

## Zirconium(IV) Oxide Patinal®

### GENERAL INFORMATION

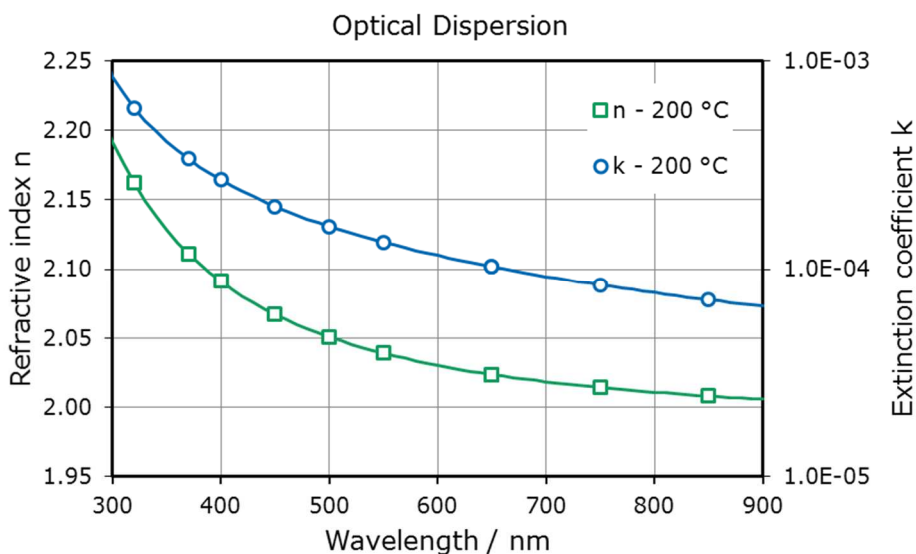
Zirconium(IV) Oxide Patinal® forms hard and durable high refractive index films, that can be used for laser filters, imaging applications and ophthalmics.

### 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 |



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| 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<br>IAD @ RT - 250 °C |
| QCR-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

| Product Code | Description                                | Purity*        | Dimensions                               |
|--------------|--|----------------|--|
| 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

|         |               |
|---------|---------------|
| 1.08614 | grey granules |
| 1.08907 | grey tablets  |
| 1.08902 | grey tablets  |
| 1.08905 | grey discs    |



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## 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

|         |  |
|---------|--|
| 1.08614 | Granules 3.15 – 6.3 mm<br>≥ 80 %       |
| 1.08907 | h = 3.2 – 3.7 mm<br>Ø = 9.6 – 10.4 mm  |
| 1.08902 | h = 9.1 – 9.9 mm<br>Ø = 13.2 – 13.8 mm |
| 1.08905 | h = 4.7 – 5.3 mm<br>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 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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