umicore

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.

Contents

Barium Fluoride BaF_2

- **BaF_2 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 BaF_2 granulate from boat or with e-gun.**
- **BaF_2 source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.**
- **BaF_2 films have a wide range of transparency.**

Film properties

Refractive index at	260 nm	~ 1.51
	550 nm	~ 1.47 – 1.48
	10 µm	~ 1.33 – 1.42
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 interupted 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 ThF_4 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

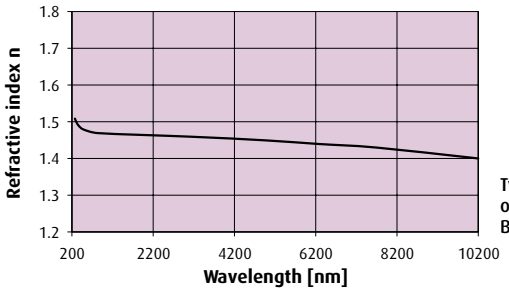
Characteristics of starting material

Chemical formula	BaF_2
Color	White/glassy – light grey (depending on production route)
Density g/cm³	~ 4.9
Melting point °C	1280
Form	Granulate

Evaporation technique

BaF_2 films can be deposited from BaF_2 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, Y_2O_3) 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 CeF_3

- **CeF_3 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 CeF_3 granulate by boat or e-gun evaporation.**
- **CeF_3 films have a range of transparency from 300 nm to 13 µm.**
- **Durable low absorption films of CeF_3 can be obtained using boat or well-optimized e-gun deposition.**

Film properties

Refractive index at	250 nm	~ 1.75 – 1.78
	550 nm	~ 1.59 – 1.62
	10 µm	~ 1.42 – 1.47
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 ThF_4.

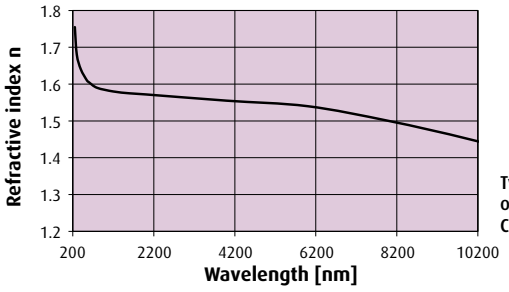
Application Guidelines

Characteristics of starting material

Chemical formula	CeF_3
Color	White to brownish with reddish or rosa tint
Density g/cm³	~ 6.2
Melting point °C	1460
Form	Granulate

Evaporation technique

CeF_3 films can be deposited from CeF_3 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 DyF_3

- **DyF_3 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 DyF_3 discs, from pieces or granules by evaporation with e-gun and thermal deposition.**
- **DyF_3 source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.**
- **DyF_3 films have a wide range of transparency and reduced stress.**

Film properties

Refractive index at	300 nm	~ 1.63 – 1.60
	550 nm	~ 1.48 – 1.55
	10 µm	~ 1.38 – 1.42
Range of transparency		~ 200 nm – 16 µm weak intrinsic absorption band ~ 750 – 950 nm
Environmental stability		fairly good
Stress		low tensile, magnitude depending on source material and process parameters

The wide spectral region 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 DyF_3 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 NIR and MIR (LWIR) spectral ranges as well as for laser and broadband applications beyond 12 µm wavelength.

Application Guidelines

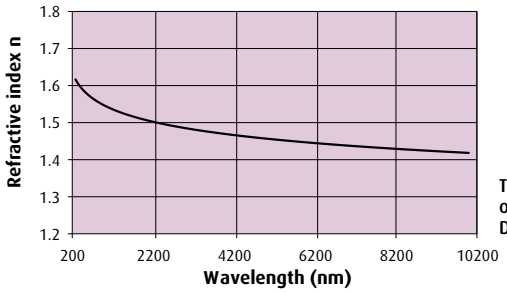
Characteristics of starting material

Chemical formula	DyF_3
Color	Green-yellowish to grey
Density g/cm³	~ 7.5
Melting point °C	1155
Form	Discs, pieces, granulate

Evaporation technique

DyF_3 films can be deposited from DyF_3 starting material by evaporation with e-gun and boat deposition. Disc material can be evaporated out of a rotating crucible by e-gun. Adhesion and environmental resistance can be enhanced using substrate pretreatment by glow discharge and thin adhesion layers (SiO, MgO, Y_2O_3) depending on substrate type and spectral range of the application. Substrate temperatures are substrate depending in a typical range of 140 – 200°C and can be varied to optimize optical losses, stress and environmental stability.

The best low absorption films for the IR spectral range 8 – 16 µm can be obtained with well optimized e-gun deposition from rotating DyF_3 discs at substrate temperatures ~ 180 – 200°C.



Typical dispersion curve of the refractive index of Dysprosium Fluoride films.

Yttrium Fluoride YF_3

- **YF_3 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 YF_3 granulate or tablets by evaporation from boat or with e-gun.**
- **YF_3 source material from UMICORE exhibits no spitting and outgassing and is optimized with respect to low absorption.**
- **YF_3 films have a wide range of transparency, reduced stress and are environmentally fairly stable.**

Film properties

Refractive index at	200 nm	~ 1.56 – 1.65
	550 nm	~ 1.48 – 1.52
	10 µm	~ 1.28 – 1.42
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 region 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 excluded. Absorption values < 0.2% (10 µm) for 1 µm thick films have been obtained from UMICORE YF_3 material.

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 ThF_4 in coatings for IR laser applications as well as for night vision. Additional applications are protective and reflection-enhancing layers for high-reflectance coatings in the VIS and IR spectral regions.

Application Guidelines

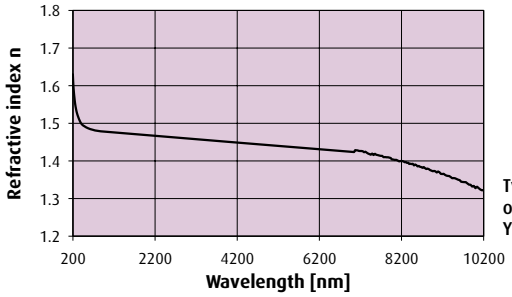
Characteristics of starting material

Chemical formula	YF_3
Color	White-light grey
Density g/cm³	~ 4.8
Melting point °C	1155
Form	Granulate, tablets, discs, slugs (premelted material)

Evaporation technique

YF_3 films can be deposited from YF_3 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, Y_2O_3, Sc_2O_3) 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.



Typical dispersion curve of the refractive index of Yttrium Fluoride films.

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 substitute for radioactive ThF_4.**

Film properties

Refractive index at	300 nm	~ 1.48 – 1.55
	550 nm	~ 1.47 – 1.52
	10 µm	~ 1.28 – 1.42
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 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 YF_3 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 YF_3, too.

Application Guidelines

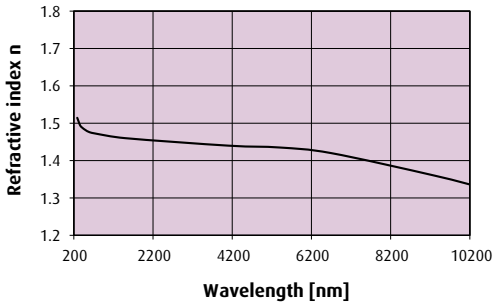
Characteristics of starting material

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, Y_2O_3) 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.



Typical dispersion curve of the refractive index of IR-F625 films.

Ytterbium Fluoride YbF_3

- **YbF_3 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 YbF_3 granules by electron beam and thermal evaporation.**
- **YbF_3 source material from UMICORE is tailored for low spitting and outgassing.**
- **YbF_3 films deposited with YbF_3 source material from UMICORE show lowest possible absorption.**

Film properties

Refractive index at	300 nm	~ 1.56 – 1.62
	550 nm	~ 1.51 – 1.55
	10 µm	~ 1.36 – 1.42
Range of transparency		~ 200 nm – 12 µm (for typical use) weak intrinsic absorption band ~ 750 – 950 nm
Environmental stability		good
Stress		low tensile magnitude depending on process type and parameters

Ytterbium fluoride, YbF_3, 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. YbF_3 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 YbF_3 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 ThF_4 in coatings for IR laser applications as well as for broadband applications like night vision coatings.

Application Guidelines

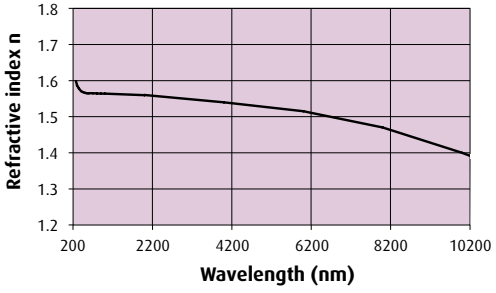
Characteristics of starting material

Chemical formula	YbF_3
Color	Beige
Density g/cm3	~ 8.2
Melting point °C	~ 1157
Form	Granulate

Evaporation technique

YbF_3 films can be deposited from YbF_3 starting material by evaporation with e-gun and boat deposition. Adhesion and environmental resistance can be enhanced using substrate pretreatment by glow discharge and thin adhesion layers (SiO, MgO, Y_2O_3) 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.

A constant evaporation rate of 1.5 nm/s can be maintained for e-gun and up to 4 nm/s for boat evaporation.



Typical dispersion curve of the refractive index of Ytterbium Fluoride films.

IR-F900

- **Homogeneous IR-F900 films with a refractive index n ~ 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 ThF_4.**

Film properties

Refractive index at	300 nm	~ 1.52 – 1.56
	550 nm	~ 1.50 – 1.55
	10 µm	~ 1.30 – 1.36
Range of transparency		~ 200 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 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 YF_3 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 ThF_4 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 YF_3, too.

Application Guidelines

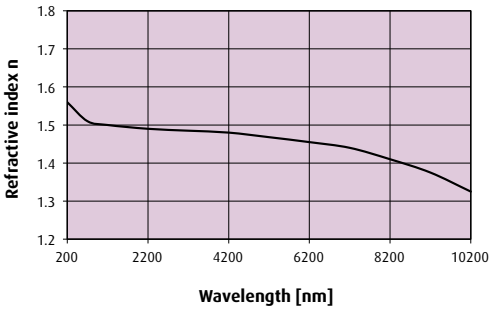
Characteristics of starting material

Chemical formula	IR-F900 proprietary mixture
Color	Grey-rose
Density g/cm³	~ 7.0
Melting point °C	~ 1150 – 1250
Form	Granulate

Evaporation technique

IR-F900 films can be deposited from IR-F900 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, Y_2O_3) depending on substrate type and spectral range of the application. Substrate temperatures > 150°C strongly reduce NIR water absorption and improve environmental durability.

Low absorption homogeneous 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.



Typical dispersion curve of the refractive index of IR-F900 films.

Zinc Sulfide ZnS

- **ZnS films with a refractive index n ~ 2.3 at 550 nm and ~ 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
	2 µm	~ 2.15 – 2.25
	10 µm	~ 2.00 – 2.15
Range of transparency		~ 400 nm – 14 µm
Environmental stability		fairly hard and good environmental stability
Stress		compressive

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.

Application Guidelines

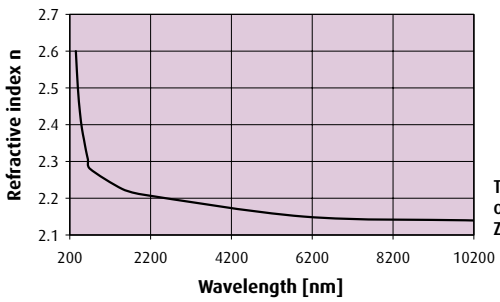
Characteristics of starting material

Chemical formula	ZnS
Color	White to yellowish opaque
Density g/cm³	~ 4.1
Melting point °C	Sublimes, evaporation temperature ~ 1000 – 1100°C
Form	Crystalline pieces and granulate (CVD grade), sintered tablets and granulate

Evaporation technique

ZnS films can be deposited non-reactively from ZnS starting material by evaporation from resistively heated boats of Mo or Ta as well as with e-gun out of Mo- or Ta- liners employing base pressures in the 10^{-5} – 10^{-8} mbar range.

The substrate temperature for ZnS deposition is limited to ~ 160°C. Typical deposition rates range from 0.1 – 0.15 nm/s to 8 – 16 nm/s. For IR coatings, deposition rates are rather on the lower side of this range.



Typical dispersion curve of the refractive index of Zinc Sulfide films.

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

Refractive index at	1.7 µm	~ 4.3 – 4.4
	2 µm	~ 4.2 – 4.4
	10 µm	~ 4.0 – 4.1
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

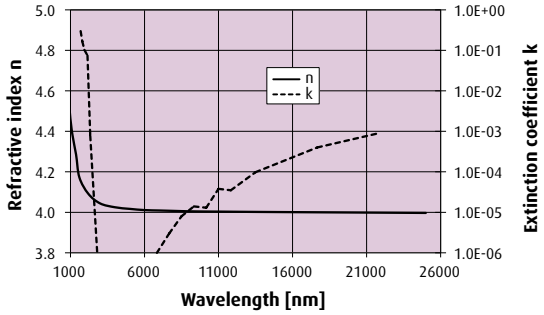
Characteristics of starting material

Chemical formula	Ge
Color	Grey-silver
Density g/cm³	~ 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.



Typical dispersion curve of the refractive index and extinction coefficient of Germanium films.

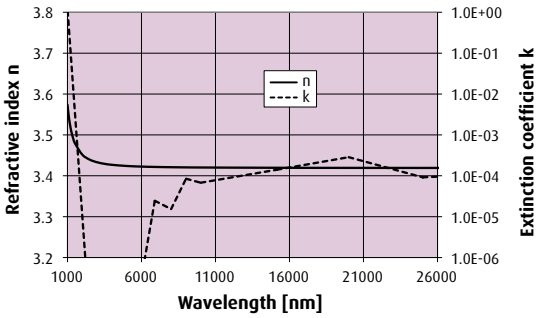
Silicon Si

› **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

Refractive index at	1 µm	~ 3.50 – 3.60
	3 µm	~ 3.40 – 3.45
Range of transparency		~ 1 – 8 µm
Environmental stability		excellent

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



Typical dispersion curve of the refractive index and extinction coefficient of Silicon films.

Application Guidelines

Characteristics of starting material

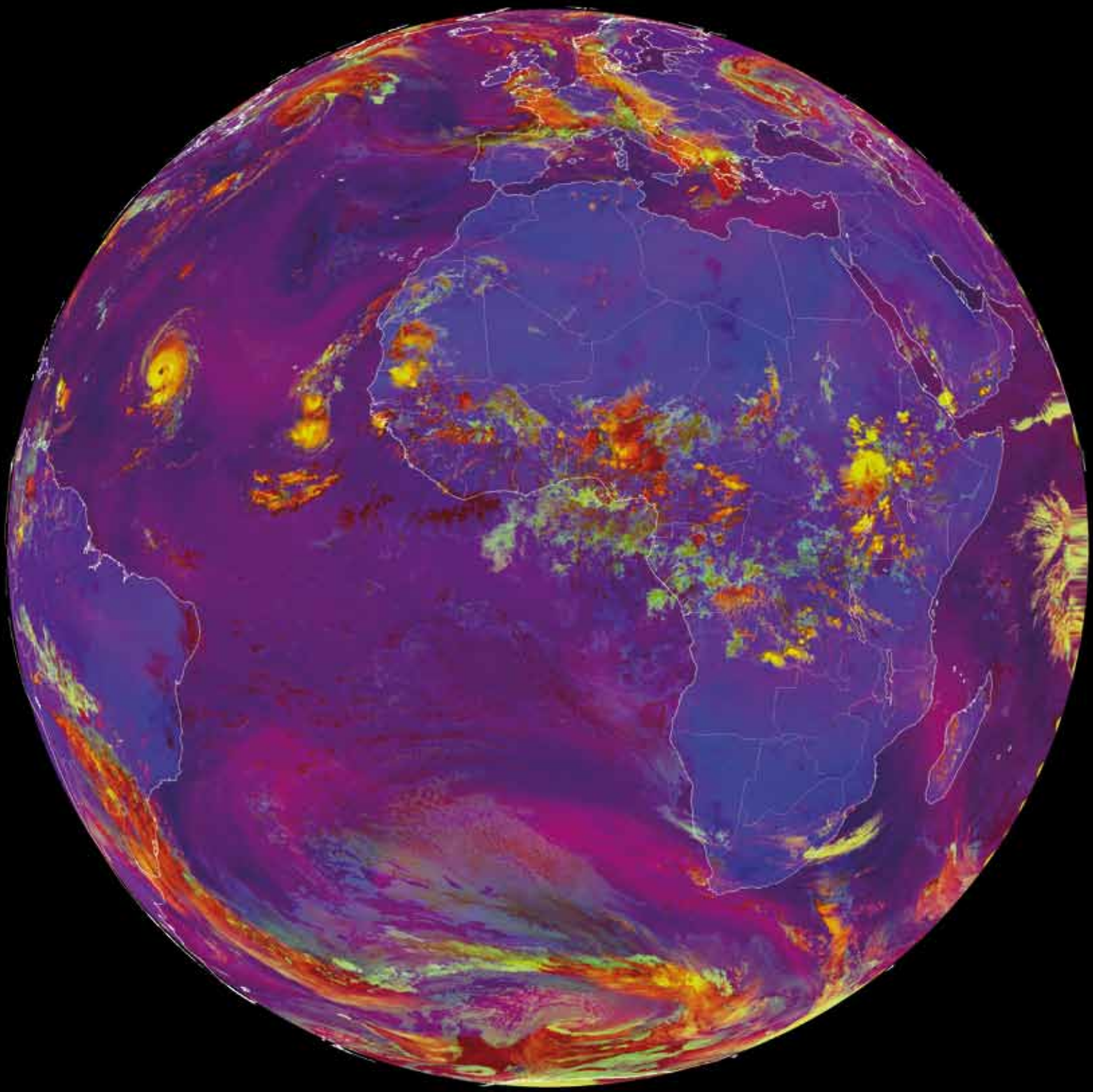
Chemical formula	Si
Color	Silver-grey
Density g/cm³	~ 2.3
Melting point °C	1410
Form	Granulate, discs, slugs

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.



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

	Au	Ag	Al
Spectral range with useful reflectance	> 700 nm	> 400 nm	> 100 nm
Environmental stability	very soft	corroding if not protected	ageing if not protected
Stress	tensile	tensile	tensile

Application Guidelines

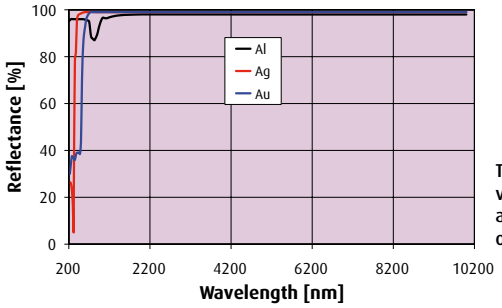
Characteristics of starting material

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

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.



Typical reflectance values for Al, Ag, Au as a function of wavelength.

Adhesion promoters

› **SiO, Sc_2O_3, MgO and Y_2O_3 are used as very thin films to promote adhesion for IR coatings on the substrate and between H- and L-index layers.**
› **Sc_2O_3, MgO and Y_2O_3 are coated by e-beam deposition, SiO additionally by boat deposition.**

Film properties

	SiO	MgO	Y_2O_3	Sc_2O_3
Refractive index at				
550 nm	1.5 – 1.6 [1]	1.7	1.77 – 1.85	1.75 – 1.82
10 µm	1.8 – 1.9 [2]		1.68	
Range of transparency	700 nm – 8 µm [2] 400 nm – 8 µm [1]	200 nm – 8 µm	250 nm – 12 µm	230 nm – 12 µm
Environmental stability	good	good	good	good
Stress	compressive to tensile depending on film oxidation	compressive	tensile	tensile

[1] fully oxidized film
[2] film produced under reducing conditions

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, Si_2O_3 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 – 8 µm. The mentioned transparency ranges qualify SiO as adhesion promoter for the VIS (Si_2O_3) 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.

Y_2O_3 films are applied both as adhesion promoter and as M-index optical layer in IR coatings out to 16 µm.

Sc_2O_3 is occasionally in use as adhesion promoter in IR coatings based on its wide transmittance range.

Application Guidelines

Characteristics of starting material

Chemical formula	SiO	MgO	Y_2O_3	Sc_2O_3
Colour	Yellowish-grey to grey-black	White	White	White to brownish
Density g/cm³	2.1	3.6	5.0	3.9
Evaporation type	Sublimation	Sublimation	Sublimation / partial melting	Sublimation / slight melting
Melting point °C			2410	(2400)
Evaporation temperature °C	~ 1100	~ 1800 – 1900	~ 2300 – 2400	~ 2400
Form	Tablets (FLEXO), granulate	Tablets, granulate	Tablets	Granulate, tablets

Evaporation technique

Sc_2O_3, MgO and Y_2O_3 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 Y_2O_3 and Sc_2O_3 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, CeO_2, Y_2O_3, HfO_2, ZrO_2, Ta_2O_5, TiO_2, Al_2O_3, SiO_2 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).

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

Customized accessories are available on request.

BV868883/7/2024

Please find your local sales partner at:
www.tfp.umicore.com

Umicore Thin Film Products AG
Headquarter
Alte Landstrasse 8
9496 Balzers
Principality of Liechtenstein
Tel +423 388 7300
Fax +423 388 7450
sales.materials@umicore.com

Umicore Optical Materials
USA Inc.
2976 S. 614 Road
Quapaw, OK 74363
USA
Tel +1 918 673 1650
Fax +1 918 673 2121
sales.materials.us@umicore.com

Umicore Thin Film Products
Taiwan Co., Ltd.
No. 22, Aly. 4, Ln. 711 Boʻai St.,
Zhubei City, Hsinchu County 302
Taiwan
Tel +886 3553 2999
Fax +8863553 2525
sales.materals.hc@umicore.com