ModernMedicine NETWORK

# MAKING A SPECTACLE

## Free-form progressive multifocal, single-vision atoric lenses are cutting-edge advances.

March 15, 2005
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We've come a long way since the antiquated lens designs of the 20th century. Manufacturers have coupled computer-aided lens design with advanced optical ray tracing programs to create some of the most exciting and cutting-edge ophthalmic lenses ever.

These advances have occurred in virtually every lens type, but most noticeably in progressive no-line multifocal lenses, single-vision atoric lenses, and thin films. These modern spectacle lenses have finally delivered exactly what your patients have been wanting and needing. Here's a look at some of the most advanced lenses in the marketplace.

Progress in progressives Free-form technology is the latest topic in the ophthalmic marketplace. Everyone is excited by the new and innovative lens technology.

Free-form technology is a logical extension of Design by Prescription, pioneered by scientists at SOLA. Their free-form progressive lens design is called SOLAOne, which uses high-tech computer-aided ray tracing technology to deliver the most advanced progressive-lens technology on the market. It allows the lens manufacturers to incorporate their specific design onto a lens blank without having to compromise visual acuity, as seen with traditional progressive lens designs.

Free-form technology virtually eliminates unwanted radial astigmatic error, the most common cause of non-adaption in patients with presbyopia. Traditional progressive lenses use one base curve to cover a number of prescriptions, which will correct power errors with a specific prescription, but yields a compromise with adjacent prescriptions within a given range.

The SOLAOne design allows presbyopic patients the ability to see at various distances without residual image jump (base down prismatic effect), restrictive focal lengths, or demarcation lines. SOLAOne employs aspherical curves across the front surface of the lens (below the major reference point), while at the same time a gradual decrease in the radius of curvature is used from the distance portion to the near area. This results in a lens that has multiple centers of curvature, which allows for multiple focus points.

Exactly what is the progressive corridor? Simply put, a corridor (umbilical line), or gradual increase in plus varying conic sections (curves) from the distance portion to the near portion of a progressive lens, creates additional plus power. As the add power increases, positive radial astigmatic dioptric power (plus cylinder) is introduced in the lens. The result is skewed aberration toward the periphery of the lens.

Traditional progressive lenses have increased residual plus cylinder, which creates the boundary or corridor, which is perceived by patients as a "busy" sensation as their angle of gaze rotates toward the periphery of the lens below the major reference point. Free-form technology helps eliminate excessive unwanted radial astigmatism, which results in a wider intermediate and reading area.

The corridor's length is the distance measured from the optical cross (not the major reference point) to the near optical center. The gradual increase in plus power through the corridor will determine the corridor's overall length. SOLAOne Design by Prescription coupled with free-form technology allows for a wide comfortable reading area with the clearest possible optics for distance.

Cutting-edge single-vision lenses When most ophthalmic professionals want the best single-vision lens for their patients, they consider benchmarks such as the substrates' refractive index, abbe value, specific gravity, and spherical versus aspherical lenses.

One lens design that makes the grade over any other single-vision lens is the VIZIO, which is a linear atoric series of finished single-vision customized lenses with a $1.66_n$ refractive index, with a double-sided anti-reflective treatment.

While aspheric lenses only set out to correct power errors in only one single power in a given plane, VIZIO has an atoric design that optimizes the patient's prescription in every meridian, including tangential and sagittal, which results in perfect optics. The design uses atoric curves on the ocular (back) surface of the lens, with aspheric curves on the front surface, which allows the lens to have a flat plate height/profile without compromising optics. This lens allows your patients to have clear, precise vision in every angle of gaze.

Advances in thin films Some doctors are reluctant to recommend thin films (antireflective treatments) because of past negative experiences with first-, second-, and third-generation treatments. Negative experiences included peeling and scratching, and grease and oils would penetrate the coating, making it impossible to clean. Modern thin-film treatments have addressed and eliminated the problems associated with earlier treatments.

To understand these new treatments, let's take a look at how thin films work. The relationship between refractive indices and reflections is that as the refractive index of a lens increases, so does the amount of reflection. By adding a very thin layer(s) of a metal oxide, typically the thickness is the wavelength of incident light. This creates a secondary wavefront, which cancels reflections of a specific wavelength. This is known as destructive wave interference.

Early-generation thin films were simple one- or two-layer treatments. Modern thin films use a multilayer, or broadband, treatment versus narrow-band treatments. Narrow-band antireflective coatings will only reduce reflections in a limited portion of the visible spectrum. Broadband treatments eliminate reflections across the entire visible spectrum (about 380 to 750 nm), which maximizes the percentage of available light. The result is more than 99% of available light reaches the retina with minimal reflections and ghost images and with reduced blur for the patient.

These broadband treatments are being applied to both the base curve (front side) and the ocular surface of the lens. Typically, a primer layer is applied onto the lens surface, giving it a platform for the remaining layers. A second layer, which acts as a hard coat, is then used, which protects the primer and lens from scratches and adds increased stability. Then a third layer, sometimes chromium dioxide ($CrO_2$), designed to resist cracking, is used.

A fourth layer through seven or eight layers are used in an alternating combination of titanium dioxide ($TiO_2$) and silicone dioxide ($SiO_2$). This is what creates the broadband thin film using an alternating wave shift motion that transmits light across the entire visible spectrum, yielding a subtle residual reflectance—blue, green, or red—depending on the manufacturer's design.

Modern-day spectacle lenses are delivering exactly what patients have desired for years. I'm looking forward to see additional exciting changes in the coming years.

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