



Watching the world
MR™ Series



MITSUI CHEMICALS, INC.
Health Care Materials Division



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www.mitsuichem.com/special/mr

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Corporate Information

About Mitsui Chemicals, Inc.

Mitsui Chemicals, Inc. (MCI) contributes to society by providing high quality products and services to customers through innovations and creation of materials while maintaining harmony with the global environment. MCI has over 30 years of experience in the development and production of innovative optical lens materials for the global market. The optical monomer brand name of MR™ is now globally recognized as a premium high index lens material. In 2008, **SDC Technologies, Inc.**, a California based premium coating material company, became a MCI group company. In 2011, MCI acquired **Acomon AG**, a leading optical lens material manufacturer well known for its RAV7 Series of R.I. 1.50 lens material. Thus MCI is able to provide a full range of lens material and coating solutions to global lens manufacturers.

In 2013, **KOC solution**, a Korean manufacturer and distributor of plastic optical lenses monomers, became a MCI group company.

This enables improvement of MCI's product portfolio by its middle index to high index monomers.



Mitsui Chemicals, Inc.
Tokyo, Japan

R&D Strength

MCI is globally known as a leading manufacturer of urethane products and in 1987 became the first company in the world to apply *thiourethane* chemical technology to ophthalmic lenses. MCI's global R&D network with a broad range of technology contributes to excellence in designing the most advanced molecules for ophthalmic lens materials.



Sodegaura R&D Center
Chiba, Japan

MR™ Series History

~ Pioneer in high index lens material development ~

Early 1980s	Started development of high index lens materials.
1987	Commercial release of MR-6™ , the world's first thiourethane high index ophthalmic lens material (R.I.1.60)
1991	Commercial release of MR-7™ , the world's first refractive index 1.67 ophthalmic lens material
1998	Commercial release of MR-10™ (R.I.1.67)
1999	Commercial release of MR-8™ (R.I.1.60)
2000	Commercial release of MR-174™ (R.I.1.74)
2008	Acquisition of SDC Technologies, Inc. , a California based premium coating material company
2009	Acquisition of Film Specialties, Inc. , an anti-fog coating specialty company of SDC Technologies, Inc.
2011	Acquisition of Acomon AG , a Swiss based lens material company
2013	Mitsui Chemicals becomes majority shareholder of KOC Solution , a Korea based lens material company

Mitsui Chemicals, Inc. contributes to the development of "epoch making" lens materials to provide the best solution for optical lens users.

Production, Quality Control and CSR

MR™ Series is produced and delivered according to strictly controlled operation protocols for the sustainable supply of high quality materials to lens manufacturers. The MR™ Series production plant is certified under ISO9001 and strict precaution is taken not only in monomer production, but also in packaging, storage and logistics. As a chemicals company, human and environmental safety is a top priority. The MR™ Series plant is certified under ISO14001 and all operations are conducted with great consideration to minimize impact on the environment.



High-end Chemical Plants

Global Network

MR™ Series sales, marketing and technical service are conducted by MCI global headquarters in Japan and 7 regional headquarters around the globe. Therefore, quick customer service in multiple languages is available for the highest customer satisfaction. Additionally, **SDC Technologies, Inc.** and **Acomon AG** also have global networks to support their customers in each region. Customer satisfaction is always the MCI group's first priority.



Product Lineup

MR™ Series ~ Trademark of Safe, Clear and Lightweight Lenses ~

Excellent optical materials with high refractive index, high Abbe number, low specific gravity and high impact resistance are provided by polymerizing monomers of MR™ Series. MR™ Series is especially suitable for ophthalmic lenses and is known as the first thiourethane based high index lens material. MR™ Series offers a variety of products to provide the best solution for optical lens users.

Note: MR™ Series is a brand name of the raw material for optical lenses.
MR™ Series based lenses are available from most leading lens manufacturers.

R.I. 1.60 : MR-8™



The best balanced high index lens material with the largest share of the R.I. 1.60 lens material market. MR-8™ is suited to any strength ophthalmic lens and is a new standard in ophthalmic lens material.

R.I. 1.67 : MR-7™ & MR-10™



Global standard R.I.1.67 lens material. Great materials for thinner lenses with strong impact resistance.

Material Characteristics

MR-7™ : Better color tintability
MR-10™ : Higher heat distortion temperature

R.I. 1.74 : MR-174™



Ultra high index lens material for ultra thin lenses. Strong prescription lens wearers are now free from thick and heavy lenses.



Comparison of physical properties of lenses made with MR™ Series vs. other optical materials

	MR™ Series				Other				
	MR-8™	MR-7™	MR-10™	MR-174™	Poly carbonate	Acrylic (R.I. 1.60)	Middle Index	ADC (CR-39® RAV7®)	Crown Glass
Refractive Index (ne)	1.60	1.67	1.67	1.74	1.59	1.60	1.55	1.50	1.52
Abbe Number (ve)	41	31	31	32	28-30	32	34-36	58	59
Heat Distortion Temperature (°C)	118	85	100	78	142-148	88-89	-	84	>450
Tintability	Good	Excellent	Good	OK	None	Good	Good	Good	None
Impact Resistance	Good	Good	Good	OK	Good	OK	OK	OK	Poor
Static Load Resistance	Good	Good	Good	OK	Good	Poor	Poor	Good	Good

CR-39 is a trademark of PPG Industries, Inc. RAV7 is a trademark of ACOMON AG.
All properties are representative measurement figures obtained under specified test methods at Mitsui Chemicals, Inc. and are not guaranteed as specifications.

Premium Lens Applications of the MR™ Series

SingleVision/Progressive Ophthalmic Lenses

MR™ Series has superb processability to realize desired lens design.

Wide Color Range Sunglasses

MR™ Series has good color tintability making it suitable for high fashion sunglasses which have special color needs.

TRANSITIONS® Photochromic Lens System

MR™ Series has good compatibility with TRANSITIONS® photochromic lens systems.

Polarized Lens

MR™ Series is widely used for both ophthalmic & plano polarized sunglasses.

Sophisticated Design

MR™ Series has good mechanical strength and stress free properties making it suitable for various unique lens designs such as "Rimless frame" or "High curve lens".

TRANSITIONS is a trademark of Transitions Optical, Inc.

Product Features

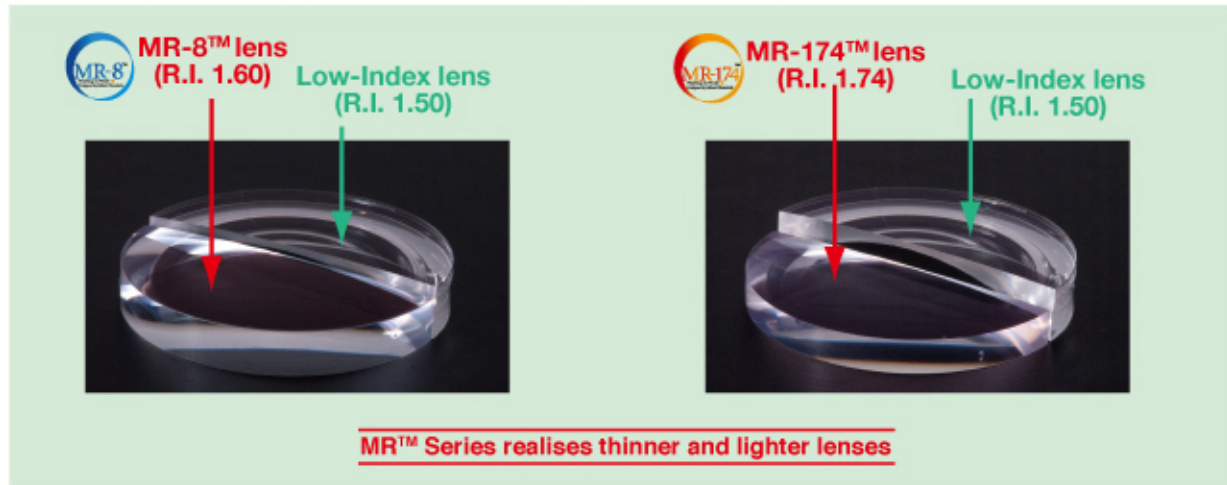
Optical Quality

- Thinner and lighter lenses can be achieved with 3 different refractive index MR™ Series. (R.I. 1.60, 1.67, 1.74)
- Both high refractive index and high Abbe number provide optical performance similar to glass lenses.
- Glass mold-casted MR™ Series shows minimal stress-strain.

High Refractive Index

- MR™ Series offers 3 different refractive index products (R.I. 1.60, 1.67, 1.74). With higher refractive index materials, it is possible to achieve thinner lenses with the same strength.

Comparison of thickness of MR™ Series and R.I. 1.50 lenses (-6.00D)



Strain Free

- MR™ Series resin is uniformly polymerized in a glass mold. Compared to injection molded polycarbonate lenses, MR™ Series lenses show minimal stress strain and offer stress free clear vision.

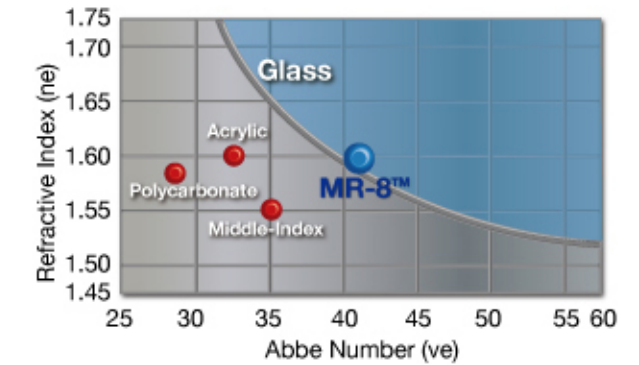
Stress Strain Observation

Crossed Nicol method using polarizing film and a white light source

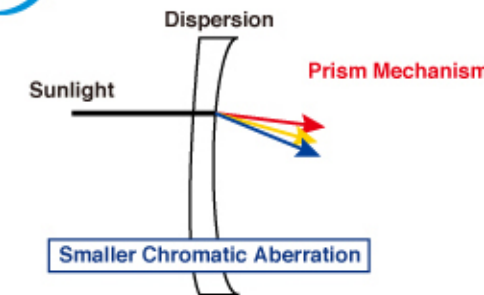


High Abbe Number

- Both high refractive index and high Abbe number provide optical performance similar to glass lenses.
- High Abbe number material such as MR-8™ minimizes the prism effect (chromatic aberration) of lenses and provides comfortable use for all wearers.

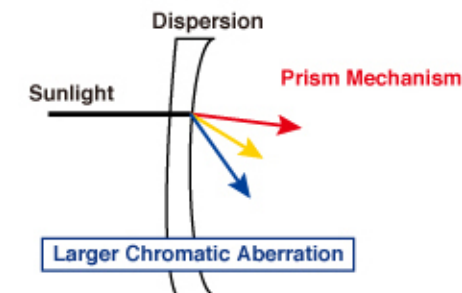


High Abbe Number Material



Low Abbe Number Material

- Polycarbonate lens: 27-30
- Acrylic lens: 32
- Middle-Index lens: 34-36



All tests were conducted under specified test methods at Mitsui Chemicals, Inc. and are not guaranteed as specifications.

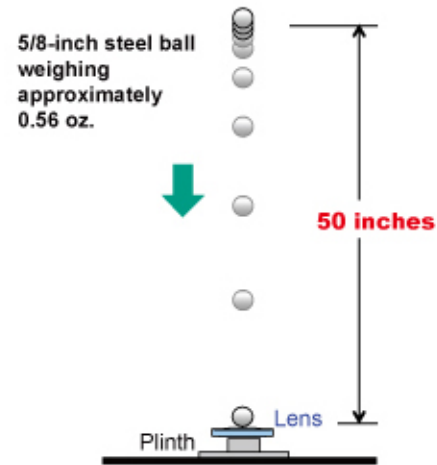
Product Features

Mechanical Strength

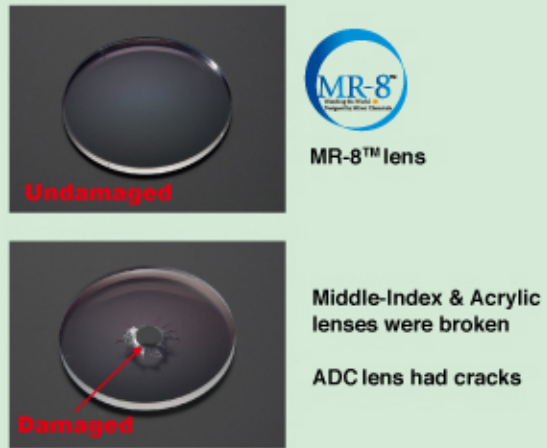
- High impact and static load resistance helps promote wearer eye safety.
- Suitable for fashionable "Rimless frame" and "High curve lens".
- Good processability for precisely designed progressive lenses. (an advantage of thiourethane materials)

Impact Resistance

FDA Drop Ball Test



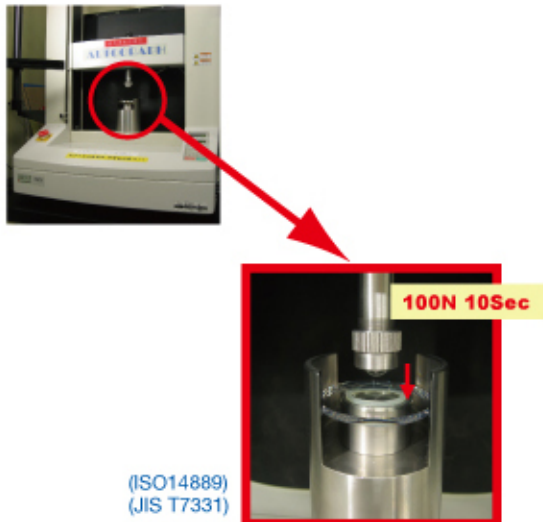
US-FDA (Food and Drug Administration) Sec. 801.410
"Use of impact-resistant lenses in eyeglasses and sunglasses"



MR-8™ shows good impact resistance

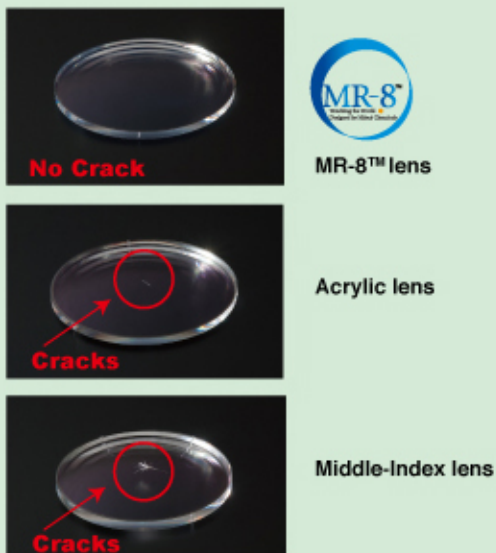
Static Load Resistance

Static Loading Test



(ISO14889)
(JIS T7331)

Quasi-static loading type test for minimum robustness

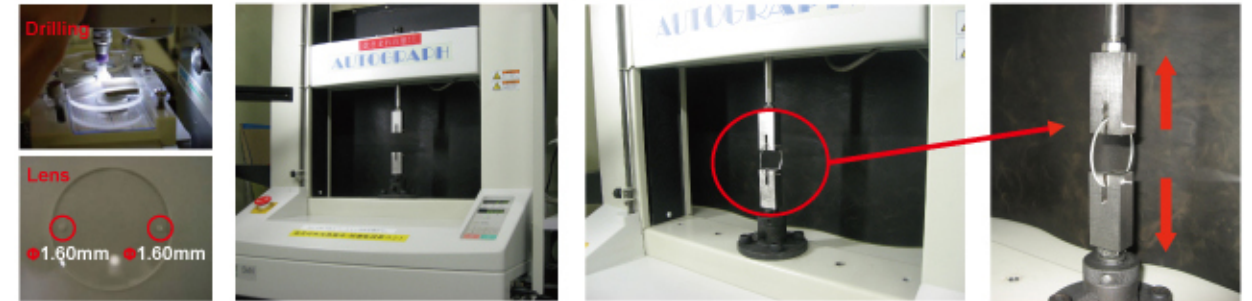


MR-8™ shows good static load resistance

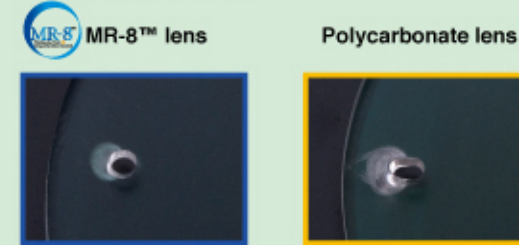
Tensile Strength Resistance

- MR-8™ lens shows good tensile strength.
- MR-8™ is widely recognized as the best material for rimless frames.

Tensile Test

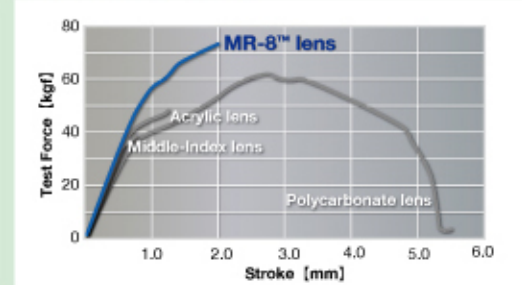


■ Lens deformation



MR-8™ lens showed no deformation of drilled hole (60kgf Tensile Force)

■ Tensile test results

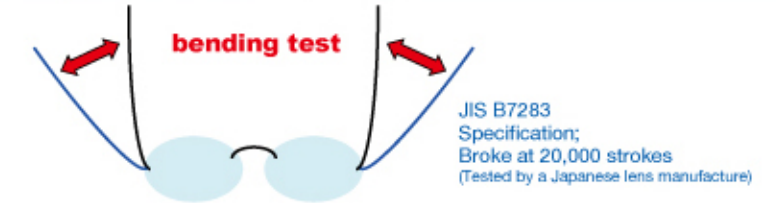


MR-8™ lens broke at 72kg tensile force (All other material lenses broke at smaller forces)

Butterfly Test

"Butterfly Test" for Rimless Frames

Endurance test under cyclic load for spectacle frames



MR-8™ lens → Broke at over 30,000 strokes

Acrylic lens



MR-8™ is adequate for the long time usage of rimless glasses

Product Features

Durability

- Good weatherability provides minimal change in lens color after years of usage.
- Good compatibility with coating materials.

Lens Color Change

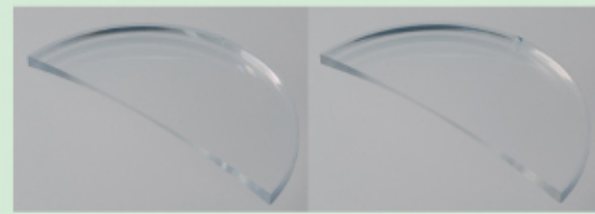
Weatherability Test

Accelerated test to observe lens color change after long-term usage

■ QUV Test: 0.50W/m², 50°C, 100hrs



MR-8™ lens



Before After

Middle-Index lens Yellowish

Acrylic lens Yellowish



Before After Before After

MR-8™ shows only minor color change after exposure to strong UV light. Wearers can enjoy clearer lenses after long-term usage.

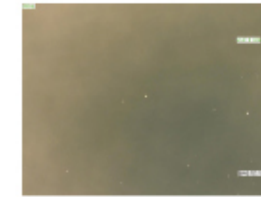
Coating Compatibility

Heat Resistance Test

Evaluation of cracks in coating after high temperature conditions

■ Test condition: 90°C, 15 min.

■ Test condition: 80°C, 15 min.



MR-8™ lens

No Cracks



Polycarbonate lens



ADC lens



MR-8™ lens

No Cracks



Middle-Index lens



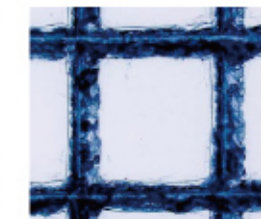
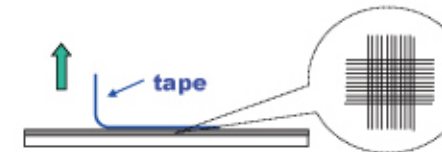
Acrylic lens

Good heat resistance and coating compatibility of MR-8™ prevent coating cracks under severe conditions.

Coating Compatibility

Cross-cut Adhesion Test

- 1) Cut a coating layer in a reticular pattern.
- 2) Apply tape over the pattern and then remove it.



MR-8™ lens

MR-8™ showed very good compatibility with coating materials. Lens wearers can enjoy unchanged high performance lens coating after long-term usage.

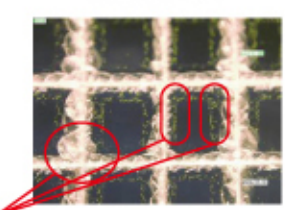
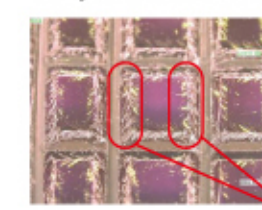
No Peeling

Middle-Index lens

Acrylic lens

Polycarbonate lens

ADC lens



Peeling

Peeling

All tests were conducted under specified test methods at Mitsui Chemicals, Inc. and are not guaranteed as specifications.

Lens Coating Materials

SDC Technologies, Inc.



SDC Technologies, Inc.
Irvine, California, USA

SDC Technologies, Inc. is a wholly owned MCI affiliate company and is the recognized world leader in the development and manufacture of abrasion-resistant and functional coatings for application to plastic, glass, and metals. SDC's products add premium performance, optical clarity, appearance and durability to eyewear, sunglasses, safety lenses, automotive and aeronautical products, electronic devices and other custom applications.

SDC High Index Coating Use on MR™ Series

SDC Technologies Inc. range of high index coating products have been specifically formulated to work with the MR™ Series and provide the best coating and product performance for MR™ Series based lenses.

SDC High Index Coating Features

- Index matched
- Tintable & Non tintable
- Excellent steel wool resistance
- AR compatible
- Optically clear
- Compatible index matched primers

Product Application

SDC Technologies Inc. recognizes that each customer has unique requirements. SDC's team of Trusted Advisors takes the time to understand customer situations, and then recommends an appropriate solution to meet customer requirements. SDC also works closely with customers during the application process to ensure high quality performance and yields. SDC's products can be applied in a variety of methods, including dip, spin, flow, spray, and sputter.

Market Applications

Optical



As the market leader in premium abrasion-resistant coatings, SDC manufactures a variety of **CrystalCoat®** coatings and primers for vision corrective lenses and other optical applications. SDC manufactures tintable and non-tintable coatings in both thermal cure and UV cure formulas. Its **CrystalCoat®** abrasion-resistant coatings can be applied to all lens substrates. SDC also manufactures high-performance index matched coatings that have been specifically formulated to work with the MR™ Series and provide the best coating & product performance for MR™ Series based lenses.

Sunglasses & Sports Eyewear



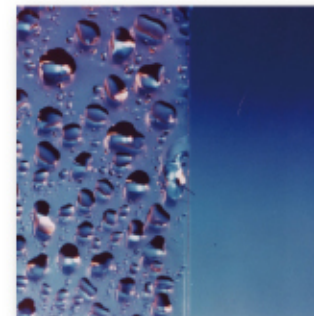
CrystalCoat® products are recommended for sunglasses and sports eyewear to improve scratch resistance and product durability. **CrystalCoat®** products can be used on tinted or clear substrates such as MR™ Series, polycarbonate, polyamide, ADC (CR-39®, RAV7®), acrylic and Trivex®. Available globally, SDC products provide tintability, anti-fog, and premium abrasion resistance for sunglass and sports eyewear applications.

Safety



SDC manufactures a broad range of **CrystalCoat®** products for safety applications. To address the current trend for anti-fog coating, SDC offers high-performance water sheeting, anti-fog coating and abrasion resistance specifically designed to meet the industry's high standards and testing requirements. SDC also offers primer-free coatings with a rapid thermal cure.

Anti-Fog

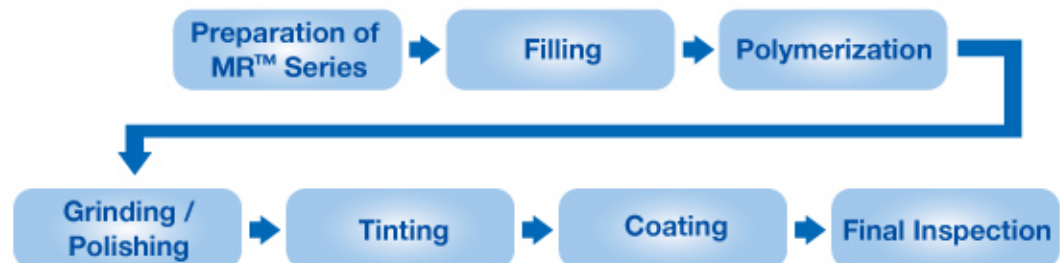


Following the recent acquisition of **FSI Coating Technologies, Inc.** (FSICT), formerly Film Specialties, Inc., SDC now offers a whole new range of premium anti-fog coatings. Solutions that improve product durability include high performance "Water Washable" anti-fog coatings, standard and customized anti-fog coated film and sheet products, as well as complementary hard coating systems and primers. Anti-fog applications include medical, safety, military, and sports eyewear as well as industrial sheet and PET film for commercial freezer display doors.

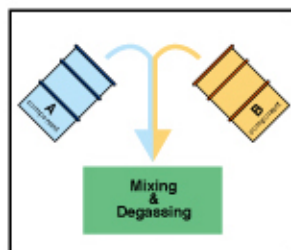
Lens Production

Contacts

MR™ Lens Production Process

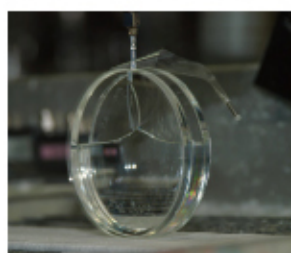


1. Preparation of MR™ Series



Mix MR™ monomer (component) A & B with additives, then degas the MR™ monomer mixture.

2. Filling



Fill molds with the MR™ monomer mixture.

3. Polymerization



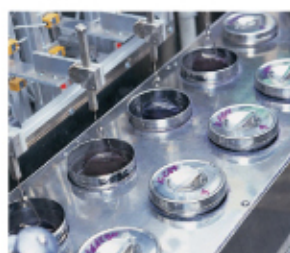
Place the filled molds into ovens, where they undergo a heat-cycle, turning the MR™ monomer mixture into a MR™ lens.

4. Grinding / Polishing



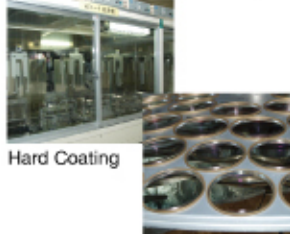
Grind and polish the surface of the MR™ lens to create a curvature for required strength.

5. Tinting



Tint the surface of the MR™ lens.

6. Coating



Coat the surface of the MR™ lens to protect from scratches, reflection etc.

7. Final Inspection



Inspect the coated lens.

Typical example of lens production process.
Lens production process varies among lens manufacturers.



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