

**Product Information**

# Zirconium(IV) Oxide Patinal®

## GENERAL INFORMATION

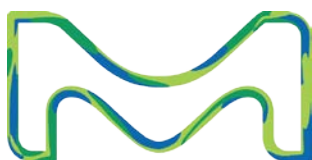
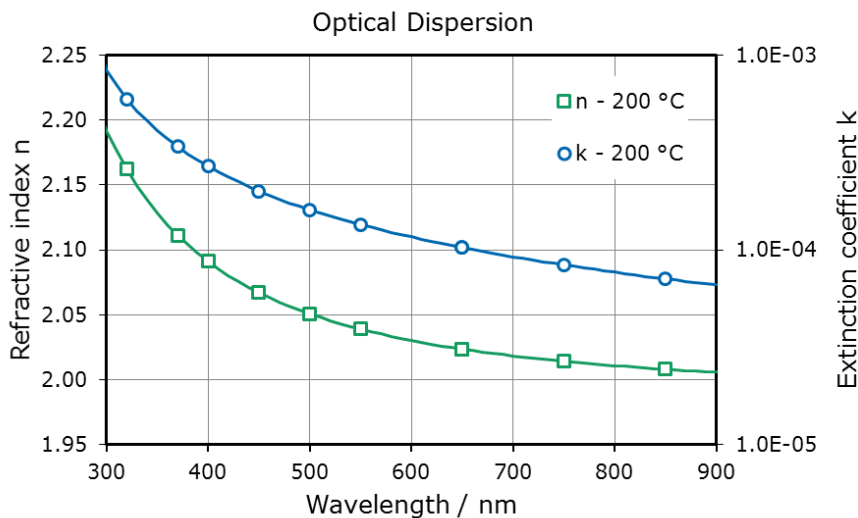
Zirconium(IV) Oxide Patinal® forms hard and durable high refractive index films, that can be used for laser filters, imaging applications and ophthalmics.

## AREAS OF APPLICATION

- Multi-layer coatings for laser mirrors and beam splitters
- Anti-reflection coatings on glass in VIS
- Hard protective films

## THIN FILM PROPERTIES

Range of transparency	300 nm – 7.0 μm
Refractive index at 500 nm	
• Conventional $T_s = 300\text{ °C}$ / no IAD	~ 2.05
• IAD – $T_s = RT$	~ 2.00
Thin film stress	Tensile, without IAD



wavl / nm	300	500	700	1050	2000
n - 200 °C	2.192	2.051	2.018	2.006	2.000
k - 200 °C	8.4E-04	1.6E-04	9.2E-05	6.6E-05	<5.0E-05

The refractive index of zirconium dioxide films depends on the deposition conditions. Deposition on cold substrates yields films with values of about 1.9. Films with a higher index are obtained at substrate temperatures above 200 °C. Zirconium dioxide films deposited onto hot substrates are extremely hard, and mechanically and chemically resistant.

Zirconium dioxide films often exhibit a negative optical inhomogeneity as the refractive index decreases with increasing thickness of the film. The structure of coatings of zirconium dioxide depends on the substrate temperature: At low temperatures amorphous films are obtained, and at higher temperatures crystalline films.

## NOTES FOR EVAPORATION

Evaporator source	Electron beam evaporator
Liner	Copper crucible or Mo liner
Evaporation temperature	2400 – 2600 °C
Deposition rate	0.1 – 0.5 nm/s
Oxygen partial pressure	$5 \cdot 10^{-5}$ - $2 \cdot 10^{-4}$ mbar
Substrate temperature	Conventional RT - 300 °C IAD @ RT - 250 °C
OCR-settings	Density 5.60 g/cm <sup>3</sup> , z-ratio 1.0

Upon heating to evaporation temperature, zirconium dioxide releases oxygen, yielding a black vitreous suboxide. The substance is evaporated with an electron beam gun at low energy density (wobbling of the beam in a to-and-from movement). An oxygen pressure of  $5 \cdot 10^{-5}$  to  $2 \cdot 10^{-4}$  mbar should be maintained during evaporation. The rate of deposition should be set at 0.2 to 0.4 nm/s. For higher rates or insufficient oxygen pressure, the films do show absorption.

In comparison with white stoichiometric zirconium dioxide tablets, dark grey materials have a deficiency in oxygen. They can therefore be evaporated with an electron beam gun without further pre-treatment. The chemical composition of the melt changes very little during evaporation thus increasing the reproducibility of the evaporation in comparison with white zirconium dioxide.



## PRODUCTS

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

Product Code	Description	Purity*	Dimensions
1.11480	Zirconium(IV) Oxide Discs Patinal®	≥ 99.5 % (2N5)	Discs, about 8 g, Ø 18.5 mm x h 7.3 mm
1.08614	Zirconium(IV) Oxide Granules Grey Patinal®	≥ 99.5 % (2N5)	Granules, about 3 – 6 mm
1.08907	Zirconium(IV) Oxide Tablets Grey Patinal®	≥ 99.5 % (2N5)	Tablets, about 1 g, Ø 10 mm x h 3.5 mm
1.08902	Zirconium(IV) Oxide Tablets Grey Patinal®	≥ 99.5 % (2N5)	Tablets, about 6 g, Ø 13.5 mm x h 9.5 mm
1.08905	Zirconium(IV) Oxide Discs Grey Patinal®	≥ 99.5 % (2N5)	Tablets, about 6 g, Ø 17.5 mm x h 5 mm

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

### Appearance

1.11480	White discs
1.08614	Grey granules
1.08907	Grey tablets
1.08902	Grey tablets
1.08905	Grey discs



## SPECIFICATION

Cobalt (Co)	≤ 0.0005 %
Chromium (Cr)	≤ 0.002 %
Copper (Cu)	≤ 0.001 %
Iron (Fe)	≤ 0.01 %
Titanium (Ti)	≤ 0.2 %
Vanadium (V)	≤ 0.005 %

### RoHS information

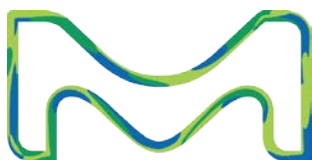
The RoHS compliance information is part of the Certificate of Analysis (CoA) for each batch of Patinal® material.

### Sizes

1.11480	h = 6.8 – 7.8 mm Ø = 18.0 – 19.0 mm
1.08614	Granules 3.15- 6.3 mm ≥ 80 %
1.08907	h = 3.2 – 3.7 mm Ø = 9.6 – 10.4 mm
1.08902	h = 9.1 – 9.9 mm Ø = 13.2 – 13.8 mm
1.08905	h = 4.7 – 5.3 mm Ø = 17.1 – 17.9 mm

### Application test

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



## Quality assurance

Research, production and sales of our Patinal® evaporation materials take place under a certified DIN EN ISO 9001:2000 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](http://www.patinal.com), from your EMD representative or distributor, or by calling your global Merck KGaA, Darmstadt, Germany, contact.

## Disclaimer

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