product information

Surface Solutions

Hafnium(IV) Oxide Patinal®

GENERAL INFORMATION

Hafnium oxide is used for thin films with high refractive index in AR coatings, filters, mirrors, and beam splitters for the spectral region from 240 nm to about 10 µm. It is especially suitable for films with low absorption down to 248 nm. It forms very hard and durable layers that make it well suited for optical coatings that require a high level of hardness and scratch resistance.

AREAS OF APPLICATION

- AR and multilayer coatings for e.g. filters, mirrors and beam splitters in the UV, VIS and NIR range
- Coatings for laser applications with strong requirements on laser damage threshold
- Protective coatings for metal mirrors

THIN FILM PROPERTIES

Range of transparency	240 nm – 10 µm
Refractive index at 500 nm	
• conventional T_s = 300 °C / no IAD	~ 1.95
• IAD – T_s = RT	~ 2.00
Absorption edge	~ 240 nm
Thin film stress	Tensile

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mail: photonicsUS@emdgroup.com / web: patinal.com

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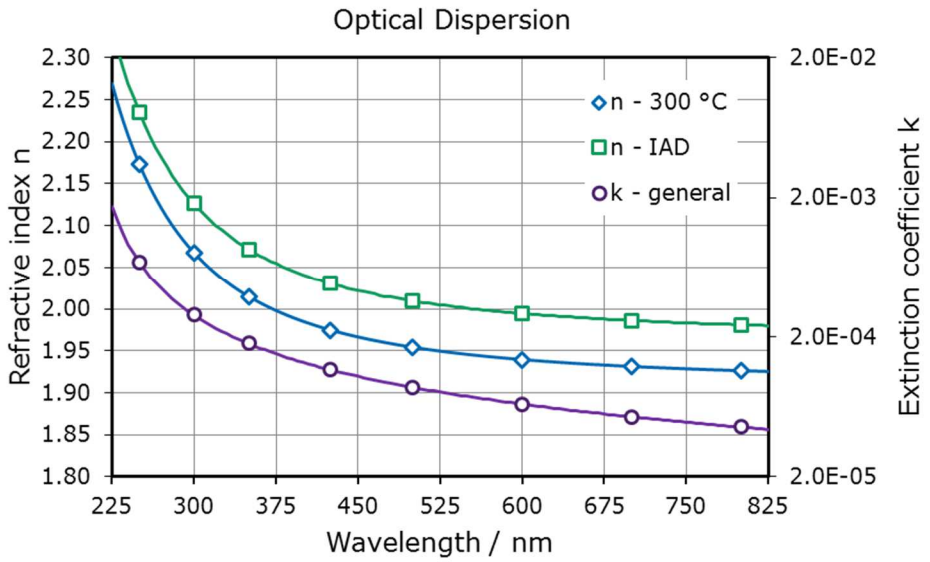
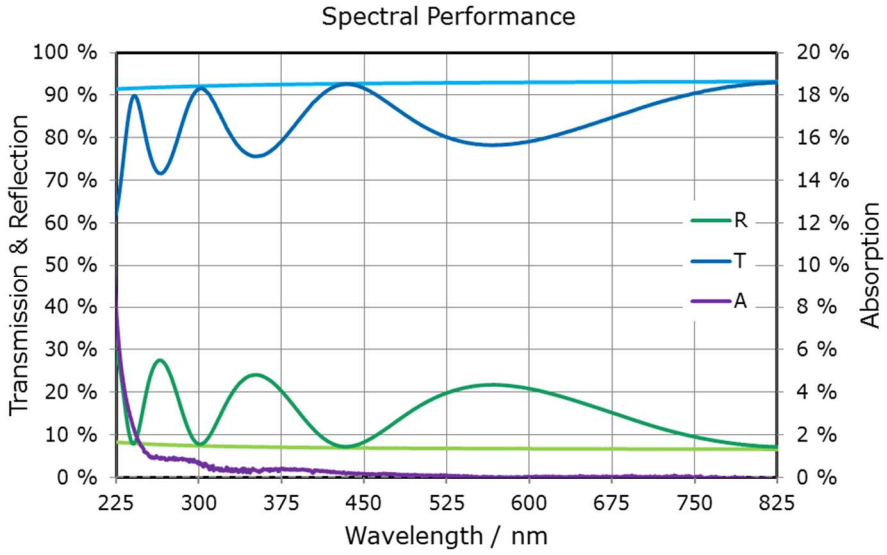


wavl / nm	250	300	350	400	500	600	800
n - 300 °C	2.173	2.068	2.015	1.975	1.954	1.940	1.926
n - IAD	2.234	2.126	2.072	2.041	2.009	1.994	1.981
k - general	6.9E-04	2.9E-04	1.8E-04	1.3E-04	8.7E-05	6.6E-05	4.5E-05

Transmission, reflection, and absorption spectrum are shown for a typical coating of Hafnium oxide. The physical thickness is about 220 nm. The coating was deposited onto fused silica at about 300 °C substrate temperature.



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NOTES FOR EVAPORATION

Evaporator source	Electron beam evaporator
Liner	Copper crucible or Mo-liner
Evaporation temperature	2000 – 2200 °C
Deposition rate	0.2 – 0.6 nm/s preferably 0.2 – 0.3 nm/s
Oxygen partial pressure	about $2 \cdot 10^{-4}$ mbar
IAD settings (Leybold Optics APS)	110 – 120 V Bias, 15 – 20 sccm O_2
Substrate temperature	conventional 150 to 350 °C, preferably 200°C IAD @ RT – 200 °C, preferably 110 - 150 °C
QCR-settings	Density 9.68 g/cm³, z-ratio 1.0

Hafnium oxide can only be evaporated by electron beam evaporation. For the deposition of homogeneous films with high density, elevated substrate temperatures are necessary. A further increase in density and a higher refractive index can be obtained by using an ion assisted deposition process (IAD). Thicker HfO_2 layers tend to show a slight amount of refractive index inhomogenity by forming more crystalline fractions with growing film thickness.
Prior to the deposition of the coatings, the material has to be premelted below a shutter using a sweeping electron beam to make sure a uniform melt surface is forming. In order to achieve the most stable process conditions, a stepwise filling of the crucible can be required to melt the material layer by layer. This will result in a properly outgassed and stable melt in the final coating process.

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PRODUCTS

Hafnium(IV) Oxide Patinal® is available as a light material sintered in air, and a dark material sintered in vacuum. The vacuum-sintered material has a slight oxygen deficiency, a higher sintering density and a better electric conductivity, compared to the air-sintered material.

Product Code	Description	Purity*	Dimensions
1.11529	Hafnium (IV) Oxide UV Discs Patinal®	≥ 99.95 % (3N5)	Discs, about 6 g Ø 13 mm x h 5 mm
1.11626	Hafnium (IV) Oxide UV Grey Granules Patinal®	≥ 99.95 % (3N5)	Granules, about 1 – 4 mm
1.12450	Hafnium (IV) Oxide UV Grey Tablets Patinal®	≥ 99.95 % (3N5)	Tablets, about 2 g Ø 9 mm x h 4 mm

* The purity values are based on the specified trace metals.

Appearance	
1.11529	White discs
1.11626	Dark grey granules
1.12450	Dark grey tablets

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SPECIFICATION

Cobalt (Co)	≤ 0.0005 %
Copper (Cu)	≤ 0.0005 %
Chromium (Cr)	≤ 0.005 %
Iron (Fe)	≤ 0.005 %
Titanium (Ti)	≤ 0.005 %
Vanadium (V)	≤ 0.005 %
Zirconium (Zr)	≤ 0.5 %

RoHS information

The RoHS compliance information is part of the Certificate of Analysis (CoA) for each batch of Patinal® material.

Sizes

1.11529	h = 4.5 – 5.5 mm Ø = 12.5 – 14.0 mm
1.11626	granules 1- 4 mm ≥ 80 %
1.12450	h = 3.9 – 4.5 mm Ø = 8.7 – 9.3 mm

Application test

Each batch has to pass a specific application test assessing its evaporation behaviour.

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Quality assurance

Research, production and sales of our Patinal® evaporation materials take place under a certified DIN EN ISO 9001 quality management system and DIN EN ISO 14001 environmental management system. The quality of the materials is assured by our manufacturing processes, in-process controls and quality tests. Each batch is released only after passing our chemical analysis and application tests designed to confirm the suitability of the material for the evaporation process.

Handling precautions

Product safety information required for safe use is not included in this document. Before handling, read product and safety sheets and container labels for safe use, physical and health hazard information. The material safety data sheet is available online at www.patinal.com, from your EMD representative or distributor, or by calling your global Merck KGaA, Darmstadt, Germany, contact.

Disclaimer

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