Special materials for Precision Optics & Laser Coatings

Fluorides and Special Materials for IR coatings
Umicore Thin Film Products

Umicore Thin Film Products, a globally active business unit within the Umicore Group, is one of the leading producers of coating materials for physical vapor deposition with more than 50 years experience in this field. Its portfolio covers a wide range of highly effective sputtering targets and evaporation materials.

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Barium Fluoride BaF₂

- BaF₂ films with a refractive index n ~ 1.47 – 1.48 at 550 nm and ~ 1.33 – 1.42 at 10 µm can be produced from BaF₂, granulate from boat or e-gun.
- BaF₂, source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.
- BaF₂ films have a wide range of transparency.

**Film properties**

<table>
<thead>
<tr>
<th>Refractive index at</th>
<th>260 nm</th>
<th>~ 1.51</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 nm</td>
<td>~ 1.47 – 1.48</td>
<td></td>
</tr>
<tr>
<td>10 µm</td>
<td>~ 1.33 – 1.42</td>
<td></td>
</tr>
</tbody>
</table>

Range of transparency ~ 250 nm – 15 µm

Environmental stability MIL-C-675 B/C passed

Stress low to intermediate tensile, magnitude depending on deposition conditions

The wide spectral region of transparency ~ 250 nm – 15 µm is merely interrupted by localized water absorption bands at ~ 3 and 6 µm. On heated substrates, the water content of the films can be reduced and the corresponding absorption reduced.

The wide spectral range of transparency, a good evaporation behaviour and low to moderate stress with consequently good environmental resistance make this material useful as the L-index material in AR coatings and optical filters from the UV to the IR range and an alternative to radioactive ThF₄ in coatings for high-power IR laser applications as well as for night vision.

Additional applications are reflection-enhancing layers for high-reflectance coatings in the IR spectral region.

Application Guidelines

**Characteristics of starting material**

- Chemical formula: BaF₂
- Color: White/glassy – light grey (depending on production route)
- Density g/cm³: ~ 4.9
- Melting point °C: 1280
- Form: Granulate

**Evaporation technique**

BaF₂ films can be deposited from BaF₂, starting material by evaporation with e-gun out of Mo- or Ta- liners or with resistively heated boats of Mo or Ta. Adhesion and environmental resistance can be enhanced using substrate pretreatment by glow discharge and thin adhesion layers (SiO, MgO, Y₂O₃) depending on substrate type and spectral range of the application. Typical substrate temperatures are ~ 200 – 300°C.

Low absorption films for the IR spectral range can be obtained using boat or well-optimized e-gun deposition.

**Typical dispersion curve of the refractive index of Barium Fluoride films.**

#### Cerium Fluoride CeF₃

- CeF₃ films with a refractive index n ~ 1.59 – 1.62 at 550 nm and ~ 1.42 – 1.47 at 10 µm can be produced from CeF₃, granulate by boat or e-gun evaporation.
- CeF₃ films have a range of transparency from 300 nm to 13 µm.
- Durable low absorption films of CeF₃ can be obtained using boat or well-optimized e-gun deposition.

**Film properties**

<table>
<thead>
<tr>
<th>Refractive index at</th>
<th>250 nm</th>
<th>~ 1.75 – 1.78</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 nm</td>
<td>~ 1.59 – 1.62</td>
<td></td>
</tr>
<tr>
<td>10 µm</td>
<td>~ 1.42 – 1.47</td>
<td></td>
</tr>
</tbody>
</table>

Range of transparency ~ 300 nm – 13 µm

Environmental stability passed MIL-F-48616 for adhesion, moderate abrasion and humidity resistance

Stress low to intermediate tensile values

The wide spectral region of transparency ~ 300 nm – 13 µm is merely interrupted by localized water absorption bands at ~ 3 and 6 µm.

Good evaporation behaviour and low to moderate stress with consequently fair environmental resistance and the spectral range of transparency make this material useful as the L-index material as an alternative to radioactive ThF₄.

Application Guidelines

**Characteristics of starting material**

- Chemical formula: CeF₃
- Color: White to brownish with reddish or rosa tint
- Density g/cm³: ~ 6.2
- Melting point °C: 1460
- Form: Granulate

**Evaporation technique**

CeF₃ films can be deposited from CeF₃, starting material by evaporation with e-gun out of Mo- or Ta- liners or with resistively heated boats of W, Mo or Ta. Adhesion and environmental resistance can be enhanced using substrate pretreatment by glow discharge and thin adhesion layers depending on substrate type and spectral range of the application. Typical substrate temperatures are ~ 150 – 300°C.

**Typical dispersion curve of the refractive index of Cerium Fluoride films.**
Dysprosium Fluoride DyF₃

- DyF₃ films with a refractive index n ~ 1.48 – 1.55 at 550 nm and ~ 1.38 – 1.42 at 10 μm can be produced from UMICORE pre-conditioned DyF₃ discs, from pieces or granules by evaporation with e-gun and thermal deposition.
- DyF₃, source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.
- DyF₃, films have a wide range of transparency and reduced stress.

**Film properties**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Refractive index n</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>~ 1.56 – 1.65</td>
</tr>
<tr>
<td>550</td>
<td>~ 1.48 – 1.52</td>
</tr>
<tr>
<td>10 μm</td>
<td>~ 1.28 – 1.42</td>
</tr>
</tbody>
</table>

**Range of transparency** ~ 190 nm – 12 μm (for typical use)

**Environmental stability** MIL-C-675 B/C passed

**Stress** low to intermediate tensile, magnitude depending on source material and process parameters

The wide spectral range of transparency, a good evaporation behaviour and low to moderate stress make this material useful as the L-index material in AR coatings, optical filters and laser protection coatings especially in the NIR and MIR (LWIR) spectral ranges as well as for laser and broadband applications beyond 12 μm wavelength.

The best low absorption films for the IR spectral range 8 – 16 μm can be obtained with well optimized e-gun deposition from rotating DyF₃ discs at substrate temperatures ~ 180 – 200°C.

Yttrium Fluoride YF₃

- YF₃ films with a refractive index n ~ 1.48 – 1.52 at 550 nm and ~ 1.28 – 1.42 at 10 μm can be produced from YF₃, granulate or tablets by evaporation from boat or with e-gun.
- YF₃, source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.
- YF₃, films have a wide range of transparency, reduced stress and are environmentally fairly stable.

**Film properties**

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Refractive index n</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>~ 1.56 – 1.65</td>
</tr>
<tr>
<td>550</td>
<td>~ 1.48 – 1.52</td>
</tr>
<tr>
<td>10 μm</td>
<td>~ 1.28 – 1.42</td>
</tr>
</tbody>
</table>

**Range of transparency** ~ 190 nm – 12 μm (for typical use)

**Environmental stability** MIL-C-675 B/C passed

**Stress** low to intermediate tensile, magnitude depending on substrate temperature and base pressure

The wide spectral range of transparency is merely interrupted by localized water absorption bands at ~ 3 and 6 μm. On heated substrates, the water content of the films can be reduced and the corresponding absorption strongly reduced. Absorption values < 0.2% (10.0 – 12.5 μm) and < 1.0% (16 μm) have been obtained for single films of quarterwave thickness at 10.6 μm deposited from UMICORE DyF₃ material.

The wide spectral range of transparency, a good evaporation behaviour and low to moderate stress make this material useful as the L-index material in AR coatings, optical filters and laser protection coatings especially in the VIS and IR spectral regions.

Low absorption films for both the UV and IR ranges can be obtained using boat or well-optimized e-gun deposition at low to moderate substrate temperatures. Substrate temperatures should not exceed 150 – 180°C due to considerably increased optical losses and stress at higher temperatures.
IR-F625

- IR-F625 films with a refractive index n ~ 1.47 – 1.52 at 550 nm and ~ 1.28 – 1.42 at 10 µm can be produced by evaporation from boat or with e-gun.
- IR-F625 source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to stress and low absorption.
- IR-F625 films have a wide range of transparency, reduced stress and are environmentally fairly stable.
- IR-F625 can be used for certain applications as a substitute for radioactive ThF₄.

Film properties

<table>
<thead>
<tr>
<th>Refractive index at 300 nm</th>
<th>~ 1.48 – 1.55</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 nm</td>
<td>~ 1.47 – 1.52</td>
</tr>
<tr>
<td>10 µm</td>
<td>~ 1.28 – 1.42</td>
</tr>
<tr>
<td>Range of transparency</td>
<td>~ 190 nm – 12 µm (for typical use)</td>
</tr>
<tr>
<td>Environmental stability</td>
<td>MIL-C-675 B/C passed</td>
</tr>
<tr>
<td>Stress</td>
<td>low to intermediate tensile, magnitude depending on substrate temperature and base pressure</td>
</tr>
</tbody>
</table>

The wide spectral region of transparency is merely interrupted by local water absorption bands at ~ 3 and 6 µm that can effectively be suppressed by elevated substrate temperature. Absorption values < 0.2% (10 µm) for 1 µm thick films have been obtained.

IR-F625 films in as-deposited state have reduced tensile stress relative to YF₃ films.

The wide spectral range of transparency, a good evaporation behaviour and low to moderate stress with consequently good environmental resistance make this material useful as the L-index material in AR coatings and optical filters from the UV to the IR range. It is an interesting material for night vision applications. With regard to film stress it is a possible alternative to YF₃, too.

Application Guidelines

Characteristics of starting material

- Chemical formula: IR-F625 proprietary mixture
- Color: White
- Density g/cm³: ~ 5.0
- Melting point °C: ~ 1200
- Form: Granulate

Evaporation technique

IR-F625 films can be deposited from IR-F625 starting material by evaporation with e-gun out of Mo- or Ta- liners or with resistively heated boats of Mo or Ta. Adhesion and environmental resistance can be enhanced using substrate pretreatment by glow discharge and thin adhesion layers (SiO, MgO, Y₂O₃) depending on substrate type and spectral range of the application. Substrate temperatures should not exceed 150 – 180°C due to considerably increased optical losses and stress at higher temperatures.

Low absorption films for both the UV and IR ranges can be obtained using boat or well-optimized e-gun deposition at low to moderate substrate temperatures. Light scatter can be further suppressed using boat evaporation.

Ytterbium Fluoride YbF₃

- YbF₃ films with a refractive index n ~ 1.51 – 1.55 at 550 nm and ~ 1.36 – 1.42 at 10 µm can be produced from YbF₃ granules by electron beam and thermal evaporation.
- YbF₃ source material from UMICORE is tailored for low spitting and outgassing.
- YbF₃ films deposited with YbF₃ source material from UMICORE show lowest possible absorption.

Film properties

<table>
<thead>
<tr>
<th>Refractive index at 300 nm</th>
<th>~ 1.56 – 1.62</th>
</tr>
</thead>
<tbody>
<tr>
<td>550 nm</td>
<td>~ 1.51 – 1.55</td>
</tr>
<tr>
<td>10 µm</td>
<td>~ 1.36 – 1.42</td>
</tr>
<tr>
<td>Range of transparency</td>
<td>~ 200 nm – 12 µm (for typical use)</td>
</tr>
<tr>
<td>Environmental stability</td>
<td>good</td>
</tr>
<tr>
<td>Stress</td>
<td>low tensile magnitude depending on process type and parameters</td>
</tr>
</tbody>
</table>

Ytterbium fluoride, YbF₃, is a low-index film material. It has a good transparency from the UV – IR spectral regions. The wide spectral region of transparency is merely interrupted by localized water absorption bands at ~ 3 and 6 µm. YbF₃ films show moderate mechanical stress that outcompetes a number of other fluoride materials. Absorption values < 0.2% have been obtained for single films of quarterwave thickness at 10.6 µm deposited from UMICORE YbF₃ material.

The spectral range of transparency, a good evaporation behaviour and moderate film stress with consequently good environmental resistance make this material useful as the L-index material in AR coatings and optical filters from the UV to the IR range and an alternative to radioactive ThF₄ in coatings for IR laser applications as well as for broadband applications like night vision coatings.
IR-F900

- Homogeneous IR-F900 films with a refractive index $n \sim 1.50 – 1.55$ at 550 nm and $1.30 – 1.36$ at 10 µm can be produced by evaporation from boat or with e-gun.
- IR-F900 source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.
- IR-F900 films have a wide range of transparency, reduced stress and are environmentally fairly stable.
- IR-F900 can be used for certain applications as substitute for radioactive ThF₄.

**Film properties**

- Refractive index at 300 nm: $1.52 – 1.56$
- Range of transparency: ~ 200 nm – 12 µm (for typical use)
- Stress: low to intermediate tensile, magnitude depending on substrate temperature and base pressure

The wide spectral region of transparency is merely interrupted by local water absorption bands at ~ 970 nm (very weak), ~ 3 and 6 µm. On heated substrates, the water content of the films can be reduced and thus the absorption at ~ 3 and 6 µm minimized. Absorption values < 0.2% (10 µm) for 1 µm thick films have been obtained from UMICORE IR-F900 material.

IR-F900 films have reduced tensile stress compared to YF₃ films.

The wide spectral range of transparency, a good evaporation behaviour and low to moderate stress with consequently good environmental resistance make this material useful as the L-index material in AR coatings and optical filters from the UV to the IR range and an alternative to radioactive ThF₄ in coatings for low-power IR laser applications as well as for night vision. With regard to film stress it is a possible alternative to YF₃, too.

Zinc Sulfide ZnS

- ZnS films with a refractive index $n \sim 2.3$ at 550 nm and $\sim 2.0$ at 10 µm can be produced from ZnS source material from boat or with e-gun.
- ZnS films can be used as H-index material in the VIS and IR, but also as L-index material in combination with Ge in the IR.
- Stress compensation in combination with fluoride films.

**Film properties**

- Refractive index at 550 nm: $2.30 – 2.40$
- Range of transparency: ~ 400 nm – 14 µm
- Stress: fairly hard and good environmental stability

The combination of refractive index and stress type makes ZnS an ideal H-index material in combination with appropriate fluorides as L-index materials that allows for sufficient stress compensation in the dielectric coating stack.

In the spectral range beyond 1.7 µm, ZnS is also used as L-index material in combination with Ge as the H-index material. ZnS is also used as last layer on ZnSe/fluoride coatings on ZnSe to yield the necessary mechanical stability.

Along with its wide spectral range of transparency, easy evaporation and good mechanical stability and overall environmental resistance Zinc sulfide is well suited for AR, beamsplitter and filter coatings for VIS and IR applications, mostly on ZnS substrates. It is also one of the most common H-index materials used for holographic applications.
Germanium Ge

- Ge films have a very high refractive index $n$ for IR applications with values ~ 4.0 – 4.3 in the range 2 – 16 μm.
- Ge films exhibit good mechanical and environmental stability.
- Ge is well suited as H-index material in combination with most L-index materials.

**Film properties**

<table>
<thead>
<tr>
<th>Wavelength [μm]</th>
<th>Refractive index $n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7</td>
<td>~ 4.3 – 4.4</td>
</tr>
<tr>
<td>2</td>
<td>~ 4.2 – 4.4</td>
</tr>
<tr>
<td>10</td>
<td>~ 4.0 – 4.1</td>
</tr>
</tbody>
</table>

| Range of transparency | ~ 1.7 – 23 μm |
| (very low absorption) | ~ 4 – 12 μm |

**Environmental stability**

- Good mechanical and environmental stability

Conventionally deposited thin films made from Ge source material have refractive indices ~ 4.17 – 4.32 (~ 1.6 μm), ~ 4.1 – 4.2 (2.0 μm), ~ 4.00 – 4.05 (10.6 μm).

The high refractive index, the spectral range of transparency and a good evaporation behaviour make Germanium the H-index material of choice for IR coatings on Ge in general and for broad-band applications 8 – 16 μm in particular.

The temperature sensitivity of the Ge absorption limits its use to low-power laser coating applications.

Application Guidelines

**Characteristics of starting material**

- **Chemical formula**: Ge
- **Color**: Grey-silver
- **Density g/cm$^3$**: ~ 5.4
- **Melting point °C**: 937
- **Form**: Granulate

**Evaporation technique**

Ge films can be deposited from Ge starting material by evaporation from boat or with e-gun out of graphite, Mo- or W-liners or directly from a water-cooled Cu crucible. Special guidelines apply to each of these deposition techniques.

For evaporation directly from the crucible the geometry (crucible aspect ratio), beam pattern and rotation have to be considered. For deposition out of the mentioned liners, prevention of alloying reactions requires to confine the molten zone away from the boundaries.

Germanium is typically deposited on heated substrates at temperatures up to 200°C. Overheating of the material needs to be avoided. Physical deposition rates are < 0.5 nm/s.

Silicon Si

- Si films show a high refractive index $n$ ~ 3.40 – 3.45 at 3 μm and are well suited for applications in the 1 – 8 μm IR region.
- Si films show excellent hardness and environmental stability.

**Film properties**

<table>
<thead>
<tr>
<th>Wavelength [μm]</th>
<th>Refractive index $n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>~ 3.50 – 3.60</td>
</tr>
<tr>
<td>3</td>
<td>~ 3.40 – 3.45</td>
</tr>
</tbody>
</table>

| Range of transparency | ~ 1 – 8 μm |
| Environment stability | excellent |

Silicon is used as the H-index material for coating applications in the 1 – 8 μm IR spectral range.

Application Guidelines

**Characteristics of starting material**

- **Chemical formula**: Si
- **Color**: Silver-grey
- **Density g/cm$^3$**: ~ 2.3
- **Melting point °C**: 1410
- **Form**: Granulate, discs, slugs

**Evaporation technique**

Si films can be deposited from Si starting material by evaporation from boat or with e-gun out of Mo-liners or directly from a water-cooled Cu crucible. Special guidelines apply to each of these deposition techniques.

For evaporation directly from the crucible the geometry (crucible aspect ratio), beam pattern and rotation have to be considered. For deposition out of a liner, prevention of alloying reactions requires to confine the molten zone away from the boundaries.

Physical deposition rates are 0.1 – 0.5 nm/s.

Low pressure is advisable, since Si shows a strong gettering effect.
Adhesion promoters

- SiO, Sc₂O₃, MgO and Y₂O₃ are used as very thin films to promote adhesion for IR coatings on the substrate and between H- and L-index layers.
- Sc₂O₃, MgO and Y₂O₃ are coated by e-beam deposition, SiO additionally by boat deposition.

### Film properties

<table>
<thead>
<tr>
<th></th>
<th>SiO</th>
<th>MgO</th>
<th>Y₂O₃</th>
<th>Sc₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral range with useful reflectance</td>
<td>&gt; 700 nm</td>
<td>&gt; 400 nm</td>
<td>&gt; 100 nm</td>
<td></td>
</tr>
<tr>
<td>Environmental stability</td>
<td>very soft</td>
<td>corroding if not protected</td>
<td>ageing if not protected</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td>compressive to tensile on film oxidation</td>
<td>tensile</td>
<td>tensile</td>
<td></td>
</tr>
</tbody>
</table>

The oxidation state and thus the refractive index and range of transparency can be widely tuned for SiO starting material depending on the presence and extent of reactive oxygen as well as on the use and parameters of ion assistance. For reactive evaporation, SiO can be obtained with refractive indices n ~ 1.5 – 1.6 and a transmittance range 400 nm – 8 µm. For non-reactive deposition, the films are not fully oxidized yielding refractive indices n ~ 1.8 – 1.9 and a transmittance range 700 nm – 12 µm. The mentioned transparency ranges qualify SiO as adhesion promoter for the VIS (SiO₂) and NIR (SiO) spectral ranges.

MgO films commonly start with an inhomogeneous growth zone which is however not relevant for their use as very thin adhesion promoters. Such films are hard and environmentally durable. In spite of the indicated transmittance range, use of MgO films as adhesion layer is known up to 12 µm.

- Sc₂O₃ is occasionally in use as adhesion promoter in IR coatings based on its wide transmittance range.

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Y₂O₃ films are applied both as adhesion promoter and as M-index optical layer in IR coatings out to 16 µm.
Sc₂O₃ is occasionally in use as adhesion promoter in IR coatings based on its wide transmittance range.

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Application Guidelines

### Characteristics of starting material

<table>
<thead>
<tr>
<th>Chemical formula</th>
<th>Au</th>
<th>Ag</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Gold</td>
<td>Silver shiny</td>
<td>Silver</td>
</tr>
<tr>
<td>Density g/cm³</td>
<td>19.3</td>
<td>10.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Melting point °C</td>
<td>1063</td>
<td>961</td>
<td>660</td>
</tr>
<tr>
<td>Form</td>
<td>Granulate, wire, discs, tiles</td>
<td>Granulate, wire, rods, discs</td>
<td>Granulate, wire, rods, bars, discs, slugs</td>
</tr>
</tbody>
</table>

**Evaporation technique**

All the metals can be deposited by e-beam either from water-cooled Cu crucibles or from liners. For evaporation from the Cu crucible it is required to confine the molten zone away from the boundaries.

Evaporation of Au and Ag is commonly done from Mo or C liners, Au also from W liner. Evaporation of Al can be made from C and BN liners.

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**Metals**

- Au, Ag and Al metal films are used for high-reflecting IR coatings.
- A number of other metals for special purposes is available on request.

### Film properties

<table>
<thead>
<tr>
<th></th>
<th>Au</th>
<th>Ag</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive index at 550 nm</td>
<td>1.5 – 1.6</td>
<td>1.7</td>
<td>1.77 – 1.85</td>
</tr>
<tr>
<td>10 µm</td>
<td>1.8 – 1.9</td>
<td>1.68</td>
<td>1.75 – 1.82</td>
</tr>
<tr>
<td>Range of transparency 700 nm – 8 µm</td>
<td>200 nm – 8 µm</td>
<td>250 nm – 12 µm</td>
<td>230 nm – 12 µm</td>
</tr>
<tr>
<td>400 nm – 8 µm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental stability</td>
<td>good</td>
<td>good</td>
<td>good</td>
</tr>
<tr>
<td>Stress</td>
<td>tensile</td>
<td>tensile</td>
<td>tensile</td>
</tr>
</tbody>
</table>

**Evaporation technique**

All the metals can be deposited by e-beam either from water-cooled Cu crucibles or from liners. For evaporation from the Cu crucible it is required to confine the molten zone away from the boundaries.

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**Special Materials for Precision Optics & Laser Coatings – Fluorides and Special Materials for IR coatings**

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**Application Guidelines**

### Characteristics of starting material

<table>
<thead>
<tr>
<th>Chemical formula</th>
<th>SiO</th>
<th>MgO</th>
<th>Y₂O₃</th>
<th>Sc₂O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Yellowish-grey to grey-black</td>
<td>White</td>
<td>White</td>
<td>White to brownish</td>
</tr>
<tr>
<td>Density g/cm³</td>
<td>2.1</td>
<td>3.6</td>
<td>5.0</td>
<td>3.9</td>
</tr>
<tr>
<td>Evaporation type</td>
<td>Sublimation</td>
<td>Sublimation</td>
<td>Sublimation / partial melting</td>
<td>Sublimation / slight melting</td>
</tr>
<tr>
<td>Melting point °C</td>
<td>2410</td>
<td>(2400)</td>
<td>2400</td>
<td>(2400)</td>
</tr>
<tr>
<td>Evaporation temperature °C</td>
<td>~ 1100</td>
<td>~ 1800 – 1900</td>
<td>~ 2300 – 2400</td>
<td>~ 2400</td>
</tr>
<tr>
<td>Form</td>
<td>Tablets (FLEXO), granulate</td>
<td>Tablets, granulate</td>
<td>Tablets</td>
<td>Granulate, tablets</td>
</tr>
</tbody>
</table>

**Evaporation technique**

Sc₂O₃, MgO and Y₂O₃ can be deposited by e-beam deposition from W, Mo and Ta liners, SiO can also be deposited thermally from Mo boat.

For SiO and MgO no premelting of the source material is needed/possible. For Y₂O₃ and Sc₂O₃ premelting can be favourable or even indispensable depending on the material geometry and film coating requirements.

Except for SiO and MgO, all materials need to be evaporated reactively. The deposition can be preceded by a glow etch step and can be assisted with ions or plasma.
Oxides for IR coatings

E-beam evaporated films from SiO, CeO₂, Y₂O₃, HfO₂, ZrO₂, Ta₂O₅, TiO₂, Al₂O₃, SiO₂ source materials can be used for coatings in the NIR spectral region. Films produced with ion assistance are quite compact and do not show appreciable water absorption in the 2.8 – 3.2 µm region.

The mentioned oxide materials have been treated in detail in the catalogue (Consumables for PVD applications – Evaporation Materials and Accessories) and in the sales folder (Special materials for Precision Optics & Laser Coatings – Oxides for Evaporation).

Weblink: www.thinfilmproducts.umicore.com/techdata.asp

Other materials, special compositions and geometries

Other materials, customized compositions and geometries are available on request.

Please contact your local Umicore Thin Film Products representative or distributor for more information and an in depth discussion of your specific requirement.

Accessories

A wide range of standard thermal, e-beam and ion source accessories, crystal quartzes and other accessories can be supplied according to the catalogue (Consumables for PVD applications – Evaporation Materials and Accessories).

Customized accessories are available on request.

Weblink: www.thinfilmproducts.umicore.com/catalog.asp
Please find your local sales partner at: www.thinfilmproducts.umaricore.com