

## Substance WR4-SF Patinal®

### GENERAL INFORMATION

Substance WR4-SF Patinal® was developed for the deposition of hydrophobic layers by evaporation in vacuum. Substance WR4-SF Patinal® has the following advantages:

- In addition to its excellent hydrophobic properties, Substance WR4-SF Patinal® is also oleophobic which eases the removal of e.g. fingerprints.
- Substance WR4-SF Patinal® forms very durable and well adhering coatings on silica and silicate glass.

The low reflection of an AR-coated surface increases the visibility of fingerprints and other contaminations due to a larger contrast between clean and dirty surface areas. The excellent hydrophobic and oleophobic properties of Substance WR4-SF Patinal® support protecting these surfaces from contaminations and maintaining their functionality. Additionally, a WR4-SF coated layer is easier to clean.

Substance WR4-SF Patinal® is delivered as tablets made from a metallic carrier doped with the hydrophobic substance.

### AREAS OF APPLICATION

- Hydrophobic & oleophobic topcoat for ophthalmic lenses
- Topcoat for camera lenses, binocular lenses & automotive cameras
- Topcoat for optical filters, spectroscopic windows & other sensitive optical components



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## THIN FILM PROPERTIES

Substance	WR4-SF Patinal®	Static $\theta_s$	Sliding angle	Boiling test	Acidic resistance	Salt water	Abrasion test (4000 cycles)
Water		116°	30°	116°	112°	112°	~ 105°
Ethylene Glycol		102°	23°	102°			
Hexadecane		70°	8°	70°			

*Typical (not guaranteed) contact angles for Substance WR4-SF Patinal®*

The contact angle is measured with a Krüss DSA 100 or a Krüss Mobile Drop.

The sliding angle is a good indicator for the smoothness of a coating. It is measured using a tilting table on a Krüss DSA 100. A 15  $\mu$ l water droplet is applied to the coated surface, then the inclination of the table is slowly increased to determine the angle at which the droplet starts to slide off.

The boiling test was performed by immersion of the coated substrate in boiling hot water for a period of 30 min. The contact angle was measured before and after the test.

Acidic resistance was tested by immersion of the coated substrate in 5 wt% HCl (aq) solution for a period of 72 hours. The contact angle was measured before and after the test.

The salt water test was performed by immersion of the coated substrate in a 4.6 wt% NaCl (aq) solution for 72 hours. The contact angle was measured before and after the test.

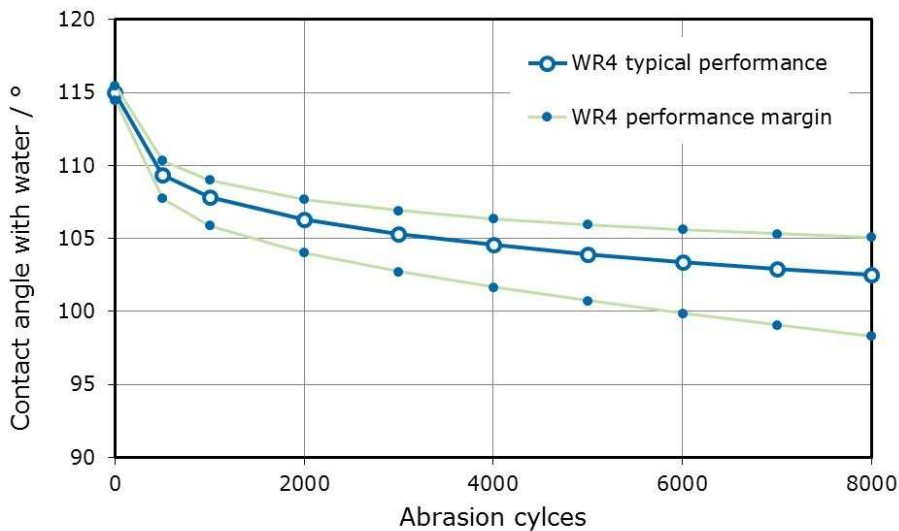
Substance WR4-SF Patinal® shows very high mechanical durability and resistance to wiping and abrasion. The stability of the coating is judged by comparing the water contact angle before and after an abrasion test with steel wool.

Test conditions:

- Cycles: up to 8000, 1 cycle = 2 hubs of 50 mm
- Hub length: 50 mm
- Speed: 60 cycles/min
- Load: 10 N/cm<sup>2</sup>
- Abrasion material: Steel wool #0000



Abrasion resistance of Substance WR4-SF Patinal® with steel wool



## NOTES FOR EVAPORATION

Evaporator source	Resistance heated thermal evaporator Electron beam evaporator (indirect)
Tablet holder	For resistive heating: Box type Ta or W boat (see fig. 2) For e-beam heating: Mo or Ta liner with perforated cover (see fig. 3)
Temperature	400 – 800 °C recommended 600 °C
Chamber pressure	$< 4 \cdot 10^{-5}$ mbar
Substrate temperature	From RT up to $< 300$ °C recommended RT
QCR-settings	Density 1.5 g/cm <sup>3</sup> , Z-ratio 1.0
Thickness (QCR)	15 – 20 nm (depending on tooling factor)

In general, we recommend the more moderate resistive source heating over e-beam heating. If e-beam heating is unavoidable, the e-beam ought not to be focused directly onto the tablet.



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## Adhesion and Durability

WR4-SF Patinal® durable films with good adhesion can be obtained when deposited onto oxidic surfaces, especially onto SiO<sub>2</sub> or Substance L5 Patinal® films.

## AR Coatings

A WR4-SF Patinal® layer can be deposited right on top of the final SiO<sub>2</sub> layer of an AR stack.

It can also be directly deposited onto MgF<sub>2</sub> layers with acceptable performance, but an intermediate layer of a few nm SiO<sub>2</sub> between MgF<sub>2</sub> and WR4-SF Patinal® is suggested for higher durability.

## Hydrophobic Glass

If WR4-SF Patinal® is to be applied onto a glass surface it can either be deposited directly onto the clean surface (e.g. silicate glasses) or on top of a thin SiO<sub>2</sub> adhesion promoting layer (recommended).

## Evaporation Process Steps

1. Substrate cleaning
2. WR4-SF Patinal® tablet transfer to evacuation chamber

Place WR4-SF Patinal® tablet (see figure 1) into evaporation chamber immediately after unpacking from original package and start evacuation. For tablet handling please use tweezers.



Fig. 1: Substance WR4-SF Patinal®



Fig. 2: Box type boat



Fig. 3: Liner with perforated cover

3. Optional plasma cleaning for adhesion and durability improvement
  - Process gas: Ar or Ar/O<sub>2</sub> mixture (80% / 20%)
  - Process time: ≥ 3 min
4. Adhesion layer (if required)
  - Material: SiO<sub>2</sub> as preferred adhesion layer or Substance L5, Al<sub>2</sub>O<sub>3</sub> etc.
  - Deposition rate: 0.15 – 0.3 nm/s
  - Thickness: 5 - 30 nm
5. Substance WR4-SF Patinal®
  - Evaporation conditions as described above
  - Process power: constant power (no rate control), low power setting depending on equipment
  - Substrate temperature range: RT – < 300 °C, no substrate heating recommended
  - Evaporation/boat temperature can be increased, but be aware that discoloration of WR4 tablet (rear side) indicates a too high boat temperature



- Process time: 60 s – 90 s till onset of evaporation, additionally up to 300 s for depletion of tablet
  - Chamber pressure:  $< 4 \cdot 10^{-5}$  mbar
6. Post deposition ripening
- Chemical ripening will be achieved during ambient storage, without acceleration
  - Optional: Store in a warm and humid environment (e.g.  $> 50$  °C @ 80% RH for  $> 2$  h)
  - Optional: Curing in air for ca. 1 h at higher temperatures (up to 150 °C)

The evaporated substance forms a thin layer on the substrate. Optimum properties can be obtained for films of ca. 10-20 nm with full depletion of the tablet.

The refractive index of Substance WR4-SF is about 1.3 in the visible spectral range. For optimum results on AR-coatings, the final AR-Layer should be reduced in thickness to compensate for the added Substance WR4-SF Patinal® layer.

In order to provide sufficient evaporation material it may be necessary to use more than one WR4-SF Patinal® tablet dependent on PVD chamber size. As a rule of thumb please refer to following table:

PVD chamber diameter [mm]	No. of tablets	Rate [nm/s]	Evaporation time [s]
600-950	1 tablet	0.4	210
950-1300	2 tablets	0.36	233
1300-1600	3 tablets	0.35	274
1600-2000	4 tablets	0.32	328



## PRODUCTS

Substance WR4-SF Patinal® is available as doped metallic tablets.

Product Code	Description	Dimensions
1.01822.0023	Substance WR4-SF Patinal® Tablets	Ø 11 mm x h 7 mm

### Storage conditions

Shelf life of Substance WR4-SF Patinal® is max. 5 months starting with date of release provided that storage conditions (as mentioned on the SDS or label) are fully met. Refer to the expiry date on the package. However, we recommend storage in a cool (2°C - 8°C) and dry place in the original sealed package.

Allow for full accommodation to room temperature before opening the package in order to prevent condensation of humidity from the environment onto the tablet.

### Shipping conditions

Substance WR4-SF Patinal® in the original package can be shipped without special precautions or temperature settings without detrimental effect on shelf life.

## SPECIFICATION

### RoHS information

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

### Sizes

1.01822.0023      h = 6.5 – 7.5 mm  
Ø = 10.5 – 11.5 mm

Contact angle       $\geq 110^\circ$  (water)

### Application test

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



## 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.

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