Special materials
for ophthalmic coating
Titanium oxides

- Highest refractive index in visible range
- High UV-blockage
- Good environmental resistance
- Best reproducibility and lowest thermal stress for coatings on plastics using TiO₂
- Stable evaporation behaviour without spitting or outgassing
- Widely tunable refractive index
- Very good environmental durability
- Well-suited for BBAR coatings on plastics

**Film properties**

- Refractive index at 550 nm
  - on unheated substrates/no IAD: 2.07 – 2.22
  - on heated substrates, Tₜ = 250 °C/no IAD: 2.25 – 2.40
  - on unheated substrates/with IAD: 2.10 – 2.50
- Range of transparency (fully oxidized film): 400 nm – 11 µm
- Environmental Stability: MIL-C-675 B/C passed
- Stress
  - on unheated substrates/no IAD: Tensile
  - on heated substrates, Tₜ = 250 °C/no IAD: Tensile
  - on unheated substrates/with IAD: Type and magnitude depending on IAD parameters

Data based on TiO₂ coatings deposited from TiO₂ starting material.

Low-absorbing films deposited from all titanium oxide starting compositions are of the composition TiO₂. The structure of the TiO₂ films depends on the deposition conditions and starting materials ranging from amorphous to crystalline anatase or rutile. This explains the wide spread in the refractive index values. TiO₂ films have the highest and most widely tunable refractive index with the best optical contrast to SiO₂ or LIMA™. This enables AR and multilayer coatings with a minimum number of layers. TiO₂ films effectively block UV-radiation for wavelengths < 400 nm which can be used for the protection of the plastic lenses. The stress of TiO₂ films can be tuned in a wide range of tensile and compressive values. Using TiO₂, starting material, thermal stresses on polymeric lenses can be kept at a minimum which makes this material an ideal choice for coatings on polymeric lenses.

**LATI™**

- Superior to other lanthanita-titania mixtures due to higher material density
- Complete melting and evaporation without spitting or outgassing
- Reduced refractive index compared to pure TiO₂, enabling a higher AR bandwidth
- Strongly reduced structural film stress compared to pure TiO₂
- Close-to-zero compressive-type stress possible without ion assistance
- Very good thickness homogeneity and run-to-run stability
- Direct adhesion to certain polymeric substrate types

**Film properties**

- Refractive index at 550 nm
  - on unheated substrates/no IAD: 1.90 – 2.02
  - on unheated substrates/with IAD: 2.04 – 2.08
  - on heated substrates, Tₜ = 300 °C: 2.09 – 2.12
- Range of transparency: 380 nm – 7.0 µm
- Environmental Stability: MIL-C-675 B/C passed
- Stress
  - Type and magnitude depending on deposition parameters

Film stress of LATI™ is smaller than for TiO₂, and its type and magnitude are variable by the choice of the process parameters. Films with close-to-zero compressive-type stress can be obtained by conventional deposition. LATI™ films are well-adhering to a number of substrate types (especially certain types of plastics) and show a good environmental stability. Due to these properties LATI™ is used as the H-index material in AR or other dielectric coatings especially on plastics, partly in combination with DRALO™.

**Application Guidelines**

**Characteristics of starting material**

- Chemical formula: Ti₂O₃ Ti₃O₅ TiO₂
- Color
  - Gold
  - Purple
  - Black-purple
  - Black, white
- Density: 4.9 – 4.6 – 4.6 – 4.2
- Melting point °C
  - 1750 ~ 1760 ~ 1760 1775
- Form
  - Tablets, granulate

**Evaporation technique**

All titanium oxides melt completely. Only the TiO₂ melt evaporates congruently. Titanium oxides are deposited reactively by electron beam evaporation from a Cu-crucible with Mo-liner or from Mo-boats.

Typical deposition in all sizes of coating systems involves rates of 0.2 – 0.5 nm/s at O₂ pressures of 2 – 3 x 10⁻⁴ mbar (or equivalent O₂ flow). The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance (IAD). O₂ operated RF plasma ion sources are able to produce high-density TiO₂ films with full stress compensation relative to SiO₂.

**Evaporation technique**

LATI™ is typically evaporated by reactive electron beam evaporation with or without ion assistance. Typical deposition in all coating systems with maximum coating distance of 900 mm involves rates 0.3 – 0.5 nm/s and O₂ pressures of 3 x 10⁻⁴ mbar (or equivalent O₂ flow). The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

Using LATI™ instead of pure titanium oxides requires to follow some particular guidelines to obtain reproducible, well-homogeneous films.

**Application Guidelines**

**Characteristics of starting material**

- Chemical formula: La-Ti-oxide
- Color
  - Dark grey with slight metallic appearance
- Density: 5.9 – 6.2
- Melting point °C
  - ~ 1800
- Form
  - Granulate

**Evaporation technique**

LATI™ is typically evaporated by reactive electron beam evaporation with or without ion assistance. Typical deposition in all coating systems with maximum coating distance of 900 mm involves rates 0.3 – 0.5 nm/s and O₂ pressures of 3 x 10⁻⁴ mbar (or equivalent O₂ flow). The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

Using LATI™ instead of pure titanium oxides requires to follow some particular guidelines to obtain reproducible, well-homogeneous films.
**DRAŁO™**

- Reduced refractive index compared to pure TiO₂, enabling a higher AR bandwidth
- Effective protection against UV radiation
- Widely tunable film stress from tensile to compressive values
- Reduced structural film stress compared to pure TiO₂
- Very good thermal homogeneity and run-to-run stability
- Excellent environmental durability
- Very good resistance against combined attack of heat, humidity and UV-radiation
- Controlled water barrier

**Film properties**

Refractive index at 550 nm
- on unheated substrates/no IAD 2.04 – 2.18
- on heated substrates, Ts ≥ 250 °C/no IAD 2.26 – 2.28
- on unheated substrates/with IAD 2.05 – 2.30

Range of transparency (fully oxidized film) 400 nm – 7.0 µm

Environmental Stability MIL-C-675 B/C passed

Stress
- on unheated substrates/no IAD Mostly tensile depending on rate and O₂ pressure
- on heated substrates, Ts ≥ 250 °C/no IAD Tensile
- on unheated substrates/with IAD Type depending on IAD parameters

These properties make DRAŁO™ layers especially well-suited as the high-index material in AR coatings for polymeric substrates such as ophthalmic lenses.

**Application Guidelines**

**Characteristics of starting material**

- Chemical formula Ti-Al-oxide
- Color Black metallic
- Density g/cm³ 4.5
- Melting point °C 1700
- Form Granulate

**Evaporation technique**

DRAŁO™ films can be produced by reactive electron beam evaporation using Cu-crucibles with Mo-liners. Typical deposition in all sizes of coating systems involves O₂ pressures of ~3 x 10⁻⁴ mbar (or equivalent O₂ flow) and rates 0.2 – 0.4 nm/s. The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

Using DRAŁO™ instead of pure titanium oxides requires to follow some particular guidelines to obtain reproducible, well-homogeneous films.

**Zirconium oxides**

- Hard and durable films
- H-index material for AR coatings especially on plastics
- ZrO starting material with higher density and complete melting for easier evaporation

**Film properties**

Refractive index at 550 nm
- on unheated substrates/no IAD 1.92 – 1.97
- on unheated substrates/with IAD 1.95 – 2.05
- on heated substrates, Ts = 300 °C 2.00 – 2.07

Range of transparency 350 nm – 7.0 µm

Environmental Stability MIL-C-675 B/C passed

Stress
- without IAD Tensile
- on unheated substrates/with IAD Tunable type and magnitude

Regardless to the starting material composition, low-absorbing zirconia films are of the composition ZrO₂. Such films are hard and durable and they can be used in AR coatings – partly along with thin layers of TiO₂ or DRAŁO™ to adjust the reflection characteristic.

**Application Guidelines**

**Characteristics of starting material**

- Available as zirconium dioxide ZrO₂ (with or without minor deficiency x of oxygen) or zirconium monoxide ZrO.
- Chemical formula ZrO₂ ZrO 2-X ZrO
- Color White Grey-black Dark grey to black
- Density 5.6 5.6 6.4
- Melting point °C ~ 2700 ~ 2700 ~ 2200
- Form Tablets, granulate

**Evaporation technique**

Zirconium oxides are mostly evaporated by reactive e-beam evaporation from a Cu-crucible with Mo-liner. Zirconium dioxide ZrO₂ melts only superficially and predominantly sublimes. Therefore it requires a very uniform beam pattern to avoid craters and uniformity problems. ZrO is fully melting and can be used to prevent such problems. It can also be evaporated from W-boat. The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

Deposition occurs typically at O₂ pressures of 1 – 3 x 10⁻⁴ mbar (or equivalent O₂ flow) for ZrO₂/ZrO₂-X and 2 – 3 x 10⁻⁴ mbar (or equivalent O₂ flow) for ZrO. Typical deposition in all sizes of coating systems involves rates 0.2 – 0.5 nm/s. The tendency to inhomogeneity can be counteracted using IAD.
Zr-Ti-oxides

- Zr-Ti-oxide tablets show a stable evaporation behaviour without spitting or outgassing
- Optimized film stress compared to pure ZrO₂, and TiO₂, films
- Widely tunable refractive index n
- Very good environmental durability
- Well-suited for BBAR coatings on plastics with refractive indices n > 1.60

Film properties

<table>
<thead>
<tr>
<th>Refractive index at 550 nm</th>
<th>on unheated substrates/no IAD</th>
<th>1.80 – 1.88</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on heated substrates, Tₛ = 250 °C/no IAD</td>
<td>2.01 – 2.03 (2.10 at 300 °C)</td>
</tr>
<tr>
<td></td>
<td>on heated substrates/with IAD</td>
<td>1.94 – 1.96</td>
</tr>
<tr>
<td>Range of transparency (fully oxidized film)</td>
<td>400 nm – 11 μm</td>
<td></td>
</tr>
<tr>
<td>Environmental Stability</td>
<td>MIL-C-675 B/C passed</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td>on unheated substrates/no IAD</td>
<td>Tensile</td>
</tr>
<tr>
<td></td>
<td>on heated substrates, Tₛ ≥ 250 °C/no IAD</td>
<td>Tensile</td>
</tr>
<tr>
<td></td>
<td>on unheated substrates/with IAD</td>
<td>Tensile</td>
</tr>
</tbody>
</table>

Thin films made from Zr-Ti-oxide effectively block UV-radiation for wavelengths > 240 nm. Compared to pure ZrO₂ and TiO₂, Zr-Ti-oxide films have a reduced tensile film stress. Refractive index and reduced mechanical stress of Zr-Ti-oxide films made from Zr-Ti-oxide source material by conventional or slightly assisted deposition without substrate heating makes this material a good choice for coatings on plastics with refractive indices n > 1.60.

Zr-Ti-oxide with higher refractive index is available.

ROMA™

- Stable evaporation behaviour without spitting or outgassing
- Yields homogeneous layers in contrast to pure ZrO₂, and an improved oxidation behaviour relative to Ta₂O₅
- Optimized film stress compared to pure ZrO₂, films
- Moisture barrier leading to considerably increased environmental durability
- Well-suited for BBAR coatings on plastics

Film properties

<table>
<thead>
<tr>
<th>Refractive index at 550 nm</th>
<th>on heated substrates, Tₛ ≥ 250 °C/no IAD</th>
<th>2.04 – 2.07</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>on heated substrates/with IAD</td>
<td>1.85 – 2.10</td>
</tr>
<tr>
<td>Range of transparency (fully oxidized film)</td>
<td>350 nm – 10 μm</td>
<td></td>
</tr>
<tr>
<td>Environmental Stability</td>
<td>MIL-C-675 B/C passed</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td>on heated substrates, Tₛ ≥ 250 °C/no IAD</td>
<td>Depending on deposition conditions</td>
</tr>
<tr>
<td></td>
<td>on unheated substrates/with IAD</td>
<td>Tensile</td>
</tr>
</tbody>
</table>

ROMA™ has been designed to yield very homogeneous layers in contrast to pure ZrO₂, and an improved oxidation behaviour relative to Ta₂O₅. ROMA™ films also show a considerably improved climate test resistance due to their increased water impermeability.

Thin films made from ROMA™ effectively block UV-radiation for wavelengths < 350 nm. Compared to pure ZrO₂, films, ROMA™ films have a reduced tensile film stress. Refractive index, reduced mechanical stress and environmental durability of ROMA™ films from assisted deposition without substrate heating makes this material a good choice for coatings on plastics.

Application Guidelines

**Characteristics of starting material**

- **Chemical formula**: Zr-Ti-oxide
- **Color**: Black to dark gray
- **Density g/cm³**: ~ 5.1
- **Melting point °C**: ~ 1850
- **Form**: Tablets, granulate

**Evaporation technique**

Zr-Ti-oxide films can be produced by reactive deposition from Zr-Ti-oxide tablets by electron beam evaporation using water cooled Cu-crucibles with Mo-liners. Typical deposition in all coating systems with maximum coating distance of 900 mm involves O₂ pressures of ~3 x 10⁻⁴ mbar (or equivalent O₂ flow) and rates 0.2 – 0.4 nm/s. The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

Using Zr-Ti-oxide instead of pure zirconium oxide requires to follow some particular guidelines to obtain reproducible, well-homogeneous films.

**Application Guidelines**

**Characteristics of starting material**

- **Chemical formula**: Zr-Ta-oxide
- **Color**: Black to dark gray
- **Density g/cm³**: ~ 6.82
- **Melting point °C**: ~ 2100
- **Form**: Tablets, granulate

**Evaporation technique**

ROMA™ films can be produced by reactive electron beam evaporation using water cooled Cu-crucibles with Mo-liners. Typical deposition in all sizes of coating systems involves rates of 0.2 – 0.4 nm/s at O₂ pressures of 2 – 4 x 10⁻⁴ mbar (or equivalent O₂ flow) at increased substrate temperature or with ion assistance. The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance.

For ROMA™ containing coatings on plastic lenses ion assistance is indispensable to obtain low-absorbing layers. Using ROMA™ instead of pure zirconium or tantalum oxide requires to follow some particular guidelines to obtain reproducible, low-absorbing and well-homogeneous films.
LIMA™

- L-index material for AR coatings especially on plastics
- Refractive index and hardness similar to SiO₂
- Optimized water impermeability compared to SiO₂
- Higher environmental durability than SiO₂,

**Film properties**

- Refractive index at 550 nm
  - on unheated substrates/no IAD ~ 1.48
- Range of transparency (fully oxidized film) 190 nm – 9.0 µm
- Environmental Stability MIL-C-675 B/C passed
- Stress
  - on unheated substrates/no IAD Mostly compressive
  - on unheated substrates/with IAD Compressive

LIMA™ films have optical properties (refractive index, transmission range) and mechanical properties (hardness, stress) that are similar to those of pure SiO₂. LIMA™ is designed to obtain films with water impermeability that leads to an increased resistance against environmental impact. For certain coating conditions, LIMA™ films exhibit smaller values of compressive stress than films of pure SiO₂.

**Application Guidelines**

**Characteristics of starting material**

- Chemical formula: Si-Al-oxide
- Color: White to light grey
- Density g/cm³: 2.25
- Melting point °C: ~ 1730
- Form: Tablets, granulate

**Evaporation technique**

LIMA™ predominantly sublimes. LIMA™ films are deposited by reactive or non-reactive electron beam evaporation using Cu-crucibles with Mo-liners. Typical deposition rates are 0.5 – 2.0 nm/s. The intended values of refractive index and film stress can be obtained by variation of substrate temperature, oxygen pressure or flow, deposition rate and the parameters of ion assistance. Post-deposition treatment of the last LIMA™ layer with ion assistance can be used to increase the climate resistance of the film stack.

Using LIMA™ instead of pure SiO₂ requires to follow some particular guidelines to obtain reproducible, well-homogeneous films.

ITO

- Transparent conductive material for conducting or antistatic function
- Antistatic function complements easy-to-clean coatings on AR and color coatings
- Additional function as adhesion promoter for use as the first layer
- Inhouse raw material source and recycling capabilities

**Film properties**

- Refractive index at 550 nm 1.9 – 2.2
- Range of transparency (T ≥ 80%) ~400 nm – ~1.1 µm
- Sheet resistance Ω/sq to the MO/sq-range
- Environmental Stability MIL-C-675 B/C passed

Low-absorbing ITO films are transparent in the visible and near-infrared spectral ranges, but strongly reflecting in the IR range. Depending on the In-/Sn-oxide ratio and the deposition conditions, ITO films can be electrically conductive with sheet resistances from the Ω/sq to the MO/sq-range. Resistances in the kΩ/sq-range are enough for an antistatic effect and can be achieved with an ITO thickness of only a few nanometers.

The ratio of transmittance in the visible range and conductivity can be adjusted by post-deposition thermal treatment in vacuum or air (increase or decrease of conductivity, respectively).

For coatings on plastics, for example AR coatings on eyeglasses, the absorption of ITO for an unassisted deposition can be compromised by the small layer thickness. Also, it can be improved by ion assisted deposition.

**Application Guidelines**

**Characteristics of starting material**

- Chemical formula: In-Sn-oxide
- Color: Steel-grey to green
- Density g/cm³: ~ 7.1 (In-/Sn-oxide 90/10)
- Melting point °C: ~ 1730
- Form: Tablets, granulate

The material can be supplied in different ratios In-/Sn-oxide from 83/17 to 95/5 %wt.

**Evaporation technique**

ITO fully sublimes. ITO films are deposited by reactive or non-reactive electron beam evaporation using Cu-crucibles with Mo-liners or thermal evaporation using Mo-boats with cover.

The refractive index of ITO films, the degree of transmittance in the VIS, the onset of reflectance in the IR spectral range and the conductivity can be tuned using the composition of the starting material or the deposition parameters like temperature, oxygen pressure and the parameters of ion assistance.

To obtain the required low absorption for ITO films in coatings on plastics it is possible to use either a very small layer thickness or ion assistance with an O₂ flow through the ion source.
Color materials

- Color tinting of ophthalmic lenses without wet chemistry
- Good UV protection
- Precise controllability of light intensity and UV blockage independently from substrate curvature and thickness
- Adhesion promotion for coating stack
- Possible combination with AR coating
- Partly for plastics with refractive indices $n > 1.60$

<table>
<thead>
<tr>
<th>Material</th>
<th>Color</th>
<th>Transmittance % at 550 nm</th>
<th>Form</th>
<th>Application notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALBUNIT™ F1</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
</tr>
<tr>
<td>MALBUNIT™ F1G</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
</tr>
<tr>
<td>MALBUNIT™ F10</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
</tr>
<tr>
<td>MALBUNIT™ F13</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
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<tr>
<td>MALBUNIT™ F23</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
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<td>MALBUNIT™ F24</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, W-boat</td>
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<td>MALBUNIT™ 8/1</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Granulate, tablets</td>
<td>E-beam graphite-liner, W-boat</td>
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<tr>
<td>MALBUNIT™ G</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, e-beam Mo-liner, W-boat</td>
</tr>
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<td>MELDINA™ III</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, e-beam Mo-liner</td>
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<td>MELDINA™ V</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Fine granulate</td>
<td>Flash coating, e-beam Mo-liner</td>
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<td>MELDINA™ TAB</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Tablets, discs</td>
<td>E-beam Mo-liner</td>
</tr>
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<td>MELDINA™ H</td>
<td>Brown</td>
<td>20 – 80</td>
<td>Discs</td>
<td>E-beam Mo-liner</td>
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<tr>
<td>MG51™</td>
<td>Grey</td>
<td>20 – 80</td>
<td>Powder</td>
<td>Mo-boat, e-beam Mo-liner</td>
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<td>GREY A™</td>
<td>Grey</td>
<td>20 – 80</td>
<td>Granulate</td>
<td>W-boat</td>
</tr>
<tr>
<td>OLIVIN™ C1</td>
<td>Blue*</td>
<td>Tablets</td>
<td>Mo-boat, special guidelines</td>
<td></td>
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<tr>
<td>OLIVIN™ C2</td>
<td>Yellow</td>
<td>Granulate</td>
<td>Mo-boat</td>
<td></td>
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<tr>
<td>OLIVIN™ C1 + OLIVIN™ C2</td>
<td>Green*</td>
<td>s. OLIVIN™ C1 + OLIVIN™ C2</td>
<td>Mo-boat, multilayer, special guidelines</td>
<td></td>
</tr>
</tbody>
</table>

Reflected color

- Cr + SiO (FLEXO)  
  - Silver  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 20 nm

- Cr + SiO (FLEXO)  
  - Bronze  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 50 nm

- Cr + SiO (FLEXO)  
  - Blue  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 80 nm

- Cr + SiO (FLEXO)  
  - Green-Yellow  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 150 nm

- Cr + SiO (FLEXO)  
  - Gold  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 180 nm

- Cr + SiO (FLEXO)  
  - Violet  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 240 nm

- Cr + SiO (FLEXO)  
  - Green  
  - Cr granulate, SiO granulate, tablets  
  - E-beam, Mo-liner, Cr 60 nm, SiO 300 nm

Reflected/transmitted color

- TiO$_2$ + SiO$_2$  
  - All colors, non-absorbing layers  
  - Depending on thicknesses and color  
  - TiO$_2$: s. Titanium oxides,  
    - SiO$_2$: Granulate, discs  
  - E-beam, Mo-liner, Ht-alternating dielectric stack or combination with absorbing material

The indicated color tones for MALBUNIT™ and MELDINA™ are obtained for same film thickness of ~ 300 nm.

* For mineral glass only.
Hydrophobic materials

HYDROPHOBIC™ or TOPCOAT™ films make coated lenses water and dirt repellent
HYDROPHOBIC™ or TOPCOAT™ films ease the cleaning of eyeglasses
HYDROPHOBIC™ or TOPCOAT™ films can be complemented by antistatic layers for higher cleaning comfort
Lenses with HYDROPHOBIC™ or TOPCOAT™ films can be easily processed after coating
HYDROPHOBIC™ or TOPCOAT™ films show a very abrasion-resistant hydrophobic effect

Film properties

<table>
<thead>
<tr>
<th>Cleaning properties</th>
<th>as-deposited</th>
<th>after abrasion testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA water [°]</td>
<td>107 – 111</td>
<td>104 – 106</td>
</tr>
</tbody>
</table>

Optical properties

<table>
<thead>
<tr>
<th>Range of transparency</th>
<th>Refractive index at 550 nm</th>
<th>1.36 – 1.46 depending on deposition conditions and thickness</th>
</tr>
</thead>
</table>

HYDROPHOBIC™ or TOPCOAT™ films have very good hydrophobic properties thus providing a good cleaning comfort. These properties are very resistant to abrasion. Also, HYDROPHOBIC™ or TOPCOAT™ films are of reduced slippery thus enabling all post-deposition processing steps without additional adhesion layers or additional pads.

HYDROPHOBIC™ or TOPCOAT™ films are optically transparent and have an optical index that is close to that for SiO2. Therefore, the change in the reflective color of an AR coating is small but it has sometimes to be compensated for in the optical design.

Superhydrophobic and oleophobic materials

EVERCLEAN™ superhydrophobic and oleophobic films make coated lenses water, oil and grease repellent
EVERCLEAN™ films give the highest possible cleaning comfort for coated lenses
EVERCLEAN™ topcoat can be complemented by antistatic layers for higher cleaning comfort
EVERCLEAN™ is very resistant to abrasion and combined action of UV, humidity and temperature
EVERCLEAN™ tablets have a shelf life time > 1.5 years

Film properties

<table>
<thead>
<tr>
<th>Cleaning properties</th>
<th>as-deposited</th>
<th>after abrasion testing</th>
<th>after QUV ageing</th>
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</thead>
<tbody>
<tr>
<td>CA water [°]</td>
<td>112 – 118</td>
<td>108 – 112</td>
<td>~ 100</td>
</tr>
<tr>
<td>CA angle n-hexadecane [°]</td>
<td>68 – 71</td>
<td>68 – 70</td>
<td>~ 51</td>
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<tr>
<td>Cleanability</td>
<td>1</td>
<td>1 – 2</td>
<td>1 – 3</td>
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</table>

Optical properties

<table>
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<tr>
<th>Range of transparency</th>
<th>Refractive index at 550 nm</th>
<th>1.36 – 1.46 depending on deposition conditions and thickness</th>
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</table>

EVERCLEAN™ films are at the chemically achievable limit for water, oil and grease repellence and therefore give the highest available cleaning comfort. The films are very resistant against abrasion and QUV weathering.
EVERCLEAN™ coated lenses show good adhesion of the marking ink for the positioning pattern. Due to their strongly reduced slipperiness, they can be processed without any additional adhesion layers for better pad adhesion or additional pads.

Application Guidelines

Characteristics of starting material

<table>
<thead>
<tr>
<th>Name</th>
<th>HYDROPHOBIC™/TOPCOAT™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
<td>White</td>
</tr>
<tr>
<td>Density g/cm³</td>
<td>~ 1.0</td>
</tr>
<tr>
<td>Z-Ratio</td>
<td>1.00</td>
</tr>
<tr>
<td>Tooling</td>
<td>1.00</td>
</tr>
<tr>
<td>Evaporation temperature °C</td>
<td>~ 300</td>
</tr>
<tr>
<td>Form</td>
<td>Tablets</td>
</tr>
</tbody>
</table>

The material can be supplied in different sizes and with customized amounts of hydrophobic substance.

Evaporation technique

Films from HYDROPHOBIC™ or TOPCOAT™ tablets are applicable to coatings with SiO2 or LIMA™ as the last layer. Minimum film thicknesses for optimum hydrophobic function is ~25 nm for the nominal density indicated in the table.

Deposition is possible from a resistively heated Mo-boat or a spiral heater as well as by electron beam evaporation using a topcoat liner. Typically, coating is done in constant power mode. Special guidelines apply to each of these techniques.

The material is in use on table coaters and on a wide range of box coater types.

Characteristics of starting material

<table>
<thead>
<tr>
<th>Name</th>
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The optical index of EVERCLEAN™ films is close to SiO2. Therefore, the change in the reflective color of an AR coating is small but it has sometimes to be compensated for in the optical design.

Evaporation technique

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