# HEV Blue Light Filtering Technologies

## Technical Report

KODAK Lens

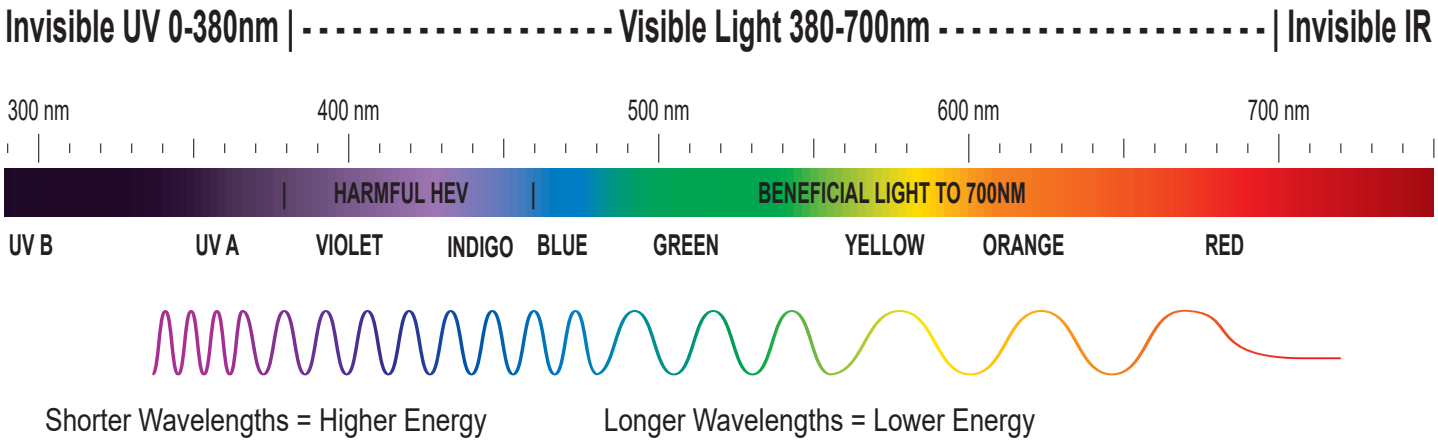
Creating products that help in the filtering of potentially Harmful Blue Light while harnessing the power of good blue light has been a specific area of innovation and focus for the development of the KODAK Lens portfolio. The purpose of this document is to explain the interaction of vision with color and specifically, the benefits of KODAK Lens products that target sections of the color spectrum that could be potentially harmful to the lens wearer's eyes.

Included in this report:

- Visible Spectrum
- Ultra Violet and High Energy Visible (HEV) Blue Light
- Sources of UV and HEV
- Managing Blue Light
- Blue Light Filtering Options
- KODAK Lens Blue Light Solutions

## Visible Spectrum

The visible light is the portion of the electromagnetic spectrum that is visible to the human eye. The visible spectrum is created by different energy wavelengths measured in nanometers (nm). Blue Light is the portion of the electromagnetic spectrum with wavelengths between 380 and 500nm. Blue-turquoise light ranges from 465-495nm and it serves many benefits to humans including regulation of the sleep cycle. As wavelengths increase in distance, their energy diminishes. The short wavelengths at the blue end of the spectrum have the most energy. The high energy end of the visible light spectrum is known as High Energy Visible (HEV) Blue Light. Studies have shown that HEV Blue Light between 415 and 455nm is the most harmful. These same studies showed maximum cell damage from 415-455nm, with a peak at 435nm.[1]




[1] Barrau C, et al. Blue Light Scientific Discovery. Essilor White Paper 1.0, 2013. Arnault E, Barrau C, Nanteau C, Gondouin P, Bigot K, et al. Photo-toxic Action Spectrum on a Retinal Pigment Epithelium Model of Age-Related Macular Degeneration Exposed to Sunlight Normalized Conditions. PloS One,23 August 2013, (8)

## Blue Light and The World Around Us

Although a large amount of blue light exposure comes from the sun, the increasing prevalence of blue light emitting devices has introduced the potential for another level of vision protection. Technology has made a large impact not only on how we communicate and keep in touch with the world, but also the amount of devices and time we spend using them.

We may spend a majority of our days being exposed to potentially Harmful Blue Light without even knowing it. It is common knowledge that we need protection against UV rays, not only for our skin, but for our eyes. In recent years, increasing numbers of eye health specialists are suggesting we need protection from our digital devices.[2]

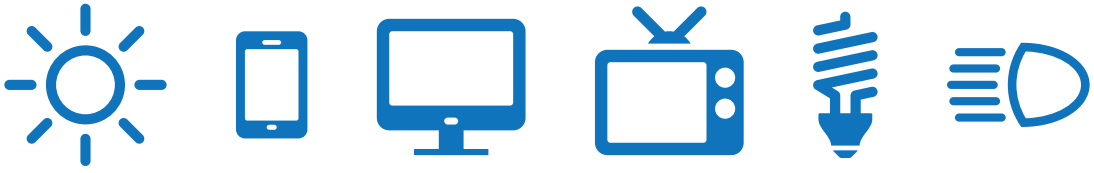
## Ultraviolet Light

As well as the potential damage of HEV Blue Light is the known concern of Ultraviolet light.

We are all aware of the importance of applying sunblock to our skin to prevent sunburn. Those same harmful UV rays may have an impact on eye health, accelerating eye aging and may also contribute to a variety of severe eye conditions, including cataracts.

## HEV Blue Light

Specifically, the prolonged usage of digital devices has increased the average person's exposure to HEV Blue Light. It is not clear what long-term damage HEV Blue Light causes, but various studies have shown a potential link with AMD (Age-Related Macular Degeneration), visual discomfort and disrupted sleep patterns. [3]



[2] Barrau C, Villette T, Cohen-Tannoudji D. Blue light: Scientific discovery. Essilor. 2013 February; 1-49. Blue Light Hazard: New Knowledge, New Approaches to Maintaining Ocular Health, Report of a Round table, 2013

[3] www.health.harvard.edu/staying-healthy/blue-light-has-a-dark-side

## Sources of UV and HEV:

### Daylight

Sunlight is the electromagnetic radiation, which reaches the earth from the sun and is not filtered by the upper atmosphere. It also contains a high proportion of Blue Light.

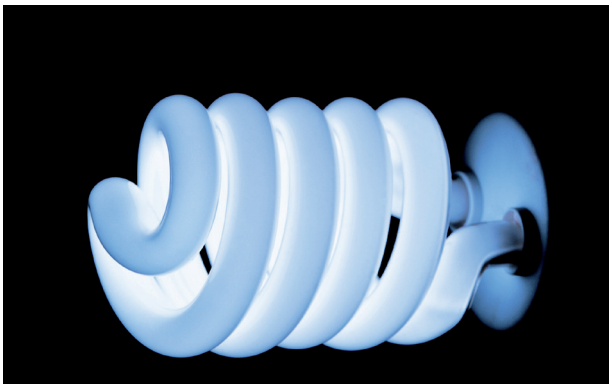
- *Up to 80% of UV rays can pass through the clouds on an overcast day.*[4]
- *Up to 40% of damage caused by UV rays occurs when we are not directly in the sun.*[4]

### LED Backlit LCD

Many modern devices use LED as a light source for backlit LCD screens, these often emit peaks of Blue Light in the shorter wavelengths of 400-455nm. 35% of the optical radiation from LEDs is blue.[5]


### Fluorescent

The cool blue light or 'daylight' fluorescent bulbs give strong white light for good color rendition, but emit strong levels of HEV Blue Light.



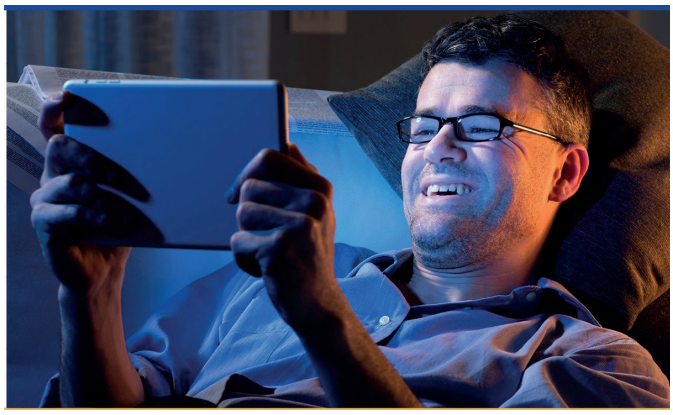
[4] U.S. Environmental Protection Agency, Review of Ophthalmology, Skin Cancer Foundation.

[5] Barrau C, Villette T, Cohen-Tannoudji D. Blue light: Scientific discovery. Essilor. 2013 February; 1-49. Blue Light Hazard: New Knowledge, New Approaches to Maintaining Ocular Health, Report of a Round table, 2013

## Managing Blue Light

Not all blue light is bad and is necessary for full color vision. Certain portions of blue light on the visible spectrum are an essential part of our daily rhythm, and control our sleeping and waking patterns.

With proper blue light filtering eyewear that blocks the harmful HEV wavelengths and allows the good blue light through, you can the avoid disruptions to your sleep cycle and maintain good color vision.



Exposure to artificial HEV 'Blue Light' during naturally dark periods after dusk or before dawn can affect the body's ability to switch off and produce natural hormones associated with the Circadian Rhythm.[6]

HEV Blue Light Filters can reduce the impact on sleep cycles from exposure to HEV sources during pre-bedtime hours.

[6] www.preventblindness.org

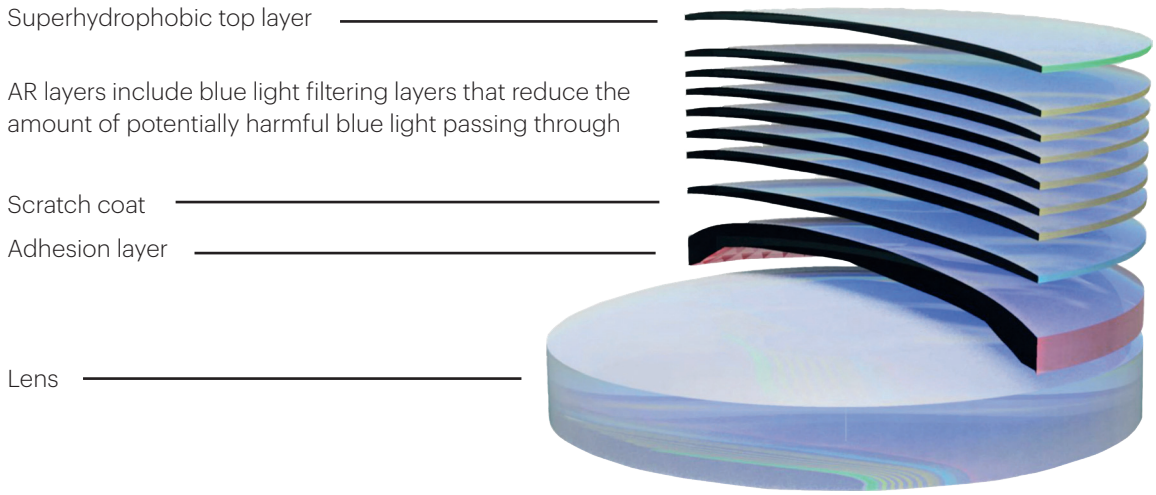
## Blue Light Filtering Options

### Lens Coatings

A blue light filtering lens coating can be applied to the lens, to provide a certain level of potentially Harmful Blue Light filtering as well as the benefits of an AR lens coating.

These coatings reduce glare caused by blue light entering the eye and therefore enable the wearer to better compensate for lighting conditions and off er great visible contrast. This type of coating may have a blue hue reflectance color compared to the majority of anti-reflection coatings that have a green residual hue. While effective in certain blue light wavelengths, the coating is limited to the % of filtration while maintaining a minimal reflection surface on the lens. To protect from blue light further, the coating would add more reflections on the lens and require a mirror-like surface to filter a higher %. Most blue light coatings opt to limit the filtration in order to keep reflections to a minimum.

Blue light coatings are applied in the same vacuum chamber deposition process by modifying the AR stack.



### Blue Light Filtering Lens Materials

The development of specific lens materials is another level of protection from damaging UV rays while filtering potentially Harmful Blue Light.

There are several options in the market ranging from virtually clear to amber tints.

Blue Light filtering materials also known as blue cut lenses include specially-formulated monomers that absorb HEV Light transmission, block UV and filter potentially Harmful Blue light.

### Blue Light Filtering in Photochromics

Photochromic lenses darken with exposure to UV rays. This type of lens is especially convenient for people who spend equal time indoors and outdoors. A photochromic lens is also ideal for those that experience light sensitivity. An additional benefit of a photochromic lens is the ability to filter Harmful Blue Light.

Indoors, inactivated photochromic lenses filter a range of 20-36% of Harmful Blue Light. Outdoors and fully darkened, they filter over 76%.[7]

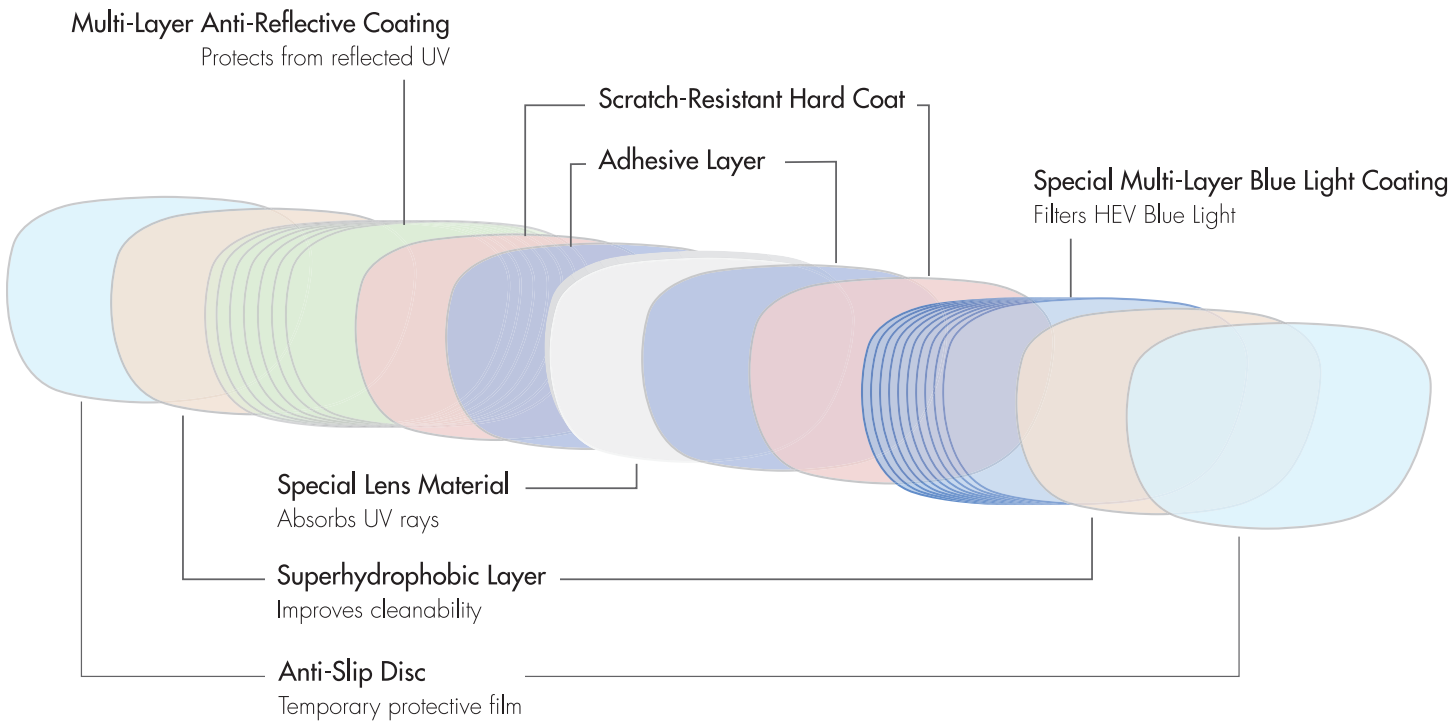
[7] 126266 Transitions Blue Light Sales Aid 2021. Transitions Optical, Inc.

## Combining Material and Coating for Blue Light Filtering

The combination of lens material and coating allows for the highest level of blue light filtering in a clear lens as well as the additional benefits associated with an anti-reflective lens coating.

This lens and coating combination blocks 100% of UV light from the sun, filters out potentially Harmful Blue Light emitted from digital screens and reduces the reflections and glare of blinding lights both day and night.

**Hybrid KODAK Total Blue® Lens.**




**An example of a combination of lens coating and material to filter HEV Blue Light.**

## KODAK Lens Blue Light Solutions

With the use of digital devices and time spent online increasing every year, the need for protection from potentially Harmful Blue Light exposure has also increased. We do not know for certain to what extent the long-term impact will be on vision but the KODAK Lens portfolio will continue to expand with designs and technologies to guarantee that all patients have a solution to fit their vision needs.

| | KODAK UVBlue™ Lens | KODAK Transitions® Lens | KODAK Total Blue® Lens |
|---|---|---|---|
| **Product Type** | Blue cut lens material | Photochromic lens material | Combination: blue cut lens + blue light filtering AR |
| **Material Indexes** | 1.50, Poly, 1.67 | 1.50, Poly, Trivex, 1.60, 1.67, 1.74 | Clear: Poly, 1.56, 1.67, 1.74<br>Polarized: 1.50, Poly, 1.67, 1.74 |
| **Includes AR** | No, compatible with Crizal® and KODAK AR | No, compatible with Crizal and KODAK AR | Yes, dual-side AR and Silk top coat |
| **UV Protection** | 100% | 100% | 100% |
| **Blue Light Filtration** | 20% between 400-455nm | 20% Inactive* to 85% Fully dark between 415-455nm | 80%+ between 380-440nm |
| **Which to Choose?** | Standard filtration for all ages, comparable to most products on the market | Ideal for constant indoor/ outdoor activities. Light sensitive individuals | Premium, best protection, long periods of exposure, light sensitive individuals. |

* Transitions XTRActive® lenses have a light tint while inactive and filter over 30% indoors.[7]

[7] 126266 Transitions Blue Light Sales Aid 2021. Transitions Optical, Inc.

## NOTES

KODAK Lens
See the Colors of Life

**RESOURCES:**

www.KodakLens.us/pro / www.SignetArmorlite.com / www.SALitOnline.com

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