Anti-reflection (AR) coating is an excellent spectacle lens option for increasing luminous transmission of the lens, reducing glare, and enhancing the cosmetic appearance of the wearer [4]. It is recommended for virtually all types of eyewear, including clear lenses for general, everyday use as well as nighttime driving; photochromic lenses for patients who frequently move between indoors and outdoors throughout the day; and occupational near and intermediate lenses for computer users indoors. AR coating should be applied to both lens surfaces, since it will decrease the direct and internal reflections that can occur at each surface. This will reduce glare from light sources both in front of and behind the wearer.

By the very nature of how AR coatings work, they will generally increase reflection of non-visible wavelengths, notably ultraviolet (UV) and infrared (IR) [5]. At typical levels in the natural environment, IR from sunlight gives the sensation of warmth on the skin, but poses little risk to the structures of the eye [12, 4]. On the other hand, short exposure of several hours to normal UV levels, or brief exposure to high levels of UV, can cause immediate and painful problems such as sunburn to skin and keratitis [12, 13, 16, 4]. Continued long-term exposure over months and years can cause or exacerbate conditions such as pre-mature aging of the skin, cancer, pterygium, cataract, and macular degeneration.

For an AR coating applied to the front surface of a lens, the coating provides additional protection beyond the UV-absorbing properties of the lens itself. Different AR coatings can reflect 25% or more UV, depending on wavelength [5]. By comparison, lenses with scratchresistant coatings usually reflect no more than about 5% of any UV wavelengths, what would be expected of a typical uncoated ophthalmic material. Thus, with an AR coating on the front lens surface, harmful UV radiation now will be reflected back into the environment and away from the wearer’s eye. But the same AR coating on the back surface of the lens can actually increase the amount of UV incident at the eye. In addition, this will happen under viewing conditions and times of day when the wearer is least likely to be aware of any danger.

Many patients are familiar with the risk of sunburn in mid-day hours, from about 10 AM to about 2 PM, especially during summer months. However, Sasaki et al. [15] demonstrated that most of the direct exposure of the eye to UV will occur mid-morning (before 10 AM) and mid-afternoon (after 2 PM) throughout the year, when the sun is lower in the sky and close to the wearer’s horizontal
viewing plane. The potential risk of UV exposure is present either from the front, if the lens does not adequately block UV, or from the side, if the combined lens and frame do not provide appropriate coverage of the wearer’s face [16, 9, 14]. With the consideration of possible UV reflection from the back surface of the lens, the risk is also greatest at these hours, but now when the wearer actually faces away from the sun! A recent study demonstrates that the UV reflection risk is greatest when the wearer is about 145 degrees from the sun, that is, with sunlight coming from behind the wearer, just over his or her shoulder [6]. Figure 1 demonstrates eyewear that leaves the wearer’s eye exposed from the side and from behind.

![Fig. 1](image)

The various international standards for prescription and non-prescription lenses address UV exposure only in terms of limiting or minimizing transmission through the lens [1, 2, 7, 10, 11, 3]. None of the standards address UV exposure caused by a lens that does not adequately cover the eye, thus leaving the eye exposed from the side or above. Also, none of the standards address UV reflection from the back surface of the lens, which will depend not only on the AR coating but the size, curvature, wrap (faceform) angle, and vertex distance of the lens. This could leave the patient – and the practitioner! – with the mistaken impression that UV transmission through a finished lens is the only hazard that needs to be considered.

What can eyecare practitioners do to provide the best possible UV protection for their patients? In addition to minimizing visible wavelength reflection, the AR coating applied to the back surface of all prescription lenses intended for daytime use outdoors should minimize UV reflection, down to the wavelengths expected from sunlight in the natural environment at about 290 nm. A new index, the Eye-Sun Protection Factor (E-SPF) [6], informs the practitioner and the wearer about the UV protection provided by such a lens. It takes into account UV transmission through the lens and UV reflection from the back surface of the lens, as well as the varying sensitivity of the cornea to different wavelengths within the UV spectrum. Technically, E-SPF can be determined empirically by measuring the UV incident at the eye first without and then with the lens in place, or it can be estimated by calculating the inverse of the sum of the UV transmittance and reflectance [6].

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E-SPF is an index similar to that used for sunscreen products (see Urbach, 2001 [17], for an excellent historical review) and ultraviolet protective clothing (see Gambichler et al., 2006 [8], for a review of the development of the European standard, EN 13758), in that a higher category value indicates greater UV protection. The category value specifies the approximate multiple units of time necessary to receive a given exposure dosage: for example, with an E-SPF 25 lens, it would take about 25 minutes to receive the equivalent total dosage as 5 minutes for an E-SPF 5 lens.

The eyecare practitioner also should make appropriate frame recommendations to the patient, and adjustments to any dispensed eyewear, all of which derive from the proper positioning of the lens with respect to the eye [16, 9, 14]. This is especially relevant for over-the-counter nonprescription sun eyewear for contact lens wearers and patients who otherwise do not need a prescription. The best protection will be provided by a frame that is contoured with sufficient faceform and pantoscopic angles to fit closely to the wearer’s face and head (see Fig. 2). Such a frame often requires that the lens have a steep base curve, usually 6 D or greater. This may not be possible or practical for certain prescription powers.

If the frame has a relatively flat front, or when a high faceform angle is not possible or desirable, then it should have a wide temple or sideshield. But the frame horizontal dimension should not extend significantly past the side of the wearer’s face or head, even if the temple is wide. The frame vertical dimension should be large enough to fully cover the eye and extend upward to cover the brow, thus minimizing direct exposure of the eye from above. Finally, nosepads should be correctly chosen or adjusted to minimize the vertex distance. Eyewear can be fashionable and functional. For patients who spend much of their time outdoors, it also needs to be protective. An appropriate AR coating on each lens surface, indicated by a high ESPF value, as well as proper frame choice and fitting techniques, will contribute to the patient’s long-term eye health.

References