

Black A Patinal®

GENERAL INFORMATION

Black A Patinal® is a light grey powder mixture suitable to produce dark-brown to black low reflectance layers on glass and plastics. Black A layers appear brownish in transmission, i.e. not black. The name Black A originates from the original application in the 80's where it was used for dark sunglasses with blackish appearance. The Black A layers are hard, adhesive and resistant against humid air (90 % humidity at 35 °C) and salt solutions (4 % NaCl in water at 25 °C). They are not affected by temperature (8 hours at 360 °C in air).

AREAS OF APPLICATION

- Light absorbing filters
- Sun glasses
- Scales or decorative coatings & black coatings for optical applications

THIN FILM PROPERTIES

Refractive index n and extinction coefficient k of Black A layers depend on the coating conditions. Typical data obtained for Black A films deposited on unheated silica substrates are shown below:

Optical Dispersion of Black A

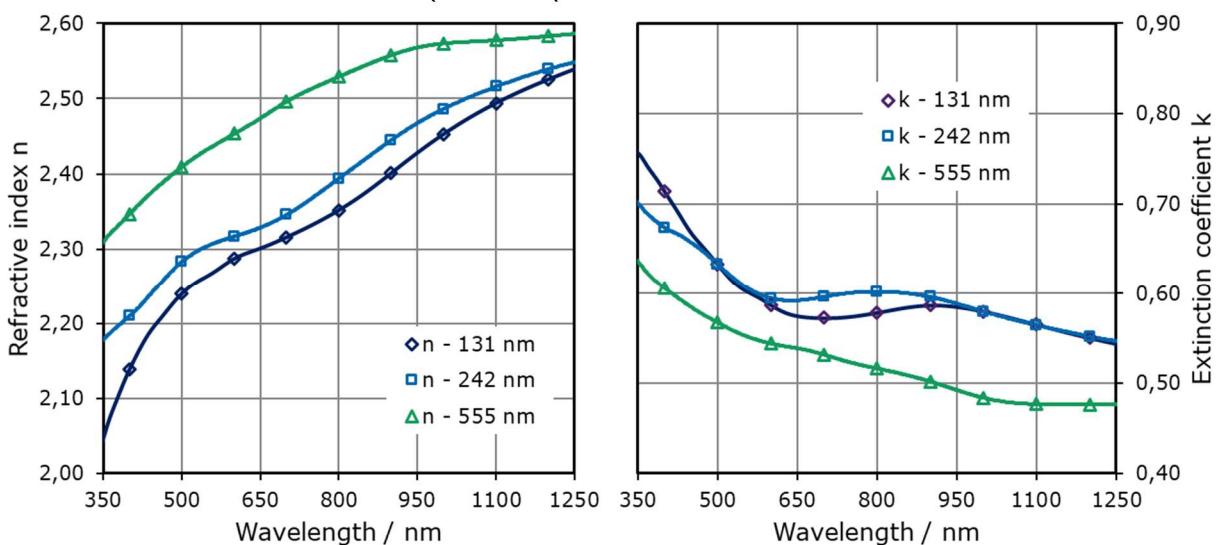
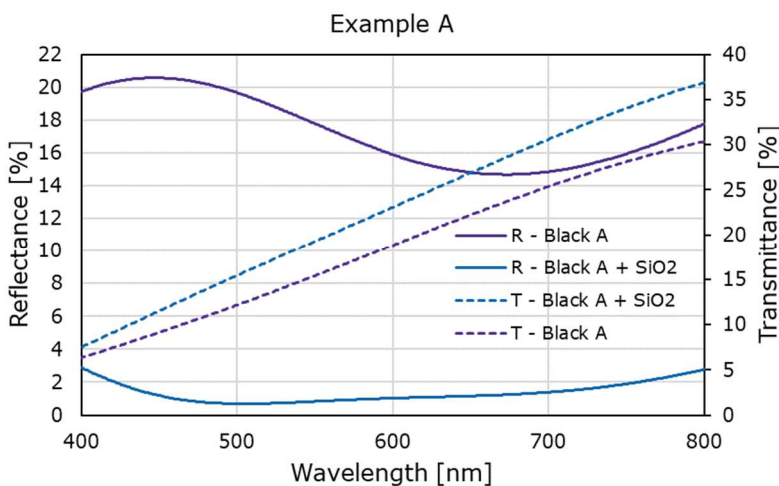


Table of n&k for different wavelengths (average for different thicknesses):

λ [nm]	300	400	500	600	700	800	900	1000
n	2.12	2.23	2.31	2.35	2.39	2.43	2.47	2.50
k	0.732	0.665	0.611	0.575	0.567	0.566	0.562	0.548

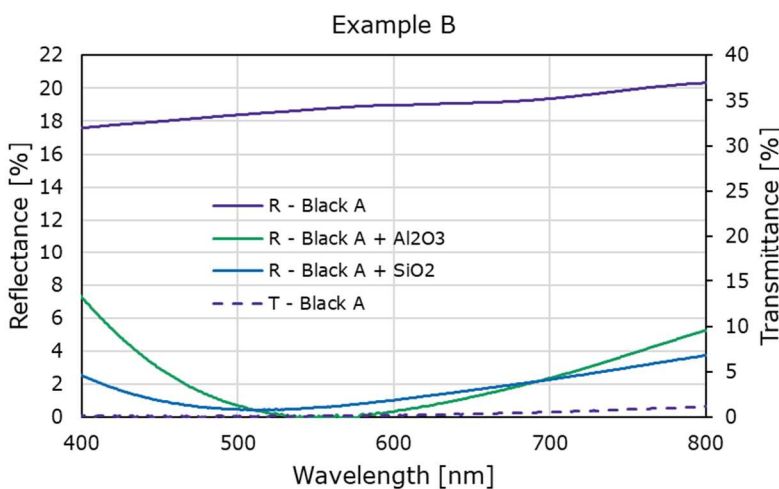
As can be seen from the data plot above Black A layers tend to show index gradients with a refractive index increasing with layer thickness. The visual appearance is almost black at the glass/layer interface when observed in reflection. The layer/air interface will develop a more metallic behavior with increasing thickness and can be AR-coated e.g. by SiO₂, SiO or Al₂O₃. This should be determined by experiments.

The following two examples show some spectral data of Black layers with and without a single layer AR coating on top, coated at room temperature on fused silica:



Example A:

Black A 130 nm
 SiO₂ 70 nm



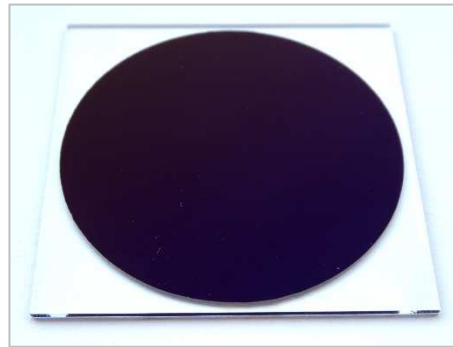
Example B:

Black A 500 nm
 Al₂O₃ 55 nm
 SiO₂ 70 nm



It should be kept in mind that dispersion and spectral data depend on the process conditions including base pressure or oxygen background pressure.

The following pictures were taken from Example B (see above) with Al_2O_3 as AR layer. Both pictures were taken from the sample against a bright background.



Black A + AR coatings of that kind can be useful e.g. for decorative purposes with very low reflectance, black appearance and a high hardness/durability. The appropriate layer design and process settings depend on the visual appearance and reflected color that need to be met. Furthermore the type of substrate material has to be taken into account.

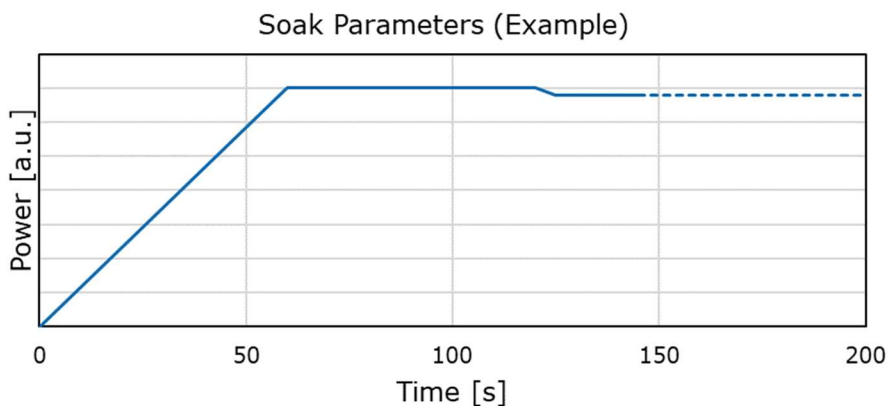


NOTES FOR EVAPORATION

Evaporator source	Resistance heated evaporator
Boat	Mo boat
Evaporation temperature	~1600 °C
Deposition rate	0.6 – 1.0 nm/s
Oxygen partial pressure	$\leq 5 \cdot 10^{-5}$ mbar
QCR-settings	Density 4.00 g/cm ³ , z-ratio 1.0

The substrates should be cleaned carefully prior to deposition e.g. by a glow discharge. It is recommended to evaporate Black A Powder Patinal® from molybdenum boats at a pressure of less than $1 \cdot 10^{-5}$ mbar.

The boat should be heated within about one minute to the evaporation temperature around 1600 °C. Typical soak parameters are shown in the plot below:



A layer thickness of 120 nm is obtained within about three minutes. The material residues remaining in the boat have to be disposed of after each coating process. Pictures of a typical boat before and after deposition (without cover) are shown below:



It is suggested to apply an overcoat with silicon dioxide, silicon monoxide or Al_2O_3 in order to reduce reflection. In the case of silicon monoxide the material should be evaporated with high deposition rate at a pressure less than $5 \cdot 10^{-5}$ mbar until the desired reflectance is achieved. The layer properties and therefore their impact on the optical properties of the coating strongly depend on the process conditions.

INSTRUCTIONS FOR ETCHING

For masking to the appropriate pattern the film may be etched using the following procedure:

1. Treatment for 30 seconds with a mixture consisting of equal parts of hydrofluoric acid (HF) 40 %, concentrated sulfuric acid (H_2SO_4) and water (H_2O)
2. Rinse with water
3. Treat with concentrated ferric chloride (FeCl_3) solution until the color of the layer becomes light
4. Rinse with water
5. Apply the mixture as for step 1 again
6. Rinse with slightly warm (40 °C) water



PRODUCTS

Black A Patinal® is available as powder.

Product Code	Description	Dimensions
1.15031	Black A Powder Patinal®	Powder, less than 0.3 mm

Appearance

1.15031	Grey powder
---------	-------------

SPECIFICATION

RoHS information

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

Application test

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

Sizes

1.15031	< 0.315 mm ≥ 90 %
---------	----------------------



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

Products are warranted to meet the specifications set forth on their label/packaging and/or certificate of analysis at the time of shipment or for the expressly stated duration. EMD PERFORMANCE MATERIALS CORP. MAKES NO REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE REGARDING OUR PRODUCTS OR ANY INFORMATION PROVIDED IN CONNECTION THEREWITH. Customer is responsible for and must independently determine suitability of our products for its intended use and processes, including the non-infringement of any third parties' intellectual property rights. EMD Performance Materials Corp. shall not in any event be liable for incidental, consequential, indirect, exemplary or special damages of any kind resulting from any use or failure of the products: All sales are subject to our complete Terms and Conditions of Sale. Prices are subject to change without notice. EMD Performance Materials Corp. reserves the right to discontinue products without prior notice.

© 2021 Merck KGaA, Darmstadt, Germany and/or its affiliates. EMD Electronics, the vibrant M, Patinal are trademarks of Merck KGaA, Darmstadt, Germany or its affiliates.



Date of Issue: 12 / 2021, Page 7 of 7

EMD Electronics

The Electronics Business of Merck KGaA, Darmstadt, Germany operates as EMD Electronics in the U.S and Canada.

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

