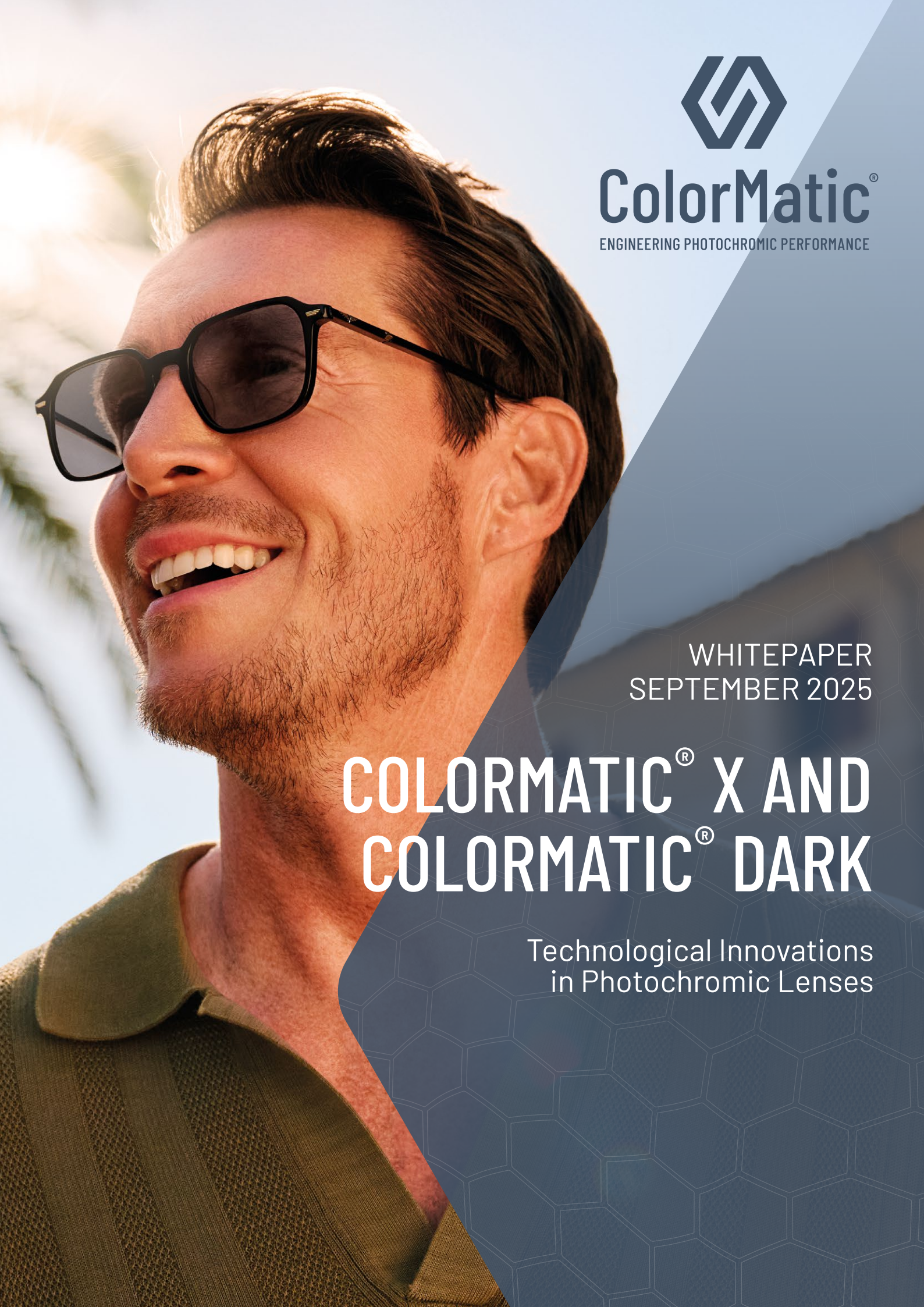

ColorMatic®

ENGINEERING PHOTOCHROMIC PERFORMANCE

WHITEPAPER
SEPTEMBER 2025

COLORMATIC® X AND COLORMATIC® DARK

Technological Innovations in Photochromic Lenses

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1. COLORMATIC®

1.1. REACTS TO LIGHT – RESPONDS TO LIFE

As modern lifestyles demand versatility and comfort for vision in diverse lighting conditions, photochromic lenses **have emerged as a critical solution for glasses wearers worldwide.** Rodenstock's ColorMatic® lenses stand at the forefront of this transformative technology, offering innovative and adaptive solutions for seamless vision in constantly changing environments.

ColorMatic® lenses go **beyond the basics of traditional photochromic technology.** Designed with precision and incorporating advanced materials, they provide a remarkable balance between functionality and aesthetics. Their ability to dynamically adapt to changing light intensities ensures **optimal vision, comfort, convenience, style and eye protection** – whether you are indoors, outdoors or transitioning between both.

The importance of ColorMatic® lenses lies in their dedication to solving modern challenges. Whether protecting the eyes from harmful ultraviolet (UV) rays, reducing glare or enhancing contrast perception, these lenses cater to the needs of active individuals, professionals and anyone seeking an effortless visual experience. By eliminating the inconvenience of switching between prescription glasses and sunglasses, ColorMatic® lenses redefine convenience and offer exceptional value to wearers.

For Rodenstock, ColorMatic® lenses are more than just a product innovation – they represent the company's unwavering commitment to excellence, **pushing the boundaries of optical technology to enhance quality of life.**

1.2. HERITAGE AND EXPERTISE

In 1986 **Rodenstock was one of the first** to launch photochromic plastic lenses, and this marks **over 35 years of profound photochromic know-how.**

Rodenstock runs its **own photochromic R & D department** in Munich, Germany, where **highly skilled chemists** have invested **more than 70,000 days into researching** new technologies. As a result, Rodenstock currently holds **48 granted patents.**

Rodenstock also has its own in-house state-of-the-art photochromic-dye department, where more than **2,000 dyes** have been developed, allowing Rodenstock to **react extremely quickly** to changing market requirements.

Photochromic products are developed in **close cooperation with in-house coating and material experts,** providing **full process reliability** and allowing customers to benefit from Rodenstock's vast network of lens production expertise.

1.3. FUNCTIONALITY OF PHOTOCHROMIC LENSES

Photochromic lenses represent a groundbreaking solution for those seeking optimal vision comfort and clarity in varying light conditions. These lenses automatically adapt their tint based on the light environement, particularly UV radiation, offering seamless transitions between darkening in bright sunlight and returning to a clear state in low-light or indoor settings. **ColorMatic® lenses set a new standard** in Rodenstock photochromic lens technology, addressing common challenges with innovative solutions that ensure high performance.

Photochromic lenses work using **specialised molecules, such as spiropyrans, naphthopyrans or fulgides, organic photochromic dyes,** embedded either directly into the lens material or onto the spin coating or double casting. These molecules **react to UV light by undergoing structural changes, which cause the lens to darken.** When UV light diminishes, for example when the wearer steps inside a building, the molecules return to their original configuration, restoring the lens to its clear state. This transformative process allows users to maintain maximum visual comfort in different lighting environments without needing to switch between glasses.

1.3.1. WHAT MAKES COLORMATIC® LENSES EXCEPTIONAL?

ColorMatic® lenses take Rodenstock photochromic technology to a new level, enhancing comfort, durability and optical quality while solving common drawbacks of traditional photochromic lenses. Below are the key factors that make ColorMatic® lenses stand out:

FAST REACTION TIMES

The lenses' advanced molecular structure ensures one of the **fastest reaction times on the market.** Whether darkening outdoors under bright sunlight or clearing up for indoor use, ColorMatic® lenses adapt quickly and effortlessly. This speed ensures uninterrupted comfort for users transitioning between different lighting conditions.

DURABILITY

Rodenstock's precisely developed spin-coating and double-cast matrix ensures that ColorMatic® lenses **retain their photochromic capabilities even after years of regular use.** Rodenstock's innovative manufacturing techniques also make them durable and resistant to wear over time, delivering long-lasting performance that users can depend on.

COLOR FIDELITY

One of the unique benefits of ColorMatic® lenses is the accuracy and natural quality regarding color perception. Unlike some photochromic lenses that may distort colors or create unnatural tints, ColorMatic® lenses transition smoothly into stable and natural tones. This ensures that **users experience clear, undistorted vision regardless of light conditions.**

EVEN TINT DISTRIBUTION

The advanced ColorMatic® manufacturing process guarantees **even tint distribution across the entire surface of the lens.** This outstanding technology eliminates imperfections like streaks or uneven shading, providing consistent clarity and comfort. This ensures that users experience clear, undistorted vision regardless of light conditions.

COMPREHENSIVE PROTECTION

ColorMatic® lenses go beyond light adaptation by integrating additional protective features, including robust UV protection and blue-light filtering. By limiting exposure to harmful blue light – like that emitted by digital screens – the lenses **reduce eye strain and enhance overall visual comfort,** while still maintaining clarity and performance in any environment.

EMBEDDED IN THE RODENSTOCK WORLD

ColorMatic® can be combined with other high-end technologies and innovations from Rodenstock, such as LayR and B.I.G. EXACT™ Sensitive. This ensures **seamless compatibility and performance,** providing wearers with optimised vision tailored specifically to their individual needs and environments.

CONCLUSION

The Rodenstock ColorMatic® lenses represent a perfect fusion of comfort, style and technological innovation. By addressing common wearer complaints such as slow reaction times, color distortion and shortened durability, they provide a premium solution for a wide variety of eyewear needs. **ColorMatic® lenses are premium photochromic lenses.** In a world where adaptability, visual clarity and protection are critical, ColorMatic® lenses empower users to experience consistent comfort and premium optical quality in all lighting environments. Rodenstock's commitment to innovation ensures that ColorMatic® remains one of the most trusted and advanced solutions in premium eyewear.

ABOUT COLORMATIC®

- ✓ In-house R&D department, which is constantly developing new products and upgrading existing ones
- ✓ 48 granted patents

2. NEW COLORMATIC® X WITH DOUBLE-CAST TECHNOLOGY

2.1. DOUBLE-CAST MATRIX SOLUTION AS A NEW BENCHMARK IN HIGH-INDEX LENSES

ColorMatic® X lenses are the **fastest ColorMatic® lenses ever developed,** making them ideal for individuals who frequently move between indoor and outdoor environments. They adapt to changing light conditions with exceptional speed, darkening in sunlight and clearing indoors, all while maintaining natural color perception. With advanced responsiveness, durable design, and full UV and blue-light protection, ColorMatic® X lenses provide unmatched comfort and clarity for both everyday use and demanding lifestyles.

RESOLVING TECHNOLOGICAL CHALLENGES

A more flexible surrounding matrix enables fast absorption changes but can negatively affect the surface hardness. Research aimed at improving established systems by increasing the flexibility of the matrix has identified certain measures to compensate for reduced scratch resistance. However, these measures usually increase the complexity in further production and pose limitations on the adhesion of anti-reflective coatings. Furthermore, they can reduce lens clarity, leading to a poor visual experience, especially in the evening or in low-light situations.

NEW TECHNOLOGY FOR HIGH-INDEX LENSES

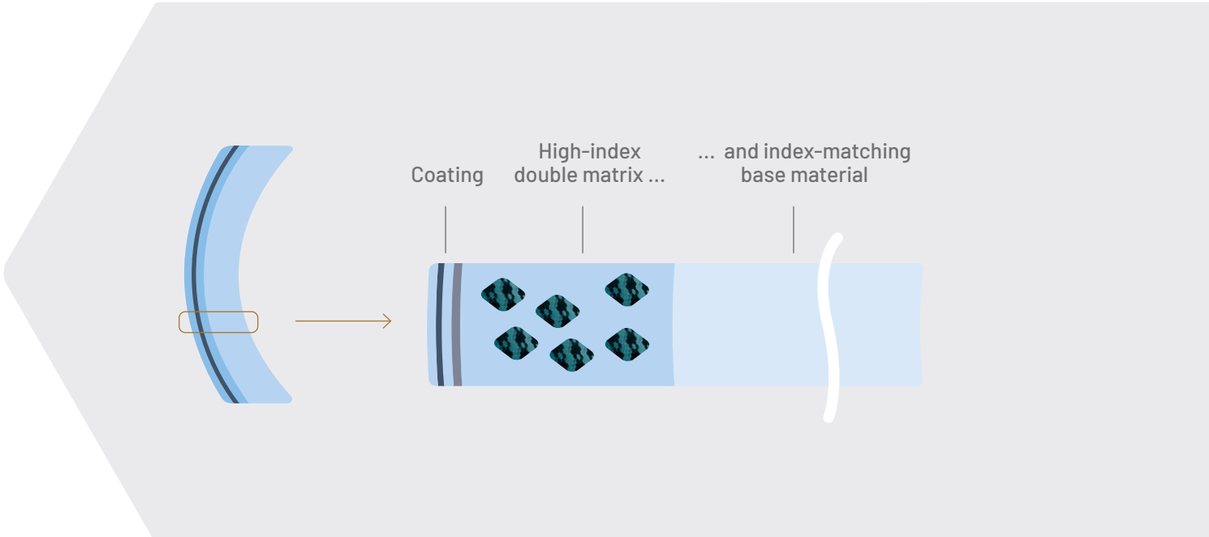
Using our comprehensive know-how in:

- ✔ plastic lens technology,
- ✔ photochromic dyes and
- ✔ photochromic matrix solutions,

we engineered a lens with the rear part of the lens **made from a high-index base material – optimised for maximum clarity, durability and 100% UV protection.** The front part of the lens is also optimised for high durability while providing premium photochromic performance. This distinct approach of ColorMatic® X represents a new technology in optical-lens engineering, providing consumers with visual comfort and durability.

IMPROVED DYE GENERATION

A major innovation in the latest generation of ColorMatic® X lenses lies in the development of **unique new dye technology, featuring double-absorption dyes.** These advanced dyes not only deliver more neutral and aesthetically pleasing colors but also increase the durability of the lenses through the addition of stabilising compounds. Furthermore, this evolution extends the offering of ColorMatic® X lenses to include **a 1.67 refractive index for thinner lenses** and introduces **two stylish new colors – Steel Blue and Pilot Green – within a 1.60 index.** This progress represents a significant milestone in dye and material innovation, improving ColorMatic® X lenses in quality, durability and visual appeal.

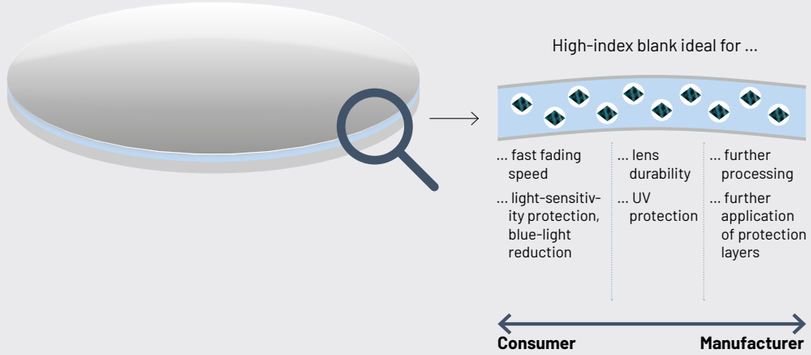


Internal exemplary scheme

2. NEW COLORMATIC® X WITH DOUBLE-CAST TECHNOLOGY

2.2. NEW PRODUCTION TECHNOLOGY FOR EASY PROCESSABILITY AND HIGH DURABILITY

Opticians appreciate the high-index material for its durability. In contrast to other techniques, ColorMatic® X is produced using an innovative approach. The ColorMatic® X lens consists of a **high-index base material in the rear part and an index-matching double-matrix material in the front of the lens, directly combined in the initial lens blank.** This ensures high resilience to external influences throughout the entire blank, forming the ideal basis for additional applied treatments. Moreover, the latest generation of ColorMatic® X benefits from advanced double-absorption dyes, which enhance color stability and achieve more consistent long-term performance. Additional protection layers or other measures for further processing steps are not needed, as the high-performing photochromic domains are separated from the durable surrounding high-index material. The blank can therefore be further processed like any high-index material, offering superior adhesion for subsequently applied layers such as hard coat and AR coating.

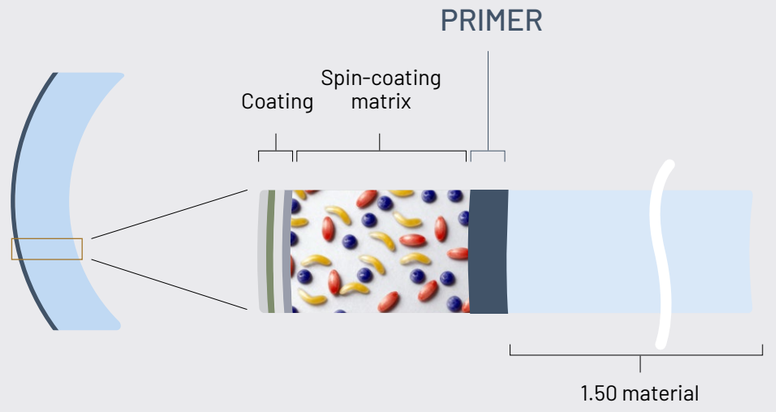


2.3. SPIN-COATING MATRIX FOR IMPROVED PERFORMANCE IN 1.50 LENSES

At Rodenstock, we are driven by our commitment to excellence, continuously refining every aspect of our ColorMatic® lenses. Significant time and resources have been dedicated to the development of a cutting-edge spin-coating matrix, resulting in remarkable advancements. By integrating a primer with an innovative photo lacquer, we have achieved photochromic performance on par with the double-matrix technology in our high-index lenses. This breakthrough ensures fast darkening under intense UV exposure while maintaining **high clarity in the clear state.**

Another significant innovation in the new ColorMatic® lens portfolio is the overarching change in index from 1.54 to 1.50. This modification simplifies the process of installing advanced coatings on the base lens. In addition, different substrates can be **combined with the same photo lacquer, which reduces the complexity at the production** site enormously.

During the spin-coating process, the photo lacquer is evenly distributed across the surface of a rapidly rotating lens, ensuring a high level of precision and uniformity. Designed specifically to maintain their performance over extended periods of daily use, lenses produced using the spin-coating process offer exceptional durability. These advancements make the spin-coating process an ideal solution for producing premium photochromic lenses, combining state-of-the-art technology with the reliability and versatility required in today's eyewear market.

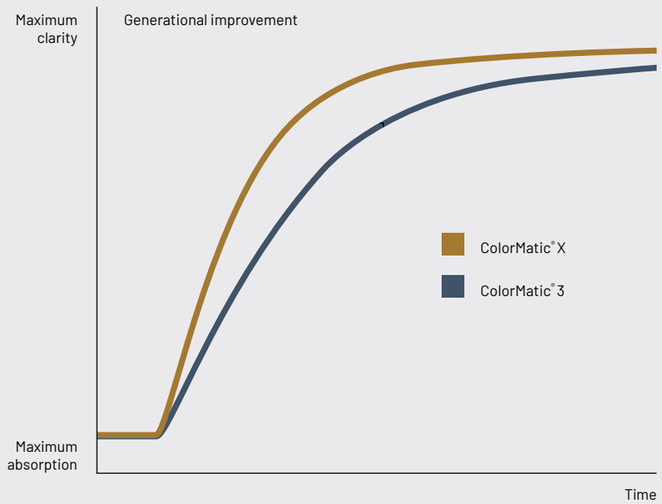


3. COLORMATIC® X – A BALANCE OF SPEED, CLARITY, ABSORPTION AND PROTECTION

3.1. THE FASTEST COLORMATIC® LENSES EVER

ColorMatic® X lenses clear up from their maximum absorption to full clarity at a faster rate than any previous ColorMatic® lens, setting a new benchmark for speed in Rodenstock's photochromic technology. Fade-back speed is a key factor for an enhanced visual experience, and with ColorMatic® X, we have made a significant leap forward. This improvement is quantifiable: ColorMatic® X clears at a rate of 14.8% per minute, compared to 9.5% per minute for ColorMatic® 3, representing a **56% speed enhancement.** While speed and darkening performance are influenced by temperature – something inherent to all photochromic lenses – ColorMatic® X is optimised to deliver performance across a wide range of conditions. For those customers who prioritise even darker lenses and enhanced performance in high-temperature environments, ColorMatic® Dark (Chapter 5) offers a tailored solution while maintaining all the core benefits of the ColorMatic® line-up. Whether speed, clarity or everyday adaptability is the priority, ColorMatic® X remains an outstanding choice for wearers seeking premium performance and comfort.

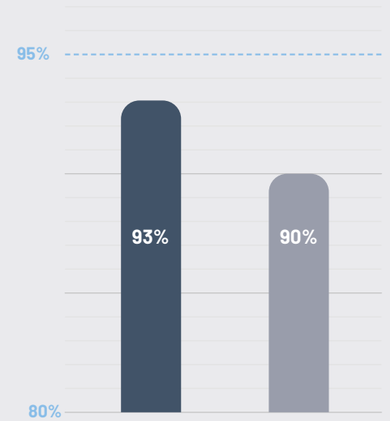
3.1.1. COMPARISON OF COLORMATIC® X WITH COLORMATIC® 3



Internal measurement, brown, 1.60, 23°C

3.2. NEW PRODUCTION TECHNOLOGY FOR EASY PROCESSABILITY AND HIGH DURABILITY

Indoors, even slight variations in clarity can significantly influence both wearing comfort and aesthetics. ColorMatic® lenses strive to be the perfect solution as an everyday lens. That is why we have focused on achieving high clarity in our lenses, reaching **transmission of up to 93% indoors.** At the same time, the lenses provide 100% UV protection, making them a reliable and compelling alternative to non-photochromic lenses.



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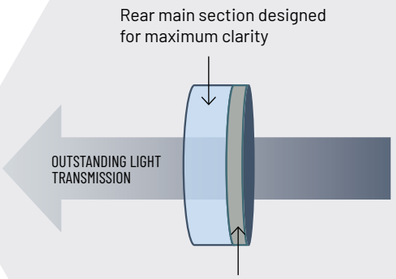


HOW DID WE ACHIEVE SUCH HIGH CLARITY?

Our ColorMatic® X lens consists of a base lens providing 100% UV protection. Thanks to the UV protection provided by the base lens, it was possible to engineer the photochromic **spin coating and double-cast matrix** for maximum clarity and performance. The embedded tailor-made dyes offer high light transmission. In addition, we include **pre-tints in the base lens** to minimise the yellow tint found in other lenses offering blue-light protection. In this way, we have created a perfect lens for everyday use indoors and outdoors.

3.3. DARKENING OF COLORMATIC® X LENSES

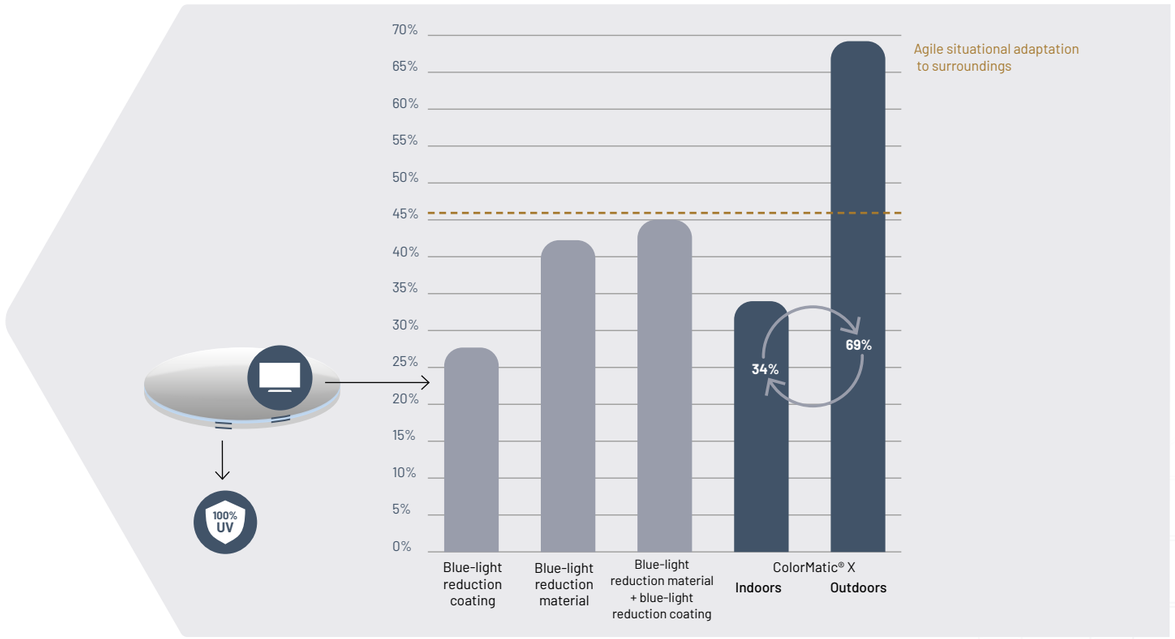
The optimised double matrix and the advanced spin-coating solution not only provide market-leading clarity but also enhance the darkening performance of the lens, ensuring reliable and uniform transitions. Thanks to our tailor-made embedded dyes, the carefully engineered molecules achieve exceptional **darkening levels of up to 88%*** in moderate climates, delivering comfort in bright sunlight while maintaining natural color perception.

3.4. 100% UV PROTECTION AND ADAPTIVE BLUE-LIGHT REDUCTION

Thanks to our unique matrix solutions, the multifunctional blank ensures:

- ✓ 100% UV protection in the rear section and
- ✓ an adaptive blue-light reduction in the front

for comfortable vision and enhanced well-being.



* Internal measurement

TECHNOLOGY

- ✓ Double-cast matrix solution for high performance of ColorMatic® X in 1.60 and 1.67
- ✓ Spin-coating matrix solution for improved performance of ColorMatic® X in 1.50
- ✓ New production technology with increased durability for further processing

COLORMATIC® X – PEAK PERFORMANCE

- ✓ Our fastest photochromic lenses to date
- ✓ With up to 93% base transmittance indoors
- ✓ The ultimate ColorMatic® lens for everyday use

THE BENEFITS OF COLORMATIC® X

- ✓ Smart eye protection throughout the day
- ✓ High wearing comfort in everyday situations
- ✓ An all-round solution, coming with performance and durability

5. COLORMATIC® DARK – HIGH PERFORMANCE IN HIGH TEMPERATURES

5.1. NEW PRODUCT, NEW APPROACH, NEW USE CASE

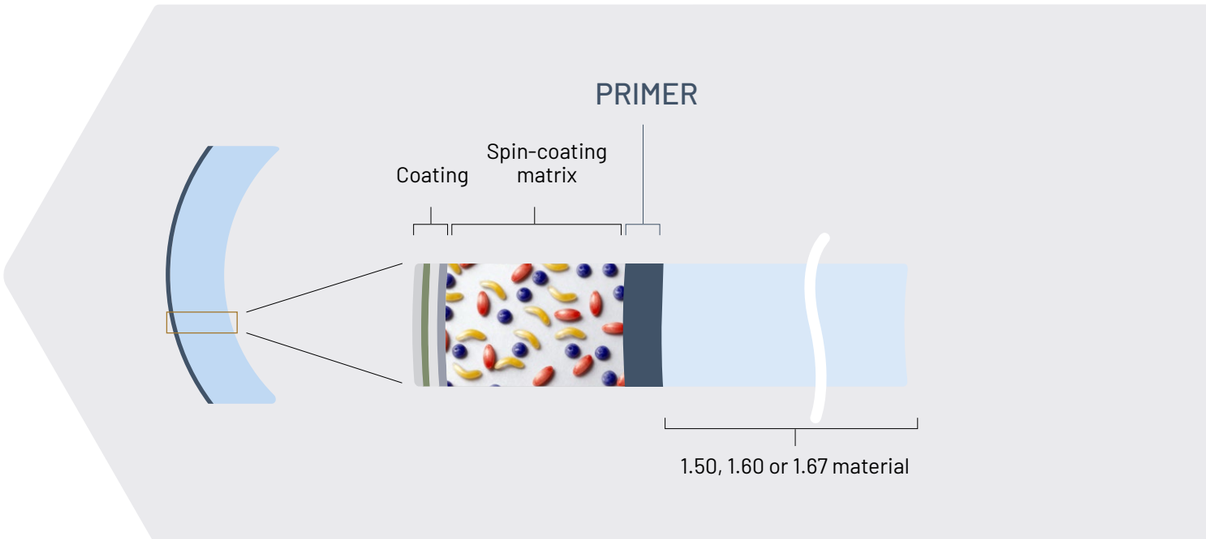
ColorMatic® Dark lenses represent the latest innovation from Rodenstock, developed to meet the highest standards of performance and wearer satisfaction. Designed for those who require superior performance in intense sunlight and warm environments, these lenses provide deep darkening while maintaining the exceptional quality of the ColorMatic® brand. Unlike normal photochromic lenses, which do not darken at all inside a car, ColorMatic® Dark lenses **adapt seamlessly to light environments, particularly UV radiation,** offering enhanced maximum absorption for brighter outdoor settings and darkening even inside vehicles, thanks to the **newly implemented visible light sensitive** (VLS) dyes. This ensures visual comfort even while driving and in other scenarios where traditional photochromic lenses only react to UV radiation. Available in **two stylish colors – Chestnut Brown and Smoky Grey** – and three indices, ColorMatic® Dark lenses maintain natural color perception while delivering aesthetic flexibility. While they are optimised for higher darkness, if the speed of fading is more important for the customer, we recommend ColorMatic® X (Chapter 2) as the preferred solution. With a robust design, 100% UV and blue-light protection, and evenly distributed tint, ColorMatic® Dark lenses deliver clarity and comfort for wearers who demand reliable performance in even the most challenging lighting and temperature conditions.

5.2. SPIN-COATING MATRIX FOR ALL INDICES

The spin-coating matrix represents a significant technological advancement in the production of innovative lens coatings. During this process, a photoactive lacquer is evenly applied to a rapidly rotating substrate, ensuring precise and consistent distribution across the lens surface. One of the **key advantages of spin coating is its versatility** – the same photo lacquer can be utilised across different substrate materials (1.50, 1.60 and 1.67 indices), significantly reducing manufacturing complexity.

The advancements that led to the development of ColorMatic® Dark are based on tailored dye mixtures that were designed to seamlessly integrate with the spin-coating matrix, ensuring deep darkening performance **even at high temperatures (approx. 35°C)** – an essential requirement for wearers in diverse environments. Additionally, VLS dyes were introduced to enable darkening behind windscreens, an important feature for usability across a variety of driving conditions.

Moreover, the lenses produced through the spin-coating process demonstrate **improved durability,** retaining their performance properties over extended periods of use. To achieve this improved lens stability, a primer is put between the base lens and the photo lacquer. Notably, the ColorMatic® Dark lenses also maintain an excellent baseline transmission level indoors, delivering superior clarity in clear conditions without compromising darkening depth or aesthetic appeal.



5. COLORMATIC® DARK – OPTIMAL PERFORMANCE IN HIGH TEMPERATURES

5.3. DARKENING PROCESS

COLORMATIC® DARK IN HIGH-TEMPERATURE ENVIRONMENTS

ColorMatic® Dark lenses are specifically designed to excel in high-temperature environments, where traditional photochromic lenses often struggle to provide effective darkening. This improvement is made possible by Rodenstock's innovative spin-coating matrix, which ensures uniform tint distribution and enhanced molecule activation, even in warm conditions. This advanced technology allows ColorMatic® Dark to **achieve a deep darkening of up to 90%* in moderate climates and up to 78%* in 35°C.** ColorMatic® Dark ensures consistent performance, delivering light protection and visual comfort for wearers in hot climates or under intense sunlight.

DARKENING INSIDE VEHICLES AND NEAR WINDOWS

Unlike traditional photochromic lenses, ColorMatic® Dark lenses feature advanced VLS (Visible Light Sensitive) dyes that allow them to adapt to light conditions **even through car windscreens.** It is important to note that the darkening levels depend on the type of windscreen and the usual external parameters (e.g. temperature, UV intensity etc.); the lenses ensure **enhanced protection and comfort for drivers.** It is important to note that those VLS dyes are also responsible for the activation of ColorMatic® Dark near windows in buildings, providing subtle darkening in such conditions, making the lenses a versatile option for wearers in a variety of lighting situations.

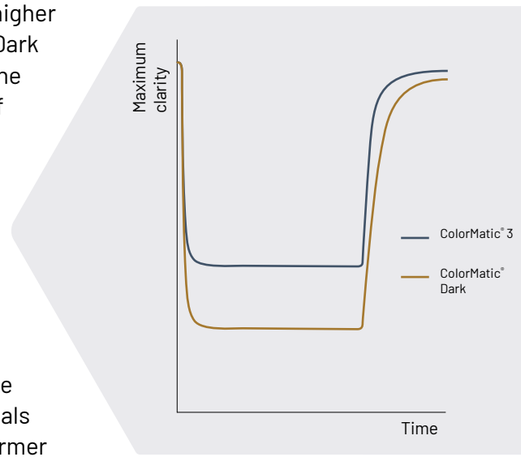
SPEED

The ColorMatic® Dark lenses are thoughtfully designed to meet the needs of customers who prioritise extra darkness and **performance in high-temperature environments.** While delivering the enhanced light protection these wearers seek, ColorMatic® Dark maintains a clearing speed consistent with the industry standard for this specific category of photochromic lenses, **clearing at a reliable rate of 5% per minute in 23°C.** In higher temperatures, there is a noticeable reduction in the time taken for the lenses to become clear again. This balance between fade-back speed and extended darkening capability ensures that wearers enjoy optimal comfort and performance, even in challenging outdoor conditions. By aligning with market expectations while offering a high level of darkness when needed, ColorMatic® Dark upholds Rodenstock's commitment to premium photochromic technology, ensuring a well-rounded and satisfying visual experience for every wearer.

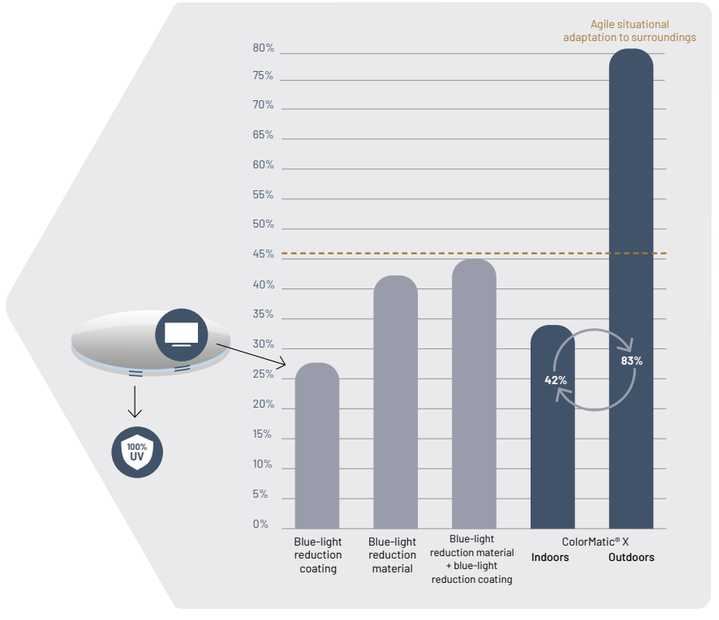
* Internal measurement

5.3.1. COMPARISON WITH COLORMATIC® 3

When it comes to adaptive sun protection in higher temperatures, the introduction of ColorMatic® Dark marks a significant leap forward. While the ColorMatic® 3 lens achieves a darkening level of approximately 55% at a temperature of 35°C, the ColorMatic® Dark lens reaches an impressive darkening of up to 78% under the same conditions. This translates to a **remarkable improvement of approximately 37% in darkening performance,** offering enhanced comfort and light protection compared to ColorMatic® 3, even in high-temperature environments. These unique capabilities make the ColorMatic® Dark lenses the ideal choice for individuals seeking the optimal photochromic lens in warmer climate conditions.



5.4. 100% UV PROTECTION AND ADAPTIVE BLUE-LIGHT REDUCTION



Due to the outstanding spin-coating matrix solution and the implementation of VLS dyes, ColorMatic® Dark lenses have an **even better blue-light reduction than the ColorMatic® X lenses.** The multifunctional blank ensures:

- ✓ 100% UV protection in the rear part and
- ✓ an adaptive blue-light reduction in the front

for comfortable vision and enhanced well-being.

6. COLORMATIC® DARK – SUMMARY

TECHNOLOGY

- Spin-coating solution for optimised performance of ColorMatic® Dark
- Tailor-made formulation suitable for 1.50, 1.60 and 1.67

COLORMATIC® DARK – OPTIMAL DARKENING

- Our darkest photochromic lenses to date with up to 90% absorption in 23°C
- Up to 78% absorption in 35°C: the best high-temperature performance of a ColorMatic® lens ever
- Thanks to VLS dyes, the lenses also activate behind the windscreen
- The ultimate ColorMatic® lenses for hotter climates or very light-sensitive people

THE BENEFITS OF COLORMATIC® DARK

- Smart eye protection throughout the day
- Perfect solution for high-temperature environments
- An all-round solution, coming with performance and durability

ColorMatic®

ENGINEERING PHOTOCHROMIC PERFORMANCE

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