**Product Spotlight – SunSensors**

# New Photochromic Lens Technology - Expanding Material –Casting –Coating Options

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Ophthalmic Level 2

## Course Description

Manufacturers are always searching for ways to improve the patient visual experience. This means pushing the limits of technology to discover new and better chemistry to produce the best material solutions for lenses including photochromic lens technology. Each photochromic technological advancement is born from either a material or coating solution improvement. This course describes the latest improvement for photochromic casting technology for in-mass and informs us of the new patented CrystalChrome, the newest thermal cured hard coat coating photochromic technology. This course is intended to help you better understand the MR series of SunSensors lenses with In-mass technology and it will also introduce you to CrystalChrome photochromic technology. Better technology means better products and satisfied customer. It is a Win, Win for the patient and the practice!

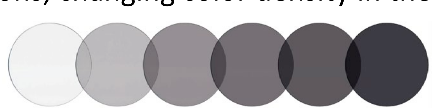
## Objectives

1. Learn a short overview of photochromic lens improvements.
2. Understand in-mass photochromic lens chemistry and how the distribution of dye molecules throughout the lens monomer
3. Learn the essentials for communicating the complementary patient benefits of high index, photochromic and new lens designs have on the patient satisfaction.

## WHY PHOTOCHROMICS?

If money were no object, patients would want every lens enhancement and only the best materials used in the making of their eyewear. Todays informed consumer weighs the value of the lens options. Therefore, each benefits must be made clear to the customer hence each benefit must be clear to the optician. It is imperative that you know the details of 'how and why' new photochromic will improve optical performance convenience and make the life of the consumer better. So why photochromic?

As a wearer of photochromic lenses, I think that convenience and comfort of photochromic lenses provide the most value in any of the pairs of eyeglasses with lenses that adapt to light conditions, changing color density in the presence of UV and back to clear upon its removal. As a person lucky enough to have multiple pairs of glasses, I often think about the day's activities, will I carry a backpack to hold an extra pair of sunglasses or will the convenience of my photochromic lenses be all that I need for the day. I believe this an opportunity that all consumers deserve. It doesn't remove the reason that that all should have a pair of polarized sunglasses, especially when driving or spending extended periods outdoors in bright or



hi-glare conditions. However, it does suggest that as long as only one pair of glasses stays the norm, that eyewear should be photochromic.

**Expanding Photochromic Solutions**

**SUNSENSORS** – Available In-Mass or with CrystalChrome Photochromic Hard Coat Technology

**CrystalChrome** is the newest hi-tech photochromic hard coat solution. The proprietary hard coat is a polysiloxane based thermal cure hard coat designed for use with Mitsui SDC's (a wholly owned subsidiary of Mitsui Chemicals, Inc.) CrystalChrome Photochromic coating system. It features: Abrasion Resistance, Chemical Resistance, Optical Clarity, and is compatible with Antireflective and metalizing treatments.

**PRODUCT OVERVIEW**

Exceptional Optical Clarity
Dip Coat and Thermal Cure Process
Compatible with A/R and Metallizing Coating treatments

**PERFORMANCE FEATURES**

Delivers best-in-class photochromic performance on all lens materials
Fast Darkening and Fading Speed
Excellent product durability and stability
Grey and Brown photochromic color options

**PRODUCTION BENEFITS**

Manufactured under stringent ISO 2001:2008 quality standards, enhancing coating performance
Long product service life reduces the need for frequent tank change-outs
CrystalChrome streamlines manufacturing, enhancing yields and profitability Access to SDC's global technical support team for your product validation & application requirements

**Materially Tuned Photochromic**

Commercial availability of photochromic lenses had its origins in 1964 when Corning released glass lenses with variable tint technology i.e., lenses changed color and density when exposed to ultraviolet light.

In 1999, Corning applied their expertise to plastic lens materials introducing the SunSensors brand. Other companies further developed the technology and grew the photochromic market to where it is today, with modern photochromic availability from a variety of manufacturing suppliers.

In 2014, Mitsui Chemicals acquired the plastic photochromic business from Corning and, as a major lens material supplier initiated development of an improved photochromic that could take advantage of the other lens material benefits that it already supplied to the market. During 2016, Mitsui began to test new SunSensors-50MPH and SunSensors-MR8 with its lens-casting customers. Why a new photochromic?

Up till then, only a 1.56 mid-index lens was possible because the technical challenge has been to get the in-mass photochromic dyes to effectively disperse within the hard lens structure, during the lens material's casting process, without denaturing the dyes. A new technique called Ultra Dye Dispersing technology now enables these new dyes to work in the current lens casting systems. And, the caster can adjust the dye load to affect how dark the lenses become in their final darkened state.

**'In-mass'** is defined as the mixture of a material or effect, dispersed evenly throughout the body of a lens that provides benefit. For example, high index lens materials like 1.6 and 1.67 are 100% UV absorbing. That's because the lens is made from a monomer and additives, that once cast, is 100% UV absorbing. Lenses do not require additional treatment to improve UV attenuation for light passing through the lens. In this same way, the chemistry that make a lens change it color and density (darkness, light absorption) can be added to the monomer before casting so that the resulting lens is photochromic throughout.

Why is an in-mass technique of manufacture an advantage? It is an alternative to current technology of embedding the photochromic material into the lens surface coating, embedding a filter layer or imbibing the photochromic dyes into the lens' front surface. Instead, the entire lens contains the light changing chemistry throughout the monomer. That expands the photochromic options for new hi-tech dual side processing (dual aspheric, dual side progressives, complex surfaces, etc.), extreme high curve lens requirements, lined multifocal and lenses for rimless frames.

Mitsui Chemicals supplies the vast majority of high index monomers used for ophthalmic lenses worldwide. Called MR (Mitsui Resin), you've seen them advertised in lab price lists as MR-8, MR-8 Plus (1.60 high index) and MR-10 (1.67 high index). New SunSensors has been tuned to these monomers. That will allow your lab to produce lightweight, premium strength, high refractive index, and prescriptions with advanced photochromic performance. The high index lenses are complemented by SunSensors 50HPM, a low index version (1.51) for general prescriptions.

Today, infused front hard coats contain the UV activated dye molecules that produce the photochromic response. There are certain lens manufacturing requirements and opportunities that would benefit from having the photochromic dyes distribution throughout the lens monomer rather than dependent on compatibility with a photochromic hard coat.

For example, there are a number of complex digital single vision (double aspheric) and progressive lenses (dual surface technologies) that require front, as well as back surface, cutting and polishing. Using in-mass prepared lens blanks allows their direct surfacing, then application of traditional premium hard and AR coatings in standard coating units. Complex dual side lens design manufacturers are experienced in using the MR lenses that add thinness and lightness to the lens' premium design. Additionally, since the improved durability of AR is a function of the hardness of the hardcoat, improved hardness hard coating systems are then viable with these photochromic lenses.

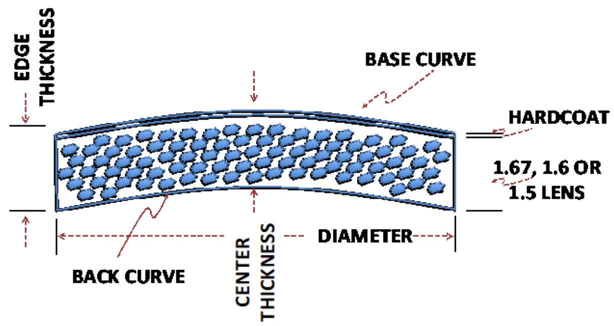



Fig. 1 Lens blank illustrating the position of the photochromic lens dyes

Next, lined multifocals like bifocals and trifocals rely on dip or spin technology to apply the lens' hard coat. However, when there is a discontinuity of the lens' surface, there is a wave of inconsistent hard coat thickness at the top of the segment and at one or both top corners of the segment. That inconsistent thickness affects the color of tints and a photochromic embedded coating and in the darkened state, shows a color and density variation. As a result, up till recently, that prevented the production of lined multifocal photochromics in materials that didn't support direct surface imbibition. However, one can cleverly embed a film of photochromics under the lens surface so that the hard coat can be made non-tintable and therefore any color is unaffected by coating irregularities. In this case, if the substrate (1.51, 1.60 and 1.67) could be cast with the photochromic dye included as part of the chemistry, only well proven hard coats and AR are necessary.

Last, high prescriptions suggest high index lenses. Most opticians and doctors recommend materials that improve thinness and lightness. These lenses also create high curves, back of high minus lenses and fronts of high plus. High curves increase coating inconsistencies during manufacture. However. If the lenses are already photochromic, premium hard coats can be used and any irregularity of thickness that might affect lens color is avoided. This is also important for rimless lenses where one drills through the coating and lens. Tension on the lens around the drill holes can stress the surface creating uneven darkening of a photochromic coating. Lenses manufactured from an in-mass product can avoid this problem.

**DARKENING AND FADING**

Most opticians, and photochromic consumers, will agree that the lenses darken fast once you step outside. However, fade back speed has not performed as well in the past and is an area that new photochromic technology has improved. Past problems with fade back time was a detractor for photochromic sales despite their overall benefits and the fact that even with slow fade back those that purchased photochromic lenses have a high rate of repurchase.

Improving the fade time addresses two issues: First, for the customer that opted out due to the slow fade time and residual color once the lens returned to its completely deactivated state indoors, a new sales opportunity now exist to bring them back to photochromic. The second opportunity addresses an optician or doctor's bias that photochromic lenses perform poorly based on past experience and that this lack of past customer satisfaction deters them from recommending the lenses. That is because a personal bias affects whether an option is recommended, or if mentioned but in a negative light. Instead of presenting the many benefits of these convenient and protective lenses, the ECP cites perceived drawbacks based on bias. For example, how many have heard the comment, "…they don't darken in the car…?" While true of photochromic lenses, it is also true of clear lenses. Yet you would not use this reasoning to deter the patient from purchasing clear lenses. New technology overcomes old objections and now we must overcome outdated bias. Do not deprive the patient of the many positive reasons to have their primary pair of eyewear with photochromic lenses thereby ensuring sunlight protection for their eyes while providing added comfort for their eyes when outdoors without their sunglasses.

*Vision Watch reports that only 31% report wearing sunglasses all the time outdoors. And, only 7.4% report that their children always wear sunglasses outdoors! Now, imagine if everyone had photochromic lenses for all of the time spent outdoors without sunglasses.*

The advantages of photochromics far outweigh not recommending them to all patients. And as we've seen, each year there is product that improves their performance.

To understand new SunSensors fade time improvement, a graph of performance (Fig 2), shows the lens darkening and fading time by material. The Table below dimensionalizes what can be described to a patient. Here's how.

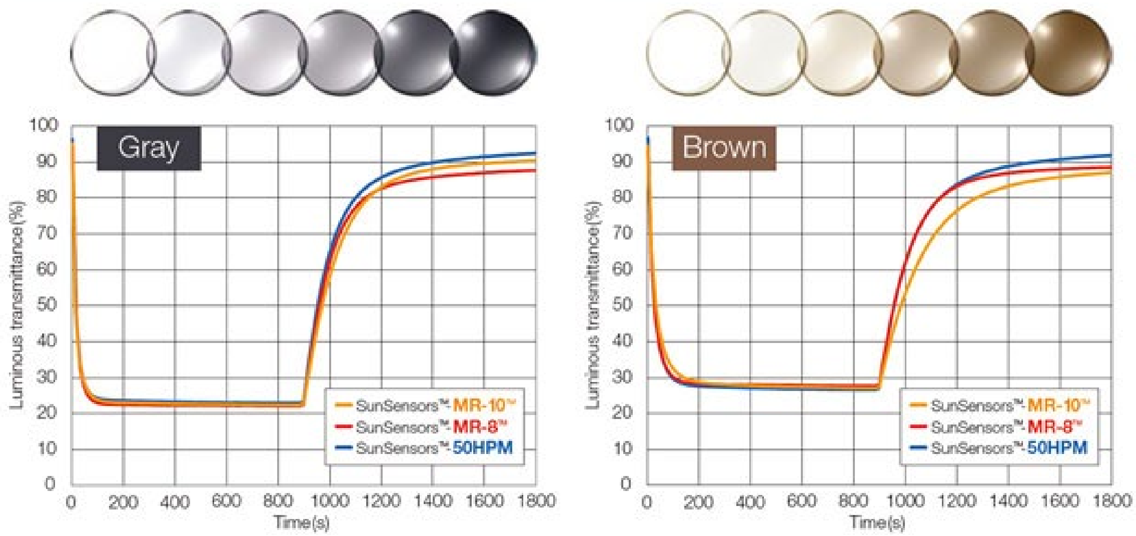
**Fading speed**

| Luminous transmittance | Half fading time (sec) | | 80% fading time (sec) | |
|---|---|---|---|---|
| | Gray | Brown | Gray | Brown |
| SunSensors™- **MR-10™** | 75 | 102 | 281 | 412 |
| SunSensors™- **MR-8™** | 65 | 75 | 269 | 267 |
| SunSensors™- **50HPM** | 62 | 75 | 232 | 266 |

Table 1. Fade time in seconds

Gray lenses fade to half their darkness in a little more than a minute, words that a patient can understand. This amount of time can be meaningful. In Brown, fade time is about the same, somewhat longer for MR-10. The time it takes to get grey or brown lenses to 80 percent clear is on average, 4 and a third minutes, brown MR-10 about 7 minutes. The figure below shows the actual curves for each of the new SunSensor material availability.

**Transmittance curve** Measured at 550 nm and 23 °C with our lens with 2 mm in central thickness




In addition, a review of performance after accelerated weather tests shows little change to either the fade time or the clear state color. These are important for the patient that keeps their glasses longer than the usual repurchase cycle. For example, the US re-purchase cycle for the over 55 year old is about 2.8 years. That means that for the customer that keeps their glasses as long as that or longer, lenses retain a near new lens performance. This is an important dimension of value for a portion of patients.

**WHEN CHOOSING MATERIAL**

Lens manufacturers choose lens materials and their raw chemical suppliers because of the products that they can manufacture that deliver superior lens attributes in final lens form. Those lenses must provide a promise of market preference and market success. Labs choose lens materials because of ECP demand and product sales opportunities but require in-lab processing efficiency and superior surface quality. ECPs choose lens materials because they are the foundation of the final lens that delivers patient satisfaction and saleable benefits. Each also requires an opportunity to make a profit. (Adapted from the CE course MR Material).

Almost 6 of every 10 pair of glasses sold in the US today are of thinner, lighter, more impact resistant lenses and 100% UV absorptive? Opticians make this conscious choice, of benefits built in when choosing lens materials for patients. When asked why opticians choose “premium high Index”, they suggest that the higher refractive index makes for thinner, better looking lenses, a higher Abbe number and surface finish ensures clarity, and the high impact and reduced notch sensitivity or tensile strength makes them also perfect for rimless. How have high index lenses evolved and what makes them a lens material choice that supports the best of premium eyewear?

Photochromic lenses, for many patients are expensive, so durability is one key criteria of customer satisfaction. A discussion about how well their photochromic will perform, for the life of their prescription (for some customers as much as twice the 2 year average repurchase cycle) improves the value of the eyewear to be sold. So, concerns about color appearance, fading and darkening speed can be addressed and put to rest. Assuring a patient about product durability is a patient's important measure of value.

Durability also means other things to casters, opticians and patients. When a lens caster chooses a material from which to make lenses, they must consider FDA 21CFR 801.410, the requirement that all lenses dispensed in the US will pass the drop-ball test. New SunSensors is also available in MR-8 Plus. This monomer allows a lens caster to improve the impact resistance of the lenses they supply without compromising the index (both are 1.60) and density (1.3gm/$cc^3$ vs. 1.31) that made ECPs purchase lenses made from MR-8. The difference was that MR-8 required an impact primer as part of the hard coating process to ensure that the subsequent lens with an AR coating would exceed the drop ball test. MR-8 Plus can remove that primer requirement. This can improve efficiency for casters and labs as they manage their lens manufacturing processes. The inclusion of the primer on an MR-8 Plus lens further improves impact resistance. An interesting application of the capabilities of lenses made from the Plus monomer can be the production of bifocals and trifocals with inherently improved impact strength and photochromic performance. Tintability is also significantly improved in lenses made from the Plus monomer.

Why know about upcoming change? Our industry is reliant on "new". We sell a product in which the wearer relies on the benefits of better vision. However, if it were just seeing, it would not be as exciting. Vision is just one part of a pair of glasses and while the usual driver to seek new eyewear, then the opportunity to add a beautiful frames, thinner and lighter lenses, improved photochromic performance, etc. That's what changes the patient's experience and that's what brings patients back.

If your office does not regularly seek out 'new', then perhaps patients come for their exam (they trust the doc) but then more might be leaving to buy their eyewear elsewhere. Know about the new, ask for it from your suppliers and shout about it to every patient you see.