



Patinal[®]

Evaporation Materials

PRODUCT INFORMATION

Magnesium fluoride Patinal[®]

Magnesium fluoride Patinal®



NOTES AND EXPLANATIONS

We advise our customers regarding technical applications to the best of our knowledge within the scope of the possibilities open to us, but without obligation. Current laws and regulations must be observed at all times. This also applies in respect of any protected rights of third parties. Our suggestions do not relieve our customers of the necessity to test our products, on their own responsibility, for suitability for the purpose envisaged. Quotations from our literature are only permitted with our written authority, and the source must be stated.

The products information sheet is based both on our own investigations and on literature data. The properties of the materials in thin coatings are affected by the choice of deposition conditions. For this reason, coating properties quoted are to be understood as being typical values and cannot be guaranteed. As far as possible, the conditions under which the coating properties were achieved are indicated.

QUALITY CONTROL

The data given in the "specification" section are guaranteed values which are monitored by checking a representative sample from each production batch using the methods indicated. The "tests" section describes all the analysis carried out on the product in question. It is our aim here to determine for the material the characteristic data which are of crucial importance for their use and for the quality of the end product.

SAFETY NOTE

Working safety requires that products which are formed during evaporation be kept in the closed system. If fine dust develops during cleaning of evaporation equipment suitable respiratory protection must be provided (approved respirators).

Magnesium fluoride Patinal®



ITEMS AND PACKAGING SIZES

Magnesium fluoride powder

- | | |
|--------------|--|
| 1.05843.0100 | Magnesium fluoride powder < 0.3 mm Patinal®
100 g Package |
| 1.05843.1000 | Magnesium fluoride powder < 0.3 mm Patinal®
1 kg Package |

Magnesium fluoride granules

- | | |
|--------------|--|
| 1.05846.0100 | Magnesium fluoride granules < 1 mm Patinal®
100 g Package |
| 1.05846.1000 | Magnesium fluoride granules < 1 mm Patinal®
1 kg Package |
| 1.05849.0100 | Magnesium fluoride granules about 0.3-1 mm Patinal®
100 g Package |
| 1.05849.1000 | Magnesium fluoride granules about 0.3-1 mm Patinal®
1 kg Package |
| 1.05823.0100 | Magnesium fluoride granules about 1-2.5 mm Patinal®
100 g Package |
| 1.05823.1000 | Magnesium fluoride granules about 1-2.5 mm Patinal®
1 kg Package |
| 1.05845.0100 | Magnesium fluoride granules about 1-4 mm Patinal®
100 g Package |
| 1.05845.1000 | Magnesium fluoride granules about 1-4 mm Patinal®
1 kg Package |

Magnesium fluoride Patinal[®]



ITEMS AND PACKAGING SIZES

1.15377.0100	Magnesium fluoride granules about 2-3 mm Patinal [®] 100 g Package
1.15377.1000	Magnesium fluoride granules about 2-3 mm Patinal [®] 1 kg Package
1.05834.0100	Magnesium fluoride granules about 2.5-4 mm Patinal [®] 100 g Package
1.05834.1000	Magnesium fluoride granules about 2.5-4 mm Patinal [®] 1 kg Package

Magnesium fluoride Low Oxide

1.10261.1000	Magnesium fluoride LO granules about 1-4 mm Patinal [®] 1 kg Package
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Magnesium fluoride LO has a low oxygen content of $\leq 0.02\%$ for reduced spitting, compared to $\leq 0.06\%$ for the standard quality. All other parameters are identical.

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MAGNESIUM FLUORIDE GRANULES PATINAL[®]

ITEM 1.05846, 1.05849, 1.05823, 1.05845, 1.15377, 1.05834 and 1.10261

GENERAL INFORMATION

Formula	MgF ₂
Molecular weight	62.31 g/mol
Composition	Mg 39.0 % F 61.0 %
Appearance	White or colorless crystalline granules
Melting point	1261 °C

SPECIFICATION

Cobalt (Co)	≤ 0.0005 %	
Chromium (Cr)	≤ 0.0005 %	
Copper (Cu)	≤ 0.0005 %	
Iron (Fe)	≤ 0.001 %	
Vanadium (V)	≤ 0.001 %	
Oxygen (O)	≤ 0.06 %	(≤ 0.02 % for item 1.10261)

RoHS information:

Cd (Cadmium)	≤ 0,01 %
Cr (Chromium)	≤ 0,1 %
Hg (Mercury)	≤ 0,1 %
Pb (Lead)	≤ 0,1 %
PBB (polybrominated biphenyls)	≤ 0,1 %
PBDE (polybrominated diphenyl ethers)	≤ 0,1 %

The Chromium(VI) concentration (RoHS requirements: ≤ 0.1 %) is always smaller than or equal to the total chromium concentration.

Application test conforms

Magnesium fluoride Patinal[®]



MAGNESIUM FLUORIDE GRANULES PATINAL[®]

ITEM 1.05846, 1.05849, 1.05823, 1.05845, 1.15377, 1.05834 and 1.10261

APPLICATION TEST

Apparatus: Leybold Univex 300
Resistance-heated Molybdenum boat without cover
(Dimensions: W 10 mm, D 10 mm, L 20 mm;
sheet thickness 0.1 mm; weight about 3.7 g)

The evaporation tests are started at a pressure of less than $5 * 10^{-5}$ mbar. During the evaporation a slide-glass is mounted 10 cm above the boat.

Test 1

The boat is filled with 0.5 g material and is heated up to 1600 °C within 30 seconds. This temperature is maintained for one minute. Then the heating is stopped.

Test 2

The boat is filled with 1 g material and is heated up to 1600 °C within 30 seconds. This temperature is maintained for one minute. Then the heating is stopped.

A batch is not released as evaporation substance if during the tests

1. the pressure increases to above $2 * 10^{-4}$ mbar,
2. the substance splashes, i.e. if the number of detectable splashes on the slide-glass exceeds three in test 1 and five in test 2.

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MAGNESIUM FLUORIDE POWDER PATINAL® ITEM 1.05843

GENERAL INFORMATION

Formula	MgF ₂
Molecular weight	62.31 g/mol
Composition	Mg: 39.0 % F: 61.0 %
Appearance	White powder
Melting point	1261 °C

SPECIFICATION

Cobalt (Co)	≤ 0.001 %
Chromium (Cr)	≤ 0.003 %
Copper (Cu)	≤ 0.001 %
Iron (Fe)	≤ 0.02 %
Vanadium (V)	≤ 0.001 %
Oxygen (O)	≤ 0.08%

RoHS information:

Cd (Cadmium)	≤ 0,01 %
Cr (Chromium)	≤ 0,1 %
Hg (Mercury)	≤ 0,1 %
Pb (Lead)	≤ 0,1 %
PBB (polybrominated biphenyls)	≤ 0,1 %
PBDE (polybrominated diphenyl ethers)	≤ 0,1 %

The Chromium(VI) concentration (RoHS requirements: ≤ 0.1 %) is always smaller than or equal to the total chromium concentration.

Application test conforms

Apparent density
(Item No. 1.05843) about 70 - 100 g/100 ml powder

Magnesium fluoride Patinal[®]



MAGNESIUM FLUORIDE POWDER PATINAL[®] ITEM 1.05843

APPLICATION TEST

Apparatus: Leybold Univex 300
Resistance-heated Molybdenum boat without cover
(Dimensions: W 10 mm, D 10 mm, L 20 mm;
sheet thickness 0.1 mm; weight about 3.7 g)

The evaporation tests are started at a pressure of less than $5 * 10^{-5}$ mbar. During the evaporation a slide-glass is mounted 10 cm above the boat.

Test 1

The boat is filled with 0.5 g material and is heated up to 1600 °C within 30 seconds. This temperature is maintained for 1 minute. Then the heating is stopped.

Test 2

The boat is filled with 1 g material and is heated up to 1600 °C within 30 seconds. This temperature is maintained for one minute. Then the heating is stopped.

A batch is not released as evaporation substance if during the tests

1. the pressure increases to above $2 * 10^{-4}$ mbar,
2. the substance splashes, i.e. if the number of detectable splashes on the slide-glass exceeds 3 in test 1 and 5 in test 2.

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NOTES FOR EVAPORATION

Evaporation source	Thermal evaporation from W, Mo, Ta or Pt boats, indirectly heated Alumina crucibles or direct electron beam evaporation from water-cooled Cu crucible.
Evaporation temperature	1300 - 1600 °C
Substrate temperature	200 - 300 °C
Residual pressure	$\leq 10^{-5}$ mbar ($\leq 10^{-3}$ Pa)
Rate	0.5 – 5 nm/s
Density	3.18 g/cm ³
z-ratio	0.637

The refractive index of Magnesium fluoride layers is very constant and it is only slightly influenced by evaporation conditions. Magnesium fluoride can be evaporated with high rates and hard, compact and stable films are achieved when the material is deposited on hot substrates (substrate temperature about 300 °C). Deposition on unheated substrates yields porous and poorly adhering films. Magnesium fluoride is by far the most used low index material in the wavelength region UV-NIR. In the IR above 4 μm Magnesium fluoride is not applied, because thicker layers show intrinsic stress and, therefore, tend to cracking. Magnesium fluoride layers for the UV should be deposited by electron beam. The use of resistance-heated boats - especially made of Tantalum - can change the optical properties.

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AREAS OF APPLICATION

Antireflection (AR) coatings on glass for VIS and NIR, e.g. together with Aluminium oxide and Substance 1.

Multilayer coatings for beam-splitters, filters

Iridescent layers in combination with Zinc sulfide

Protective layers, e.g. on Aluminium

PROPERTIES OF THE THIN FILM

Range of transparency 120 - 7000 nm

Refractive index

$\lambda = 210 \text{ nm}$ 1.42

$\lambda = 550 \text{ nm}$ 1.38

$\lambda = 2.8 \text{ }\mu\text{m}$ 1.36

$\lambda = 5.3 \text{ }\mu\text{m}$ 1.33

Absorption index

$\lambda = 121 \text{ nm}$ ~ 0.04

$\lambda = 210 \text{ nm}$ 0.005

$\lambda = 248 \text{ nm}$ < 0.001

$\lambda = 515 \text{ nm}$ $9 * 10^{-5}$

$\lambda = 1.06 \text{ }\mu\text{m}$ $6 * 10^{-6}$

Packing density

Substrate temperature 20 °C 0.72

Substrate temperature 300 °C 0.98

Tensile stress $3 - 5 * 10^8 \text{ N/m}^2$

Thermal conductivity 0.33 W/cm*K



OPTICAL PROPERTIES IN THE UV

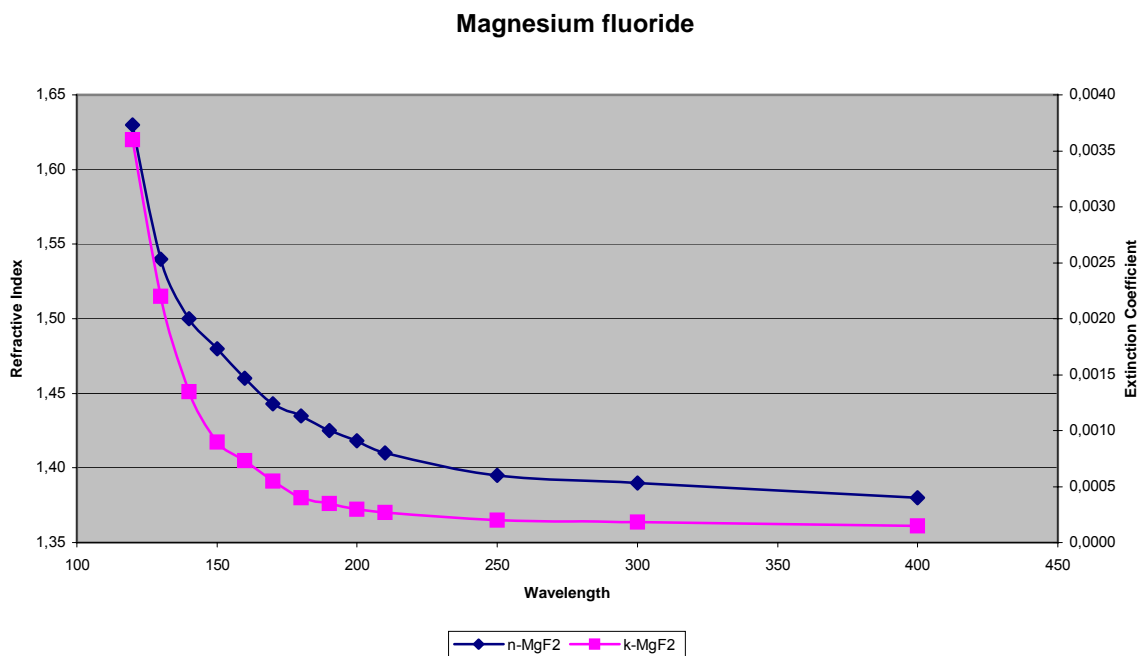


Figure: Refractive index and extinction coefficient of MgF_2 in the UV.
Source: Jürgen Kolbe: Entwicklung verlustarmer und strahlungs-resistenter dielektrischer Spiegel für den VUV-Bereich.
Dissertation Universität Hannover 1991.

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PROPERTIES OF THE SOLID SUBSTANCE

Crystalline form	tetragonal
Solubility	7.3 * 10 ⁻³ g in 100 g of water at 25 °C soluble in Nitric acid (HNO ₃) soluble in Sulfuric acid (H ₂ SO ₄) + 3 % Boron trioxide (B ₂ O ₃), hot
Density	3.18 g/cm ³
Melting point	1261 °C
Thermal conductivity	0.33 W/cm*K
Linear coefficient of thermal expansion parallel to the c-axis	13.7 * 10 ⁻⁶ K ⁻¹
perpendicular to the c-axis	8.48 * 10 ⁻⁶ K ⁻¹
Specific heat	1 J/g*K
Hardness (Mohs)	5 - 6
Hardness (Knoop)	415 kg/mm ²
Young's modulus	138 * 10 ⁹ N/m ²
Dielectric constant (at 10 ⁵ - 10 ⁷ Hz) parallel to the c-axis	4.87
perpendicular to the c-axis	5.45
Range of transparency	0.12 - 8.0 μm
Refractive index λ = 450 nm	n _o = 1.3836 n _e = 1.3957

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