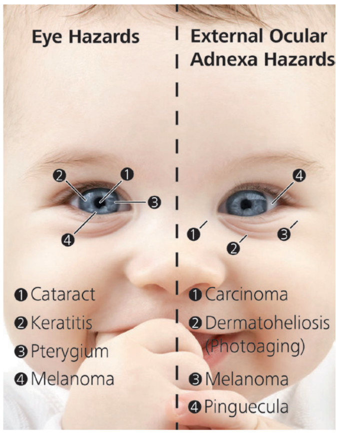

Figure 1. In her lifetime, this child will face many UVR hazards

Eyeglasses – The gap in our UV armour

Most eyeglass lenses do not fully block UVR

Given the potential harm that ultraviolet radiation may cause, it might seem obvious that doctors and consumers would seek the best UVR protection when recommending eyewear. However, this is not the case. Many eye care professionals and eyeglass wearers incorrectly believe that they already offer or have full UV protection.

The truth is that four out of five clear lenses sold today do not fully block UV light up to 400nm[1]. The World Health Organization, as well as multiple medical, scientific, and international regulatory institutions define 400nm as the threshold for UV light, yet today's most common clear lens materials only block wavelengths shorter than 380nm or even 360nm. In addition, arbitrary industry standards have somewhat conveniently defined the upper limit of UV to 380nm, allowing lens manufacturers to claim 100 percent UV protection for lens materials such as polycarbonate when they only block UV below 380nm. But 400nm is in fact the scientifically and clinically accepted UV threshold, and is applied in sunglasses, cosmetics and sunscreen products.
While the spectral gap between 380 and 400nm may not sound like much, it accounts for 40 percent of solar UVR experienced at sea level.

ZEISS has closed this significant spectral gap by including UVProtect technology in all ZEISS plastic lenses. This technology provides complete UVR blocking in the lens, all the way to 400nm, and maintains lens clarity without any noticeable tint.

The myth of UV Anti-Reflective Coatings

UV Anti-reflective (AR) coatings are often touted for their ability to reduce UV exposure. This is widely accepted in the industry – 90 percent of eyecare providers believe

AR coatings block UV[2]. These coatings merely reduce UV reflected off the lens back surface, and unfortunately provide a false sense of security.

A recent study, published in the journal Biomedical Optics Express, found that UV AR coatings provide no additional protection if the lens does not have UV absorption[3]. Testing lenses with UV absorption, backside coatings or both, the simulated real-life study found that lenses with sound UV absorption reduced exposure to 7 percent.

Those with just a coating still allowed 42 percent of UV radiation to reach the eyes.

The study also showed that, without a UV absorber, UV AR coated lenses provided worse protection than similar lenses without UV AR coating. This can be explained by ZEISS research which has shown UV AR coatings, applied to non-UV blocking lenses, increase UV transmission through the lens compared to the same lenses with normal AR coatings.

Only UVR absorption in the body of the lens can provide maximum protection, this is in all ZEISS UVProtect lenses.

The tenuous case against blue light

Unproven eye health risk from everyday blue light

Visible light can also damage eyes. Too much light can generate thermal damage and burn the retina, which is why children are repeatedly warned not to look directly into the sun, and no one should test a laser pointer by pointing it at their face. Another example is photochemical damage, in which visible light generates free radicals that impair the retina. Either type of damage is easy to recognize almost immediately after exposure.

Thermal and photochemical damage are a greater risk in industrial settings, where workers may be exposed to lasers and other energetic light sources. Agencies around the world have developed safety standards to mitigate these risks. However, most people are not exposed to enough high-intensity light to damage their eyes.

Recently, there has been much concern about visible blue wavelengths between 400 and 500 nm – the spectral region associated with blue light hazard (BLH). Some studies have linked long-term exposure to blue light in sunlight to macular degeneration.[4,5] Other research has contradicted these claims.[6,7]

Many studies have notable shortcomings. For example, researchers often ask participants to self-report how much time they spend outdoors to approximate light exposure. Also, many people who spend extended time outdoors have higher levels of other risk factors such as smoking. At best, the subject is controversial, so there is no clear dose-response relationship to help guide safety standards.

For these and other reasons, national institutes of health like the U.S. National Eye Institute (NEI) have no formal opinion on the blue light threat. Listing only age, race, family history, genetics and smoking as maculopathy risk factors. The NEI however does publish strong opinions on the eye health risk from UV exposure *(NIH National Eye Institute - https://nei.nih.gov/news/briefs/uv_cataract).*

Blue Light Hype in the Media?

Unfortunately, blue light's potential risks have been greatly exaggerated in the media. A 2018 study by researchers at the University of Toledo showed that blue light can damage the retina.[8] However, the study used a blue laser, at 445nm, to damage human cells in vitro.

Many press outlets interpreted the study to mean blue light from electronic devices can severely injure retinas. For example, a headline from Fortune Magazine stated: Blue Light Emitted From Electronics Can Cause Accelerated Blindness, Study Finds.[9]

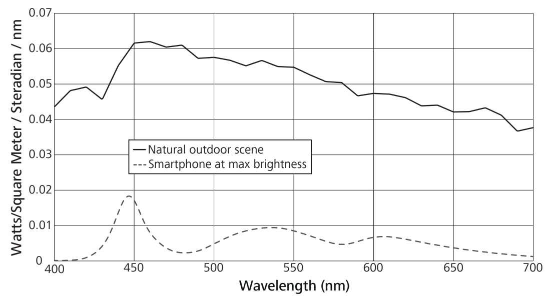

Figure 2. Spectral radiance of smartphone and typical outdoor scene

There was a profound disconnect between the findings in the study and these media stories. As noted, the researchers used blue lasers, which are far more powerful than blue light from actual devices. And while the 445nm wavelength can be hazardous, it is only one small piece of the spectrum, and no device or natural light source produces light solely at that (or any single) wavelength.

To compare apples to apples, a smartphone would have to exceed 100,000 nits to be considered unsafe by any regulatory agency. According to Samsung, their Galaxy 9 produces peak luminance of 1,130 nits.[10] In fact, 100,000 nits would be brighter than a snow covered mountain under a cloudless sky.

The study showed no cellular damage when exposure levels corresponded with outdoor light on an overcast day – which is still four to five times brighter than a digital display. Smartphones are also designed to dim indoors, which mitigates exposure.

If blue light were any hazard at all, the sun would be a far larger risk than any digital source, making a hike outdoors more dangerous than scrolling through Twitter. Given the current evidence, the eye health risk of blue light from digital devices (or natural sources) is almost certainly overblown.

Blue light can affect sleep patterns

Another concern is whether watching digital displays at night can adversely affect sleep. In recent years, scientists have discovered a new receptor type that responds to blue-green light. These receptors contain a light-sensitive pigment called melanopsin. When stimulated, melanopsin receptors control sensitivity to brightness, as well as how pupils respond to light, and influence our sleep cycles. Ideally, these receptors get turned on during the day and are left alone at night. Digital displays may increase blue-green light stimulation, and that may exacerbate sleep issues.

Researchers have also shown that, when using desktop screens for many hours, blue light can alter melanopsin levels.[11] However for smartphones and other small screens, the evidence is less clear. Still, these concerns have motivated handheld device manufacturers to include night-time modes to reduce blue light.

Blue light protection in eyeglass lenses

There is a lot of confusion in the marketplace over how to respond to blue light's perceived dangers. Lenses with blue light filters or coatings are becoming common.

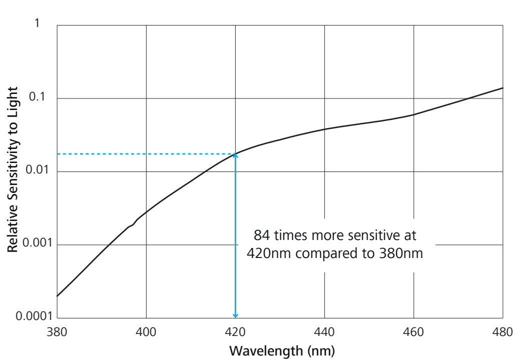

Figure 2. Human blue light sensitivity: CIE Luminosity Function

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Blocking above 400nm must have a visual compromise

Blocking blue light can be a zero-sum game. Adult visual sensitivity ramps up quickly between 380 and 420nm – increasing 84-fold. As a result, lenses that block UV below 400 nm appear clear to the human eye. However, those that block visible light above 400 nm may appear tinted and reduce visual acuity.

Neither lens type does much to protect against the potential blue light hazard, which peaks at 450nm, well above the wavelengths blocked by these materials. ZEISS research showed UV420 lenses pass 70 percent of BLH-weighted daylight, only a 22 percent reduction compared to an uncoated clear lens.12 SBF passes 83 percent with an even smaller reduction.

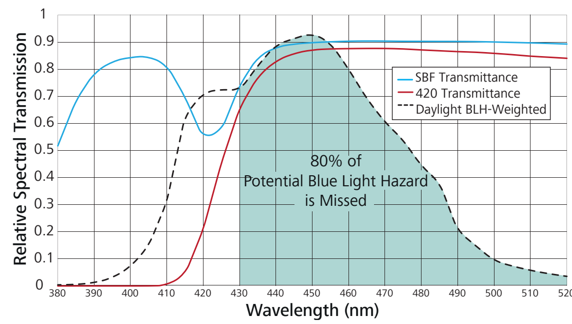

Figure 3. The minimal effect of filters on daylight Blue Light Hazard

These lenses were also ineffective at blocking wavelengths that produce the melanopsin response which also peaks above 450nm. UV420 materials pass 84 percent of the relevant wavelength intensity and SBF passes 88 percent.[13] No studies have shown any improved sleep quality from such small changes. In other words, these materials compromise vision but provide few actual benefits.

Blue Light AR Coatings are a better solution because blue light-absorbing materials have so many downsides, a better approach is AR coatings that actively reflect blue light. These coatings typically reflect blue light between 400 and 470nm, a broader range than blue blocking lenses. They reduce blue light in spectral regions of the potential BLH and activate melanopsin receptors. They are a good alternative for people who are concerned about blue light or may seek to reduce the glare associated with it.

The ZEISS Advantage: DuraVision BlueProtect

Blue light is a challenging subject. Current evidence suggests blue light only threatens eye health in extreme conditions, when people usually wear sunglasses or safety goggles. At present, there's little evidence digital displays endanger eye health.

Still, researchers make new findings every year, so it's possible blue light may pose a currently undiscovered hazard. In addition, major digital device use could disrupt sleep in some situations.

For those concerned about the potential risk, blue light AR coatings are the best bet. DuraVision BlueProtect was

Products *(in uncoated form)*	**UV Protection to 400nm (UVBlock*)**	**Luminous Transmittance (T%)**	**Yellowness (YI)**	**Assessment**
Ordinary 1.50 Index	**60%**	**92%**	**0.8**	World most common lens material
Branded competitors "smart" blue 1.50 Index	**62%**	**88%**	**2.7**	Does not take care about UVR
ZEISS UVProtect 1.50 Index	**99%**	**90%**	**2.4**	99% UVR Protection, clear lens
Typical UV420 1.50 Index	**100%**	**83%**	**4.8**	Big loss in clarity and colour

Table 1. Optical lens performance of selected lenses

designed to reflect relevant bands without distorting colors or distracting wearers with strong reflections. Blind testing[14] showed 79 percent of consumers found DuraVision BlueProtect lenses work better than the best-selling AR brand's[15] blue light AR coating.

The best way to protect our eyes is to fully block UVR

ZEISS UVProtect eyeglass lenses block UV to 400nm

The greatest eye health benefits come from preventing UV exposure. Clear lenses with ZEISS UVProtect block virtually all UV to 400 nm with no noticeable tint. Importantly, these lenses are effective because they absorb UV.

The risks of UV exposure over a lifetime are well documented, and there is no good reason today to accept eyeglass lenses that provide only partial UV protection – even if they claim 100% UV protection (up to 380nm) or include UV AR coatings.

Meanwhile, the debate over blue light will likely rage on, but the scientific and clinical data on UV are unequivocal. Eye health conversations may include blue light, but they absolutely need to start with UV protection first.

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