AR COATINGS FOR COMPLETE EYE PROTECTION - BLUE LIGHT & MORE

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During everyday activities, we are exposed to light from many different sources: the sun, tablets, digital notebooks, cell phone and TV screens, lamps, etc.

Light radiation from all of these sources is not always beneficial. In particular, blue-violet light (400 - 450 nm) and ultraviolet light can become dangerous over an extended period and the natural defenses that our eyes possess (eyelid-closing reflex, pupil diameter control, adaptation of retina to light intensity) are not always effective.

Ultraviolet light can induce ocular irritation and sometimes irreversible lesions like cataracts where the crystalline lens gets opaque and cloudy, leading to partial or total vision loss. Blue-violet light, besides inducing the deterioration of retinal cells, like age-related macular degeneration (AMD), also has a strong impact on circadian rhythm regulation, affecting people's body clocks. It can be the reason for sleep disorders and has an overall impact on health and wellness.

To help prevent these problems, it is important to wear glasses that reduce the amount of harmful light radiation reaching the eyes, minimizing negative health effects.

A certain level of protection can be achieved with lenses without specific AR coatings:

1. Clear organic lenses absorb UV light coming from the front, partially or totally depending on the material type, but still allow harmful blue-violet light to pass through and UV light to reflect on the backside directly reaching the eyes.

2. Tinted organic sunglasses absorb UV light and limit the amount of blue-violet light reaching the eyes from the front. However, at the same time they are reflecting UV light on the backside into the eyes when pupils are wide open because of the lenses' low light transmission. Color distortion is a drawback here, too.

3. Photochromic organic lenses in outdoor conditions have similar benefits and drawbacks as tinted organic sunglasses; in indoor conditions they act similarly to clear organic lenses.

Some recent efforts implement filters for harmful blue-violet light as dyes directly embedded into the organic polymers of the lenses.

AR COATINGS ON LENSES

However, it is possible to achieve a much higher protection level by adding suitable AR coatings on lenses: the global ophthalmic market offers several “Blue-cut” and “UV protective” AR products. Blue-cut products block the “blue-violet light” wavelengths by increasing blue reflection on the front side of the lenses; UV protective AR products minimize UV light by reducing UV reflection on the back side of a lens. In many instances these two products are combined in a so-called “complete protection” coating system.

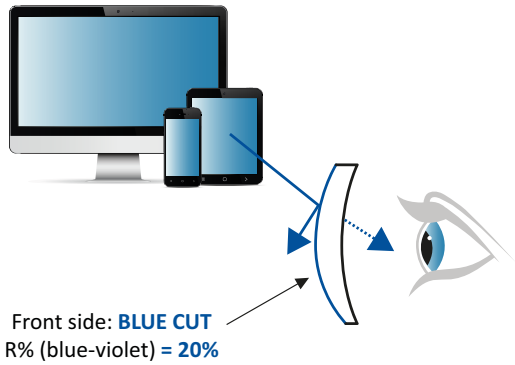

Figure 1. Blue cut

Blue-cut products (figure 1) are usually applied on the front side of clear organic lenses to reflect harmful blue-violet light from tablets, smartphones, LED TVs, and monitors. Light reflection in this wavelength band is usually less than 2% with standard AR coatings. With blue-cut coatings, light reflection reaches a value of 20%-30% or even more, significantly reducing the amount of blue-violet light that reaches the eye.

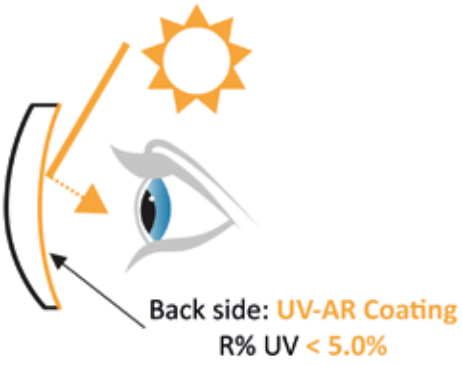

Figure 2. UV protective AR

UV protective AR products (figure 2) are usually applied on the backside of lenses and are optimized AR for the UV wavelength band. Different than standard broadband AR coatings that reflect up to 20%-50% of UV light, UV protective AR coatings bring this value down to less than 5%-10% dramatically reducing the amount of UV light that reflects from the backside of the lens into the eye. Sometimes UV protective AR can be applied to both sides of the lenses, which simplifies production.

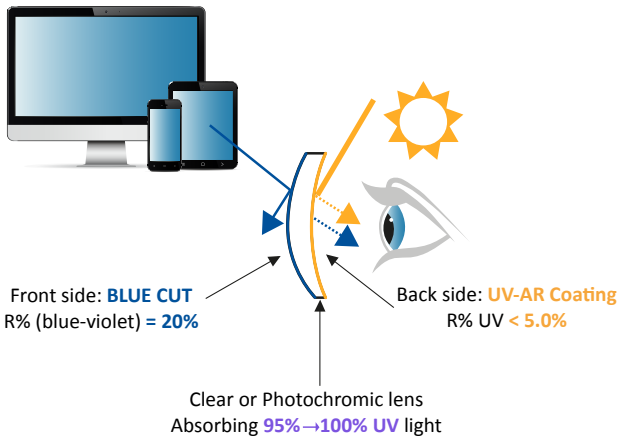

Figure 3. Complete protection AR

Complete protection AR products (figure 3) combine Blue-cut coating on the front side with UV protective AR coating on the backside. This provides the advantages of both coatings and results in the highest level of protection for the wearer: low blue light transmission and improved UV protection that can achieve, depending on the eyeglass material, between 5 and 10 times the protection levels that are reached with standard AR coatings. Complete Protection AR coatings, depending on the adopted strategy, are available with different residual colors on front and backside (front side blue and backside greenish) or with aligned residual colors (bluish on both sides).

Residual color mismatch is typical for products where the protection level is maximized at the expense of cosmetics, while matching residual colors are a compromise between cosmetics and still a good UV protection level.

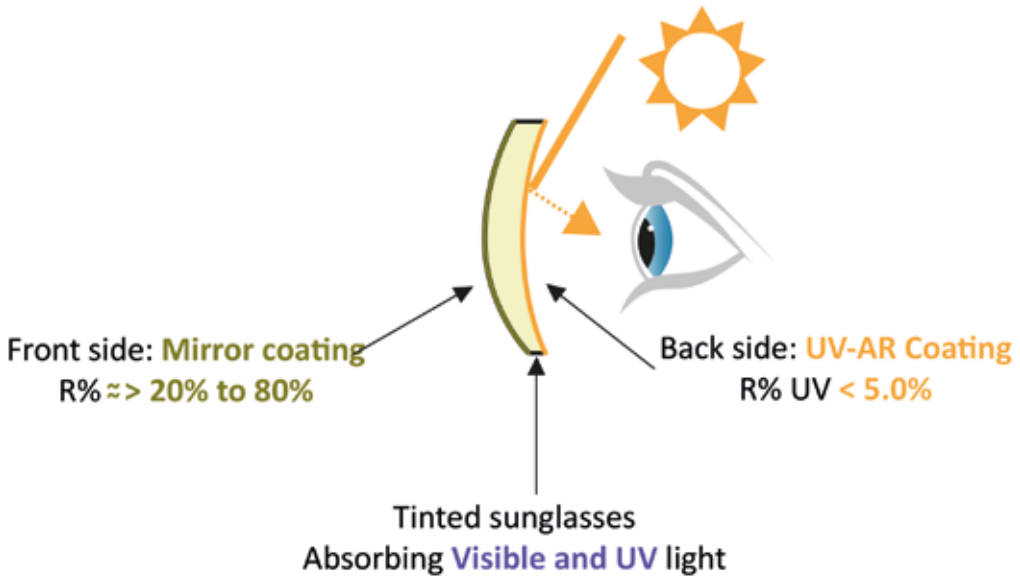

Figure 4. Mirror + UV protective AR

Mirror + UV protective AR coatings (figure 4) are usually applied on Rx sunglasses that are considered high end products and must provide the best protection against UV radiation possible. The mirror coating is deposited on the front side of the lens and minimizes UV light reaching the eyes; at the same time a UV protective AR coating is applied to the backside of the lens reducing the UV light reflection into the eye when the pupils are wide open due to the low light transmission of the sunglass lenses.

CONCLUSIONS:

The coating strategies described in this article are commonly used to increase protection from harmful blue-violet light and UV light. Table 1 summarizes these products indicating the lens types that they are usually applied to and the benefits that they provide. Complete protection AR and Mirror + UV protective AR coatings are high end, top level protection coatings that are commonly used for clear/photochromic lenses and tinted sunglasses.

Process Type	Organic Lens Type	Benefits
Blue-cut	Clear	• Front side protection from blue light. Minimizs disturbing clue light from tablets, smart phones, LED TV´s and monitors, etc.
UV protection AR	Clear and photochromatic	• Backside UV protective AR reduces UV reflection into the eye. Sometimes also the front side can be coated with the same UV protective AR to keep production simple. Recommended especially for photochromic lenses.
Complete Protection AR	Clear and photochromatic	• Front side protection from blue light. • Backside UV protection reduces UV reflection into the eye.
Mirror + UV protective AR	Tinted sunglasses	• Mirror coating on the front side. UV protective AR on backside. Highly recommended for sunglasses, because of wide-open pupils of the sunglass wearer.

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Reference: Satisloh White Paper on "Blue Cut and UV protective AR coatings" December 2015, Michael Witzany

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