SCHOTT
glass made of ideas

Interference Filters & Special Filters

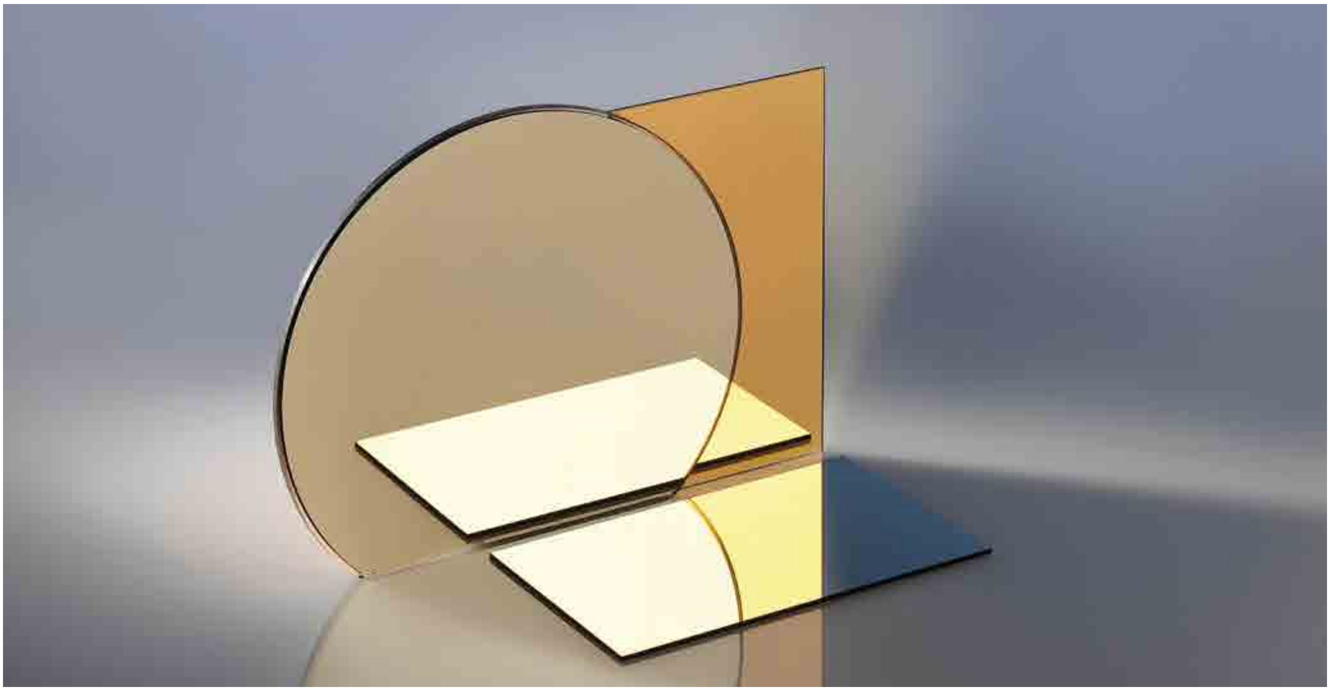
Properties - 2015

SCHOTT is an international technology group with more than 125 years of experience in the areas of specialty glasses and materials and advanced technologies. With our high-quality products and intelligent solutions, we contribute to our customers' success and make SCHOTT part of everyone's life.

SCHOTT Advanced Optics, with its deep technological expertise, is a valuable partner for its customers in developing products and customized solutions for applications in optics, lithography, astronomy, opto-electronics, life sciences, and research. With a product portfolio of more than 120 optical glasses, special materials and components, we master the value chain: from customized glass development to high-precision optical product finishing and metrology.

SCHOTT: Your Partner for Excellence in Optics.

Title
Dielectric mirror coatings.



Contents

1. SCHOTT interference product range

SCHOTT was one of the inventors of interference filters dating back since 1939. Based on this long history of experience the filter portfolio is suited to fit all applications of our customers. Most of our interference filters are designed to meet customers' specifications. Besides interference filters SCHOTT provides also optical filter glass, or a combination of interference filters and optical filter glass. The interference and special filter portfolio of SCHOTT includes the following types of filters:

- Longpass interference filters
- Shortpass interference filters
- Bandpass interference filters
- Neutral density thin-film filters
- Notch filters
- Beam splitters
- Polarizing beam splitters
- Black chrome coatings
- AR coatings: V-coating, broadband, multi-band, hard or scratch-resistant
- Transparent conductive oxide coating
- Linear variable filters
- Dielectric (laser) mirrors
- Metallic mirrors

In addition we offer barrier coatings like humidity resistant, scratch-resistant, or anti-fingerprint coatings.

Besides the filters mentioned in this "Properties" brochure we offer **customized interference filters**. Actually most of our filters are customized and we would be glad to assist you with our experienced team to find the right filter solution for your application. Please do not hesitate to contact us at an early stage of your development.

The following pages hold questionnaires on all individual filter types which should be used in order to place a request. The inquired data helps us to select the optimized filter for you and provide a customized solution reflecting your requirements.

Combinations of interference filters and optical filter glass are also part of our portfolio. Such combinations can be used for:

- Linear variable filters (VERIL), using filter glass and an additional interference filter coating
- Tristimulus filters using filter glass combinations
- Bandpass filters with broad band rejection achieved by filter glass with interference filter

2. General information on listed data

All data listed in this "Properties" brochure are to be understood as reference values. Guaranteed values are only those values listed in this "Properties" brochure.

The graphically depicted transmittance curves serve as an initial overview to aid you in finding the most suitable optical filter type for your application.

Unless otherwise indicated, all data are valid for a temperature of 23 °C.

Upon inquiry, the reference values can be more closely specified and the guaranteed values can be adapted to your requirements, where possible.

We constantly strive to improve our products to your advantage through innovation and new technical developments. Therefore, we reserve the right to change the optical and non-optical data of our filters without prior notice.

The release of this brochure replaces all previous publications.

The new brochures were assembled with the utmost care; however, we assume no liability in the unlikely event that there are content or printing errors.

The abbreviations:
- **UV** stand for ultra-violet and corresponds approximately for wavelengths below 400 nm
- **VIS** stand for visible light and corresponds approximately for wavelength range between 380 nm and 780 nm
- **IR** stand for infrared and corresponds approximately for wavelengths above 800 nm

3. Questionnaire Bandpass filter

Please copy and enter your specific requirements.

Spectral filter values		
Center wavelength	λ_m =	[nm]
Tolerance of cwl	= ±	[nm]
Half width [nm] (HW = full width at half maximum)	HW =	
Tolerance of HW	= ±	[nm]
Peak transmittance within passband	$\tau_{max} \geq$	
$\frac{\text{Tenth width}}{\text{Half width}}$	Q approx.	
$\frac{\text{Thousandth width}}{\text{Half width}}$	q approx.	
Blocking range, short-wave	from λ_{S1} = to λ_{S2} =	[nm] [nm]
Upper transmittance limit within short-wave blocking range	τ'_s =	
Blocking range, long-wave	from λ_{S3} = to λ_{S4} =	[nm] [nm]
Upper transmittance limit within long-wave blocking range	τ''_s =	
Dimensions, with tolerances		
External dimensions:		[mm]
Size of utilizable area:		[mm]
Maximum thickness:		[mm]
Requirements		
Quantity:		[pcs]
Required delivery date:		
Are repeat orders to be expected?		[pcs/a]
Inquiry from:		

Application/problem	
Kind of radiation/source:	
Kind of detector:	
Optical arrangement	**Polarization state of radiation**
Angle of incidence:	☐ unpolarized
Angle of aperture:	☐ p-polarized
☐ photometric beam ☐ imaging beam	☐ s-polarized
Operating conditions	
Maximum operating temperature:	
Other operating conditions:	
Additional demands or wishes	
Quality documents	
Measurement documents:	☐ curve per lot ☐ label per filter (λ_m, HW, τ_{max})
☐ transmission ☐ reflection ☐ blocking (logarithmic)	
Other quality-documents:	

4. Questionnaire Shortpass filter

Please copy and enter your specific requirements.

Spectral filter values		
Edge wavelength	λ_c =	[nm]
Tolerance of λ_c	= ±	[nm]
Transmittance at λ_c	$\tau(\lambda_c)$ =	
1st passband	from λ_{D1} = to λ_D =	[nm] [nm]
Minimum passband transmittance in 1st passband	τ'_D =	
2nd passband	from λ_{D1} = to λ_D =	[nm] [nm]
Minimum passband transmittance in 2nd passband	τ'_D =	
1st blocking range	from λ_{S1} = to λ_{S2} =	[nm] [nm]
Upper transmittance limit within 1st blocking range	τ'_s =	
2nd blocking range	from λ_{S3} = to λ_{S4} =	[nm] [nm]
Upper transmittance limit within 2nd blocking range	τ''_s =	
3rd blocking range	from λ_{S5} = to λ_{S6} =	[nm] [nm]
Upper transmittance limit within 3rd blocking range	τ'''_s =	
Dimensions, with tolerances		
External dimensions:		[mm]
Size of utilizable area:		[mm]
Maximum thickness:		[mm]
Requirements		
Quantity:		[pcs]
Required delivery date:		
Are repeat orders to be expected?		[pcs/a]
Inquiry from:		

Application/problem	
Kind of radiation/source:	
Kind of detector:	
Optical arrangement	**Polarization state of radiation**
Angle of incidence: Angle of aperture: ☐ photometric beam ☐ imaging beam	☐ unpolarized ☐ p-polarized ☐ s-polarized
Operating conditions	
Maximum operating temperature:	
Other operating conditions:	
Additional demands or wishes	
Quality documents	
Measurement documents:	☐ curve per lot ☐ label per filter (λ_c, HW, τ_{max})
☐ transmission ☐ reflection ☐ blocking (logarithmic)	
Other quality-documents:	

5. Questionnaire Longpass filter

Please copy and enter your specific requirements.

Spectral filter values		
Edge wavelength	λ_c =	[nm]
Tolerance of λ_c	= ±	[nm]
Transmittance at λ_c	$\tau(\lambda_c)$ =	
1st passband	from λ_{D1} = to λ_D =	[nm] [nm]
Minimum passband transmittance in 1st passband	τ'_D =	
2nd passband	from λ_{D1} = to λ_D =	[nm] [nm]
Minimum passband transmittance in 2nd passband	τ'_D =	
1st blocking range	from λ_{S1} = to λ_{S2} =	[nm] [nm]
Upper transmittance limit within 1st blocking range	τ'_s =	
2nd blocking range	from λ_{S3} = to λ_{S4} =	[nm] [nm]
Upper transmittance limit within 2nd blocking range	τ''_s =	
3rd blocking range	from λ_{S5} = to λ_{S6} =	[nm] [nm]
Upper transmittance limit within 3rd blocking range	τ'''_s =	
Dimensions, with tolerances		
External dimensions:		[mm]
Size of utilizable area:		[mm]
Maximum thickness:		[mm]
Requirements		
Quantity:		[pcs]
Required delivery date:		
Are repeat orders to be expected?		[pcs/a]
Inquiry from:		

Application/problem	
Kind of radiation/source:	
Kind of detector:	
Optical arrangement	**Polarization state of radiation**
Angle of incidence:	☐ unpolarized
Angle of aperture:	☐ p-polarized
☐ photometric beam ☐ imaging beam	☐ s-polarized
Operating conditions	
Maximum operating temperature:	
Other operating conditions:	
Additional demands or wishes	
Quality documents	
Measurement documents:	☐ curve per lot ☐ label per filter (λ_c, HW, τ_{max})
☐ transmission ☐ reflection ☐ blocking (logarithmic)	
Other quality-documents:	

6. Questionnaire Anti-reflection coating

Please copy and enter your specific requirements.

Spectral values		
Antireflection in 1st passband	from λ_{D1} = to λ_{D2} =	[nm] [nm]
Reflection level in 1st passband	$\rho \leq$	[%]
Antireflection in 2nd passband	from λ_{D3} = to λ_{D4} =	[nm] [nm]
Reflection level in 2nd passband	$\rho \leq$	[%]
Operating conditions		
For laser applications:		
☐ CW ☐ pulsed laser	power:	[kW]
	pulse width:	
	repetition rate:	
	beam diameter:	
Desired LIDT:		[J/cm^2]
Maximum operating temperature:		
Quality documents		
Measurement documents:	☐ curve per lot ☐ curve per piece	
Other quality documents:		
Special functions		
For scratch-resistant applications:	☐	
Easy to clean top-coat:	☐	
Dimensions, with tolerances		
External dimensions:	±	[mm]
Size of utilizable area:	±	[mm]
Lenses: radius of curvature	±	[mm]
(Center) thickness:	±	[mm]
Requirements		
Quantity:		[pcs]
Required delivery date:		
Are repeat orders to be expected?		[pcs/a]

Application/problem	
Kind of radiation/source:	
Kind of detector:	
Optical arrangement	**Polarization state of radiation**
Angle of incidence:	☐ unpolarized
Angle of aperture:	☐ p-polarized
☐ photometric beam ☐ imaging beam Pixel-size:	☐ s-polarized
Additional demands or wishes	
Inquiry from:	

7. Questionnaire Mirror coating

Please copy and enter your specific requirements.

Spectral values		
1st reflection-band	from λ_{D1} = to λ_{D2} =	[nm] [nm]
Reflection level in 1st band	$\rho \geq$	[%]
2nd reflection-band	from λ_{D3} = to λ_{D4} =	[nm] [nm]
Reflection level in 2nd band	$\rho \geq$	[%]
Operating conditions		
For laser applications:		
☐ CW ☐ pulsed laser	power:	[kW]
	pulse width:	
	repetition rate:	
	beam diameter:	
Desired LIDT:		[J/cm^2]
Maximum operating temperature:		
Quality documents		
Measurement documents:	☐ curve per lot ☐ curve per piece	
Other quality documents:		
Dimensions, with tolerances		
External dimensions:	±	[mm]
Size of utilizable area:	±	[mm]
Thickness:	±	[mm]
Requirements		
Quantity:		[pcs]
Required delivery date:		
Are repeat orders to be expected?		[pcs/a]

Application/problem	
Kind of radiation/source:	
Kind of detector:	
Optical arrangement	**Polarization state of radiation**
Angle of incidence:	☐ unpolarized
Angle of aperture:	☐ p-polarized
☐ photometric beam ☐ imaging beam Pixel-size:	☐ s-polarized
Additional demands or wishes	
Inquiry from:	

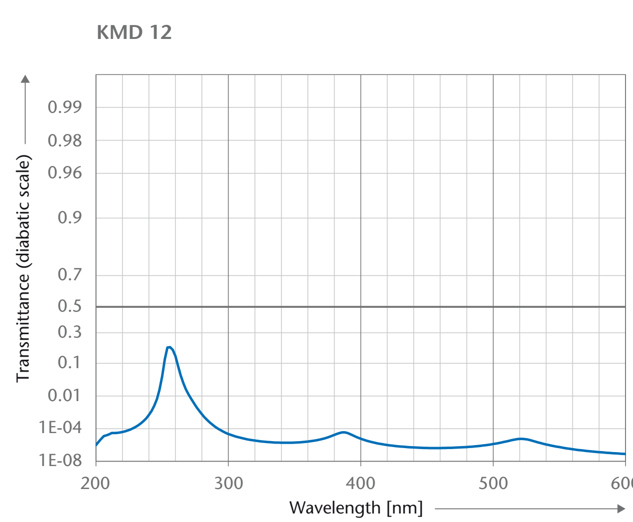
8. Datasheets

This chapter provides technical information of interference filters, special filters and coatings offered by SCHOTT Advanced Optics. A table for each filter type is displayed containing all relevant data. The shown graphics illustrate typical curves for overview purposes.

UV bandpass filter KMD 12

Spectral range 200 – 333 nm

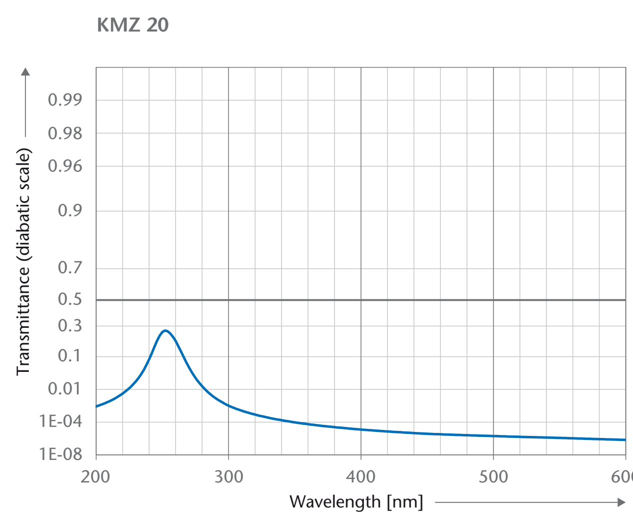
λ_m-tolerance [% of λ_m]	+/– 0.5
Available with λ_m in range	200 – 333 nm
Spectral values	
HW (= FWHM) [nm]	9 – 13 (λ_m from 200 nm to 239 nm) 11 – 15 (λ_m from 240 nm to 333 nm)
τ_{max}	≥ 0.15 (λ_m from 195 nm to 239 nm) ≥ 0.18 (λ_m from 240 nm to 333 nm)
Q	approx. 1.8
q	approx. 5
Blocking range [nm]	unlimited
τ_{SM}	≤ 10^{-5}
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.007
Notes	Filters delivered in mounts only Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.15
Usable area	Ø ≥ 9
Thickness	4.75 +/– 0.1
Other dimensions upon request	



UV bandpass filter KMZ 20

Spectral range 200–333 nm

λ_m-tolerance [% of λ_m]	+/– 1.5
Available with λ_m in range	200–333 nm
Spectral values	
HW (= FWHM) [nm]	18–24
τ_{max}	≥ 0.20
Q	approx. 2.0
q	approx. 6.0
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-4}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.007
Notes	Filters delivered in mounts only Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.15
Usable area	Ø ≥ 9
Thickness	4.75 +/– 0.1
Other dimensions upon request	

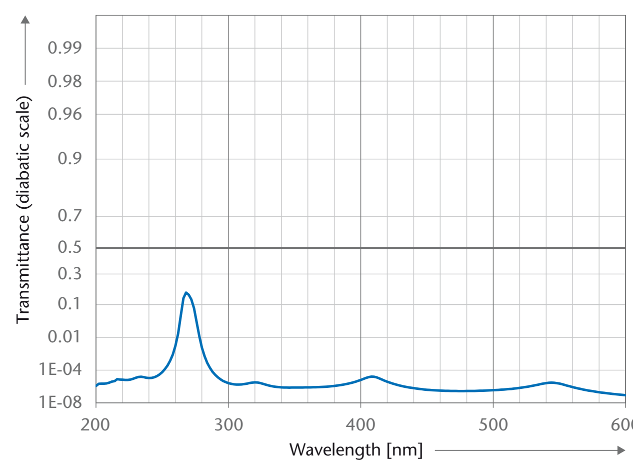


UV bandpass filter MAZ 8

Spectral range 220 – 333 nm

λ_m-tolerance [% of λ_m]	+/– 0.5
Available with λ_m in range	220 – 333 nm
Spectral values	
HW (= FWHM) [nm]	6 – 10
τ_{max}	≥ 0.15
Q	approx. 1.75
q	approx. 4.5
Blocking range [nm]	unlimited
τ_{SM}	≤ 10^{-5}
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.007
Notes	Filters delivered in mounts only Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.15
Usable area	Ø ≥ 9
Thickness	4.75 +/– 0.1
Other dimensions upon request	

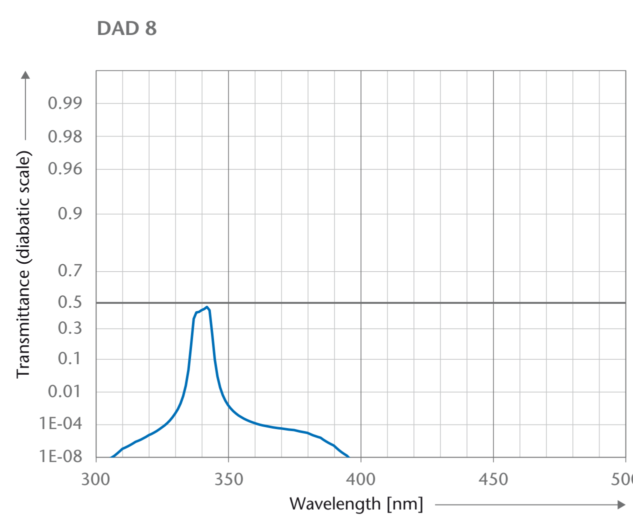
MAZ 8



UV bandpass filter DAD 8

Spectral range 334 – 399 nm

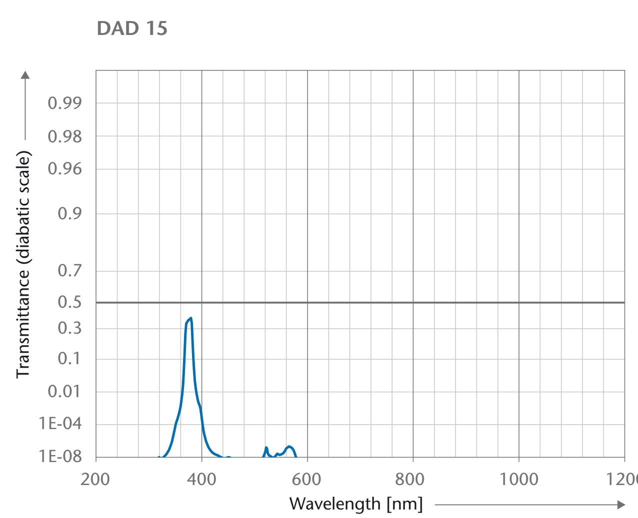
λ_m-tolerance [% of λ_m]	+/– 0.5
Available with λ_m in range	334 – 399 nm
Spectral values	
HW (= FWHM) [nm]	6 – 10
τ_{max}	≥ 0.30
Q	approx. 1.5
q	approx. 3.5
Blocking range [nm]	unlimited (λ_m from 334 nm to 360 nm) up to 1200 (λ_m from 361 nm to 399 nm)
τ_{SM}	≤ 10^{-5}
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.01
Notes	Unlimited blocking range on request, which can, however, change the filter specification
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
Thickness	≤ 7
Other dimensions upon request	



UV bandpass filter DAD 15

Spectral range 334 – 399 nm

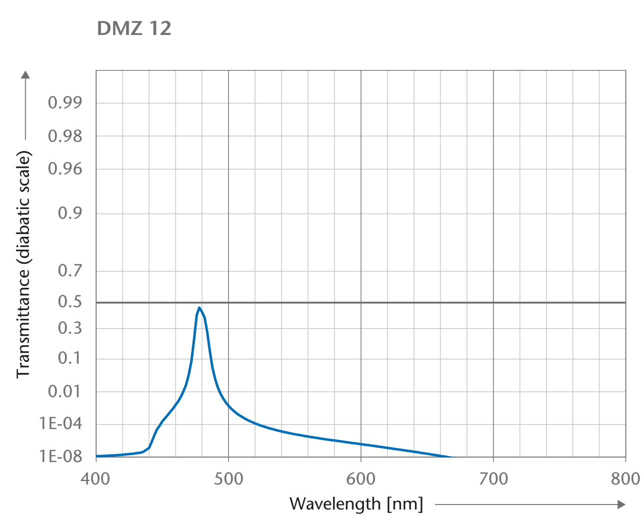
λ_m-tolerance [% of λ_m]	+/– 1.5
Available with λ_m in range	334 – 399 nm
Spectral values	
HW (= FWHM) [nm]	12 – 18
τ_{max}	≥ 0.30
Q	approx. 1.5
q	approx. 3.5
Blocking range [nm]	unlimited (λ_m from 334 nm to 360 nm) up to 1200 (λ_m from 361 nm to 399 nm)
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.01
Notes	Unlimited blocking range on request, which can, however, change the filter specification
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
Thickness	≤ 7
Other dimensions upon request	



VIS bandpass filter DMZ 12

Spectral range 400 – 599 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	400 – 599 nm
Spectral values	
HW (= FWHM) [nm]	9 – 14
τ_{max}	≥ 0.35 (λ_m from 400 nm to 449 nm) ≥ 0.40 (λ_m from 450 nm to 599 nm)
Q	approx. 1.8
q	approx. 6
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.02
Notes	Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	☐ 50 +/– 0.3
Usable area	☐ ≥ 47
Thickness	≤ 6
Other dimensions upon request	

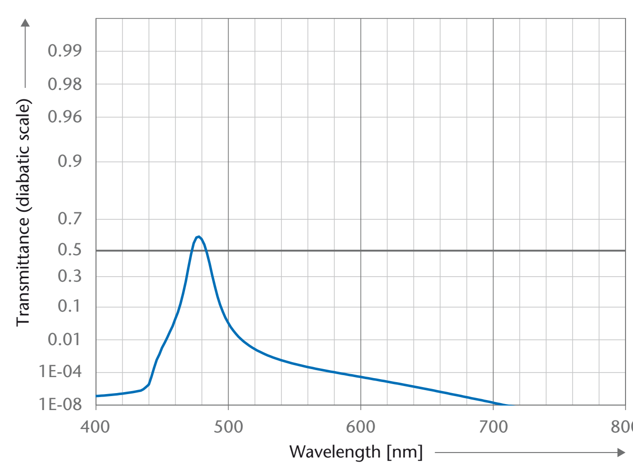


VIS bandpass filter DMZ 20

Spectral range 400 – 599 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	400 – 599 nm
Spectral values	
HW (= FWHM) [nm]	18 – 22
τ_{max}	≥ 0.45 (λ_m from 400 nm to 449 nm) ≥ 0.50 (λ_m from 450 nm to 599 nm)
Q	approx. 1.8
q	approx. 6
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.02
Notes	Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	☐ 50 +/– 0.3
Usable area	☐ ≥ 47
Thickness	≤ 6
Other dimensions upon request	

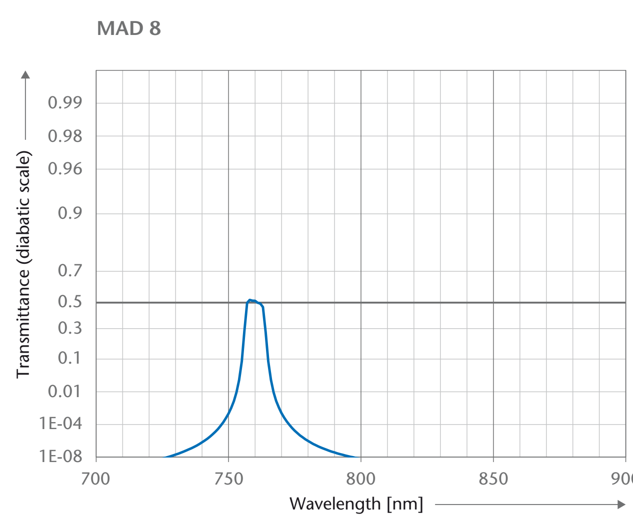
DMZ 20



VIS bandpass filter MAD 8

Spectral range 400 – 1100 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	400 – 1100 nm
Spectral values	
HW (= FWHM) [nm]	6 – 12
τ_{max}	≥ 0.30 (λ_m from 400 nm to 429 nm) ≥ 0.45 (λ_m from 430 nm to 800 nm)
Q	approx. 1.5
q	approx. 3.0
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.02
Notes	Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	□ 50 +/– 0.3
Usable area	□ ≥ 47
Thickness	≤ 7
Other dimensions upon request	

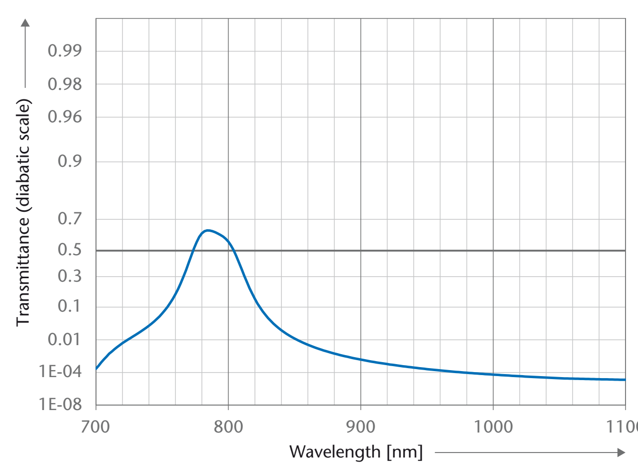


VIS bandpass filter KMZ 50

Spectral range 400 – 1400 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	400 – 1400 nm
Spectral values	
HW (= FWHM) [nm]	30 – 60
τ_{max}	≥ 0.45 (λ_m from 400 nm to 449 nm) ≥ 0.55 (λ_m from 450 nm to 800 nm)
Q	approx. 1.8
q	approx. 6
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.02
Notes	Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	☐ 50 +/– 0.3
Usable area	☐ ≥ 47
Thickness	≤ 4
Other dimensions upon request	

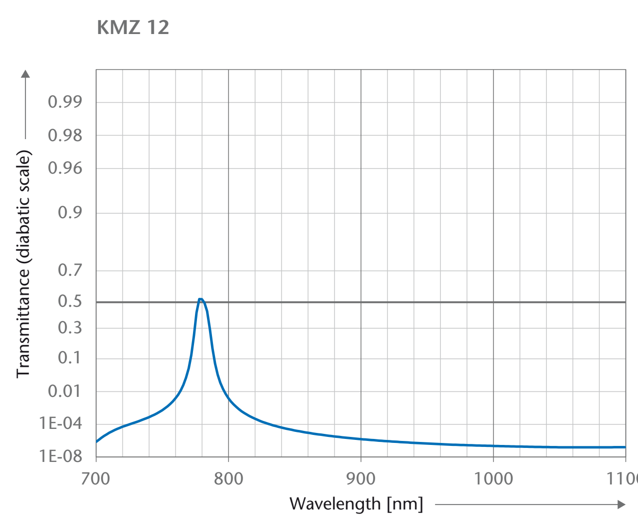
KMZ 50



VIS bandpass filter KMZ 12

Spectral range 600 – 800 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	600 – 800 nm
Spectral values	
HW (= FWHM) [nm]	9 – 16
τ_{max}	≥ 0.40
Q	approx. 1.8
q	approx. 6
Blocking range [nm]	up to 2 · λ_m
τ_{SM}	≤ 10^{-5}
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.02
Notes	Unlimited blocking range on request, which can, however, change the filter specification Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	☐ 50 +/– 0.3
Usable area	☐ ≥ 47
Thickness	≤ 4
Other dimensions upon request	

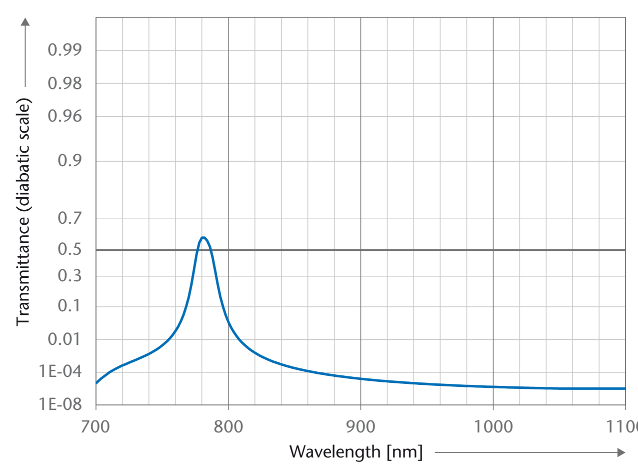


VIS bandpass filter KMZ 20

Spectral range 600–800 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	600–800 nm
Spectral values	
HW (= FWHM) [nm]	18–24
τ_{max}	≥ 0.50
Q	approx. 1.8
q	approx. 6
Blocking range [nm]	up to $2 \cdot \lambda_m$
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.02
Notes	Unlimited blocking range on request, which can, however, change the filter specification Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	☐ 50 +/– 0.3
Usable area	☐ ≥ 47
Thickness	≤ 4
Other dimensions upon request	

KMZ 20

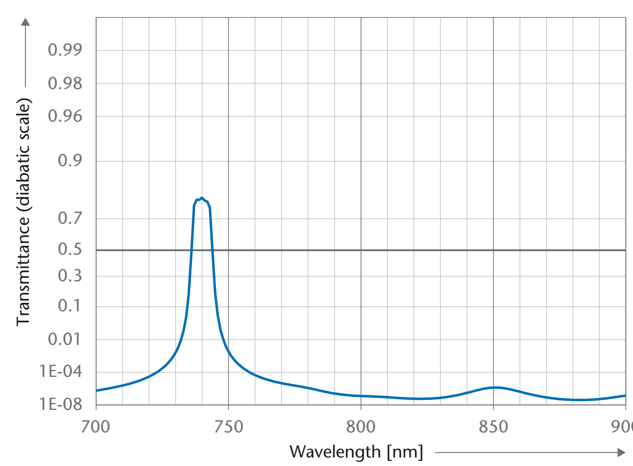


VIS and near IR bandpass filter DAD 8

Spectral range 400 – 1100 nm

λ_m-tolerance [% of λ_m]	+/– 1.0
Available with λ_m in range	400 – 1100 nm
Spectral values	
HW (= FWHM) [nm]	6 – 10 (λ_m from 400 nm to 699 nm) 8 – 12 (λ_m from 700 nm to 1100 nm)
τ_{max}	≥ 0.40 (λ_m from 400 nm to 429 nm) ≥ 0.60 (λ_m from 430 nm to 479 nm) ≥ 0.65 (λ_m from 480 nm to 749 nm) ≥ 0.70 (λ_m from 750 nm to 1100 nm)
Q	approx. 1.5
q	approx. 3.5
Blocking range [nm]	up to 1200
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.02
Notes	
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø ≥ 9
External dimensions	Ø 25 +/– 0.3
Usable area	Ø ≥ 22
External dimensions	Ø 50 +/– 0.3
Usable area	Ø ≥ 47
External dimensions	□ 50 +/– 0.3
Usable area	□ ≥ 47
Thickness	≤ 7
Other dimensions upon request	

DAD 8

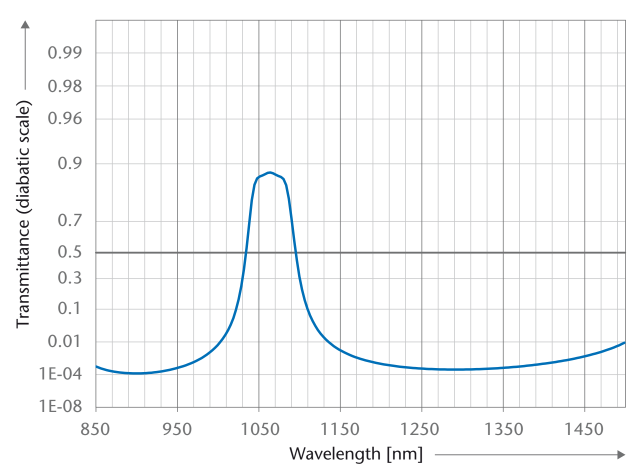


UV, VIS, and near IR bandpass filter DAD 8–70

Spectral range 300–1450 nm

Available with λ_m in range	300–1450 nm
Spectral values	
HW (= FWHM) [nm]	8–70
τ_{max}	For individual requirements concerning spectral values of λ_m, FWHM, transmittance within passband and blocking region, please contact us!
Q	
q	
Blocking range [nm]	
τ_{SM}	
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature (hard coating on single substrate)	up to approx. 350 °C
Operating temperature (if cemented mulitple substrates)	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	Can be optimized by a suitable choice of substrate and coating material combination to ≤ 0.005
Notes	Please indicate operating temperatures > 100 °C for an appropriate substrate selection
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø 12 +/– 0.3
External dimensions	Ø 25 +/– 0.3
Usable area	Ø 25 +/– 0.3
External dimensions	Ø 50 +/– 0.3
Usable area	Ø 50 +/– 0.3
External dimensions	☐ 50 +/– 0.3
Usable area	☐ 50 +/– 0.3
Thickness	1 +/– 0.2
Other dimensions upon request	

DAD 8–70



Linear variable (bandpass) filter VERIL

Spectral range 400–1000 nm

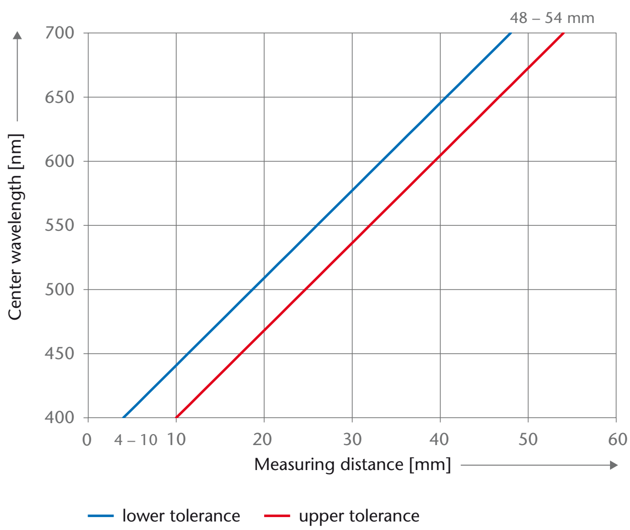
The spectral position of the center wavelength λ_m of the narrow passband of VERIL linear variable interference filters **changes constantly over the length of the filter**. These filters possess the same curve characteristics as the corresponding homogeneous filters. Additional blocking is achieved in some cases by graduated colored glasses (graduated optical filter glass).

When linear variable filters with a pre-fitted slit are used, increasing the slit width widens the passband curve and reduces the maximum transmittance λ_{max}. Slit widths up to 1 mm in the case of VERIL S 60 filters and up to 3 mm in the case of VERIL S 200 and BL 200 have practically no effect on spectral performance.

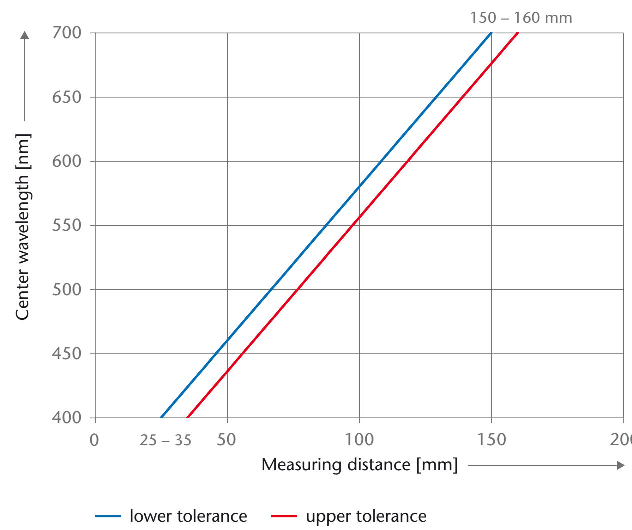
The special method of manufacturing these filters gives rise to slight deviations in dispersion from filter to filter and to deviations in linearity. A calibration curve and a calibration table are included with each linear variable filter ordered.

Type	VERIL S 60	VERIL S 200	VERIL BL 200
Design analog	KMZ12	KMZ12	KMZ40
Available with λ_m in range	400–700 nm	400–700 nm	400–1000 nm
Spectrum length [nm]	38–50	115–135	135–165
Reciprocal linear dispersion [nm/mm]	6.0–7.9	2.2–2.6	3.6–4.4
Spectral values			
HW (= FWHM) [nm]	10–16 (λ_m = 450 nm) 10–15 (λ_m = 550 nm) 10–18 (λ_m = 650 nm)	10–16 (λ_m = 450 nm) 10–15 (λ_m = 550 nm) 10–18 (λ_m = 650 nm)	25–45 (λ_m = 500 nm) 35–50 (λ_m = 700 nm) 40–65 (λ_m = 900 nm)
τ_{max}	≥ 0.35 (λ_m = 450 nm) ≥ 0.45 (λ_m = 550 nm) ≥ 0.40 (λ_m = 650 nm)	≥ 0.35 (λ_m = 450 nm) ≥ 0.45 (λ_m = 550 nm) ≥ 0.40 (λ_m = 650 nm)	≥ 0.40 (λ_m = 500 nm) ≥ 0.40 (λ_m = 700 nm) ≥ 0.30 (λ_m = 900 nm)
Q	approx. 1.8	approx. 1.8	approx. 1.8
q	approx. 6	approx. 6	approx. 6
Blocking range [nm]	up to 2 · λ_m	up to 2 · λ_m	unlimited
τ_{SM}	≤ 10^{-4}	≤ 10^{-4}	≤ 10^{-4}
Other properties			
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles	MIL-Std-810C, method 507, proc. 1 : 5 cycles	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods	up to 70 °C for several hours up to 100 °C for short periods	up to 70 °C for several hours up to 100 °C for short periods
Notes	Unlimited blocking range on request, which can, however, change the filter specification Face filters with mirror side towards light source	Unlimited blocking range on request, which can, however, change the filter specification Face filters with mirror side towards light source	Face filters with mirror side towards light source
Preferred dimensions [mm]			
Length	60 + 0/– 0.3	200 + 0/– 0.3	200 + 0/– 0.3
Width	25 + 0/– 0.3	25 + 0/– 0.3	25 + 0/– 0.3
Thickness	≤ 5	≤ 6	≤ 6

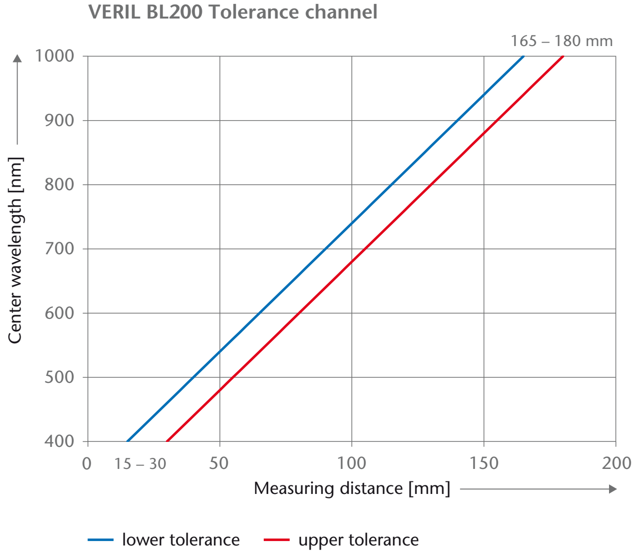
VERIL S60 Tolerance channel



VERIL S200 Tolerance channel



VERIL BL200 Tolerance channel

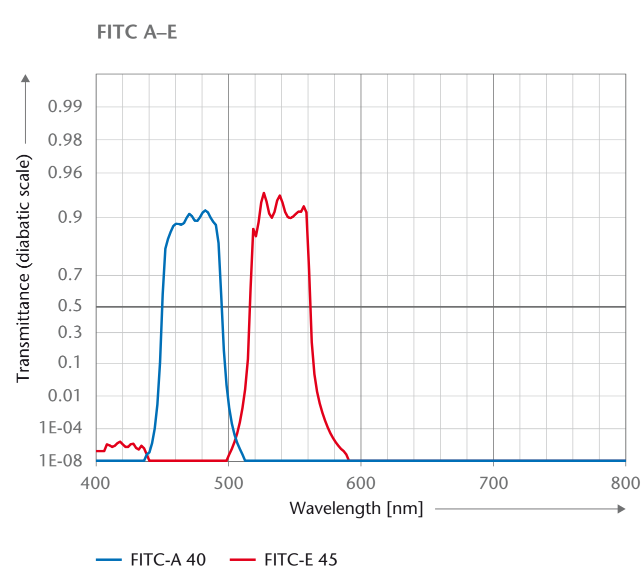


Fluorescence (bandpass) filters FITC A-40 and FITC E-45

These two filters are our standard filters for fluorescence microscopy or fluorescence spectroscopy. **Steeper filters are offered on customers' request.** If you need a steep filter please contact us.

Fluorochrome FITC (fluorescein-isothiocyanate) is used in fluorescence microscopy and spectroscopy for investigating immune reactions. These filters separate the absorbed light from the light source (FITC A-40) and the emitted light from the sample under investigation (FITC E-45).

Type	FITC A-40	FITC E-45
Spectral values		
Edge wavelengths λ_c ($\tau = 0.5$) [nm]	450 ± 5 492 ± 5	515 ± 5 560 ± 5
τ_D	0.75 (from 460 nm to 480 nm)	0.80 (from 530 nm to 550 nm)
τ_S	10^{-4} (below 430 nm) 10^{-4} (515 nm to 740 nm) 10^{-4} (740 nm to 850 nm)	10^{-5} (below 500 nm) 10^{-4} (600 nm to 700 nm)
Other properties		
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7	
Coating adhesion	MIL-M-13508 C, para 4.4.6	
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. ≤ 0.005	approx. +0.02
Notes		
Preferred dimensions [mm]		
External dimensions	Ø 18 + 0/– 0.3	Ø 18 + 0/– 0.3
Usable area	Ø ≥ 16.5	Ø ≥ 16.5
External dimensions	Ø 25 + 0/– 0.3	Ø 25 + 0/– 0.3
Usable area	Ø ≥ 23.5	Ø ≥ 23.5
Thickness	≤ 3.5	≤ 3.5
Other dimensions upon request		



"i-line" bandpass filter

Spectral range 365 – 400 nm

Accompanying optical glasses with high UV-transmittance at 365 nm (i-line wavelength) and high refractive index homogeneity, SCHOTT offers narrow bandpass filters for applications in i-line wafer steppers.

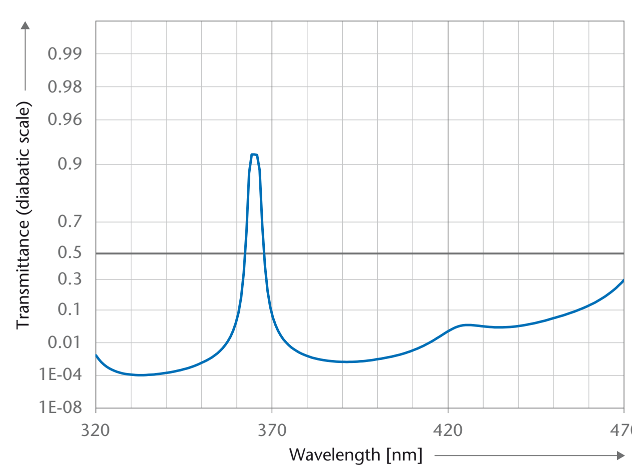
With the help of coating material development and high purity raw materials, SCHOTT is able to provide high transmission filters with extraordinary radiation resistance.

The requirements which are addressed to i-line interference filters are translated into a customized design. The filter is coated with various layers and this tailored multilayer system is characterized with an outstanding transmission at 365 nm combined with a narrow spectral bandwidth and very good homogeneity of the spectral behavior throughout the usable filter area.

Accompanied with long product life the obtained components are filters from SCHOTT, which are the materials of choice for various applications in the UV spectral region.

λ_m-tolerance [% of λ_m]	+/– 0.5
Available with λ_m in range	365 – 400 nm
Spectral values	
HW (= FWHM) [nm]	5 – 12
τ_{max}	≥ 0.85
Blocking range [nm]	unlimited
τ_{SM}	$\leq 10^{-5}$
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. + 0.007
Notes	Filters delivered in mounts only Face filters with mirror side towards light source
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.15
Usable area	Ø ≥ 9
Thickness	4.75 +/– 0.1
Other dimensions upon request	

i-line filter

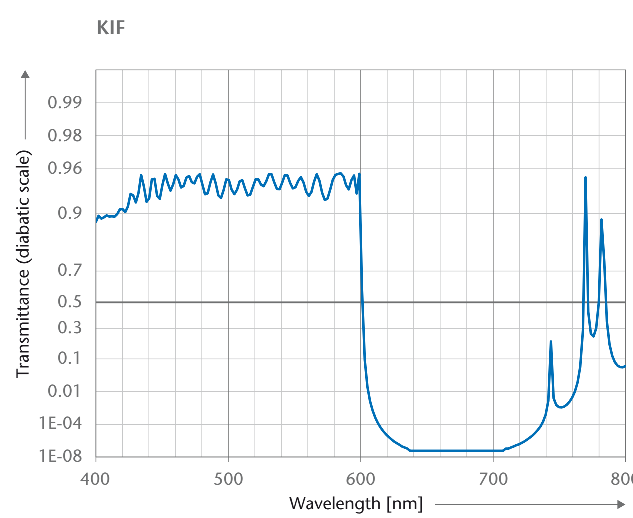


Shortpass filter KIF

Spectral range 300 – 1200 nm

These edge filters pass only the short wavelength and are made according to customers' specification for edge wavelengths between about 300 nm and 1200 nm.

Edge wavelength λ_c-tolerance [% of λ_c]	+/– 1.0 – 2.0
Available with edge wavelength λ_c ($\tau = 0.5$) in range	300 – 1200 nm
Spectral values	
Slope $S_{\%}$ [%]	For individual requirements concerning spectral transmittance within passband and blocking region, please contact us!
τ_{max}	
τ_{DM}	
τ_{SM}	
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to approx. 350 °C
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	Can be optimized by a suitable choice of substrate and coating material combination to ≤ 0.005
Notes	Please indicate operating temperatures > 100 °C for an appropriate substrate selection
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø 12 +/– 0.3
External dimensions	Ø 25 +/– 0.3
Usable area	Ø 25 +/– 0.3
External dimensions	Ø 50 +/– 0.3
Usable area	Ø 50 +/– 0.3
External dimensions	☐ 50 +/– 0.3
Usable area	☐ 50 +/– 0.3
Thickness	1 +/– 0.2
Other dimensions upon request	

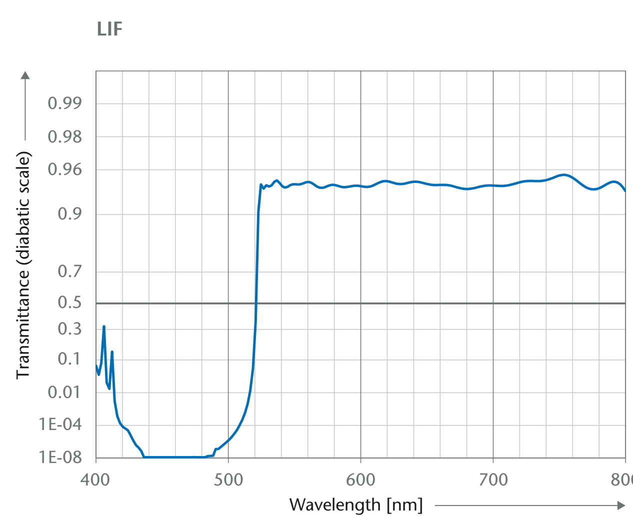


Longpass filter LIF

Spectral range 300 – 1200 nm

These edge filters pass only the long wavelength and are made according to customers' specification for edge wavelengths between about 300 nm and 1200 nm.

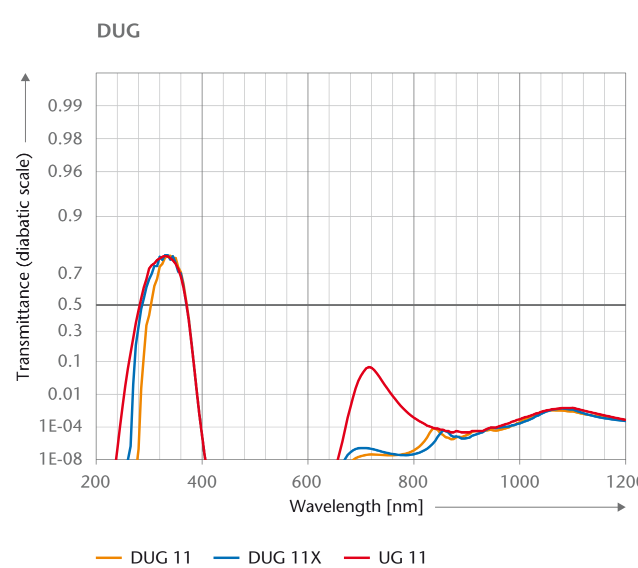
Edge wavelength λ_c-tolerance [% of λ_c]	+/– 1.0 – 2.0
Available with edge wavelength λ_c ($\tau = 0.5$) in range	300 – 1200 nm
Spectral values	
Slope $S_{\%}$ [%]	For individual requirements concerning spectral transmittance within passband and blocking region, please contact us!
τ_{max}	
τ_{DM}	
τ_{SM}	
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to approx. 350 °C
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	Can be optimized by a suitable choice of substrate and coating material combination to ≤ 0.005
Notes	Please indicate operating temperatures > 100 °C for an appropriate substrate selection
Preferred dimensions [mm]	
External dimensions	Ø 12 +/– 0.3
Usable area	Ø 12 +/– 0.3
External dimensions	Ø 25 +/– 0.3
Usable area	Ø 25 +/– 0.3
External dimensions	Ø 50 +/– 0.3
Usable area	Ø 50 +/– 0.3
External dimensions	☐ 50 +/– 0.3
Usable area	☐ 50 +/– 0.3
Thickness	1 +/– 0.2
Other dimensions upon request	



UV bandpass filters DUG 11 and DUG 11X (combination with filter glass)

The UV-broadband filter types DUG 11 & DUG 11 X are made of SCHOTT UV-transmitting optical filter glass of the type UG 11, whereby its typical secondary passband at about 720 nm has been blocked by an additional coating on both sides. These coating layers also work as a **protective coating** against external influences. The types DUG 11 and DUG 11 X, in contrast to pure UG 11 filter glass, are much **more stable** with regard to **intensive shortwave UV-radiation** (solarization resistance), as the layer systems absorb or reflect this radiation to a greater extent and hence prevent it from penetrating into the filter glass.

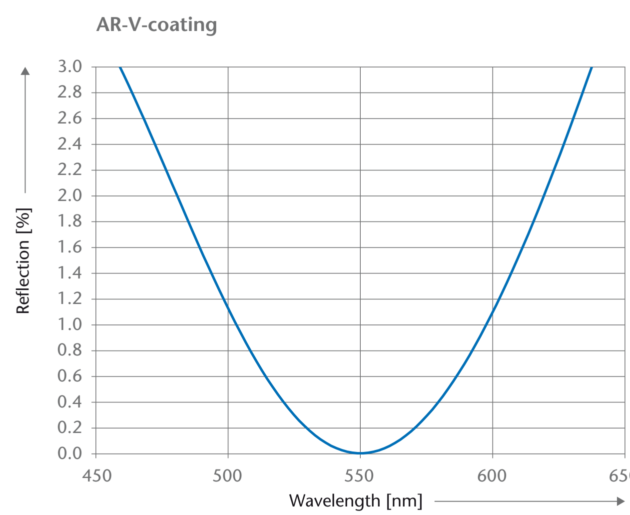
Type	DUG 11	DUG 11 X
Center wavelength λ_m [nm]	approx. 340	approx. 320
Spectral values		
HW (= FWHM) [nm]	approx. 70	approx. 100
τ_{max}	≥ 0.70	≥ 0.70
Q	approx. 1.3	approx. 1.3
q	approx. 1.6	approx. 1.6
τ_{SM}	≤ 10^{-5} (below 260 nm) ≤ 10^{-8} (420nm to 649nm) ≤ $5 \cdot 10^{-6}$ (650 nm to 799 nm) ≤ $5 \cdot 10^{-4}$ (800 nm to 999 nm) ≤ $5 \cdot 10^{-3}$ (1000 nm to 1200 nm)	≤ 10^{-5} (below 260 nm) ≤ 10^{-8} (420nm to 649nm) ≤ $5 \cdot 10^{-6}$ (650 nm to 799 nm) ≤ $5 \cdot 10^{-4}$ (800 nm to 999 nm) ≤ $5 \cdot 10^{-3}$ (1000 nm to 1200 nm)
Other properties		
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7	MIL-C-14806 A, para. 3.8
Coating adhesion	MIL-M-13508 C, para 4.4.6	MIL-M-13508 C, para 4.4.6
Operating temperature	up to approx. 220 °C	up to approx. 220 °C
Notes	Please indicate operating temperatures > 100 °C for appropriate measures for minimizing breakage risk	Please indicate operating temperatures > 100 °C for appropriate measures for minimizing breakage risk
Preferred dimensions [mm]		
External dimensions	☐ 50 + 0/– 0.3	☐ 50 + 0/– 0.3
Usable area	☐ ≥ 46	☐ ≥ 46
Thickness	2.0 +/– 0.2	2.0 +/– 0.2
Other dimensions on request		
Thickness changes lead to transmittance changes		



AR coating AR-V-coating

Spectral range 200 – 25000 nm

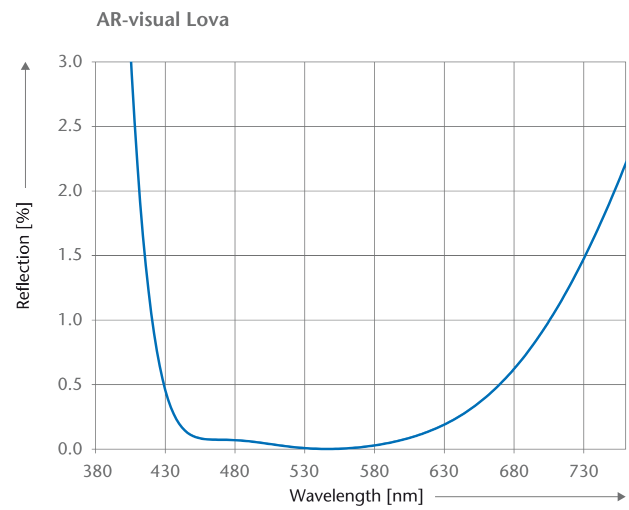
Center wavelength-tolerance [%]	+/– 0.5
Available with center wavelength in range	200 – 25000 nm
Spectral values	
Reflectance ρ at center wavelength	< 0.2 %
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to 250 °C for several hours
Notes	
Preferred dimensions [mm]	
External dimensions	up to 590 x 730 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	



AR coating AR-VIS Lova

Spectral range 350 – 1000 nm

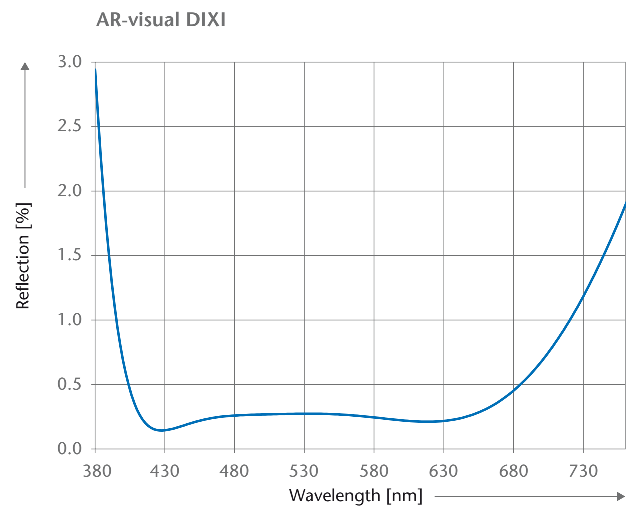
Coating materials	metaloxide + MgF_2
Available performance shifted in range	350 – 1000 nm
Spectral values	
Reflectance ρ	440 – 650 nm < 0.5 % average
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-675 C, para. 4.5.10
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to 250 °C for several hours
Notes	
Preferred dimensions [mm]	
External dimensions	up to Ø 200 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	



AR coating AR-VIS DIXI

Spectral range 350 – 1000 nm

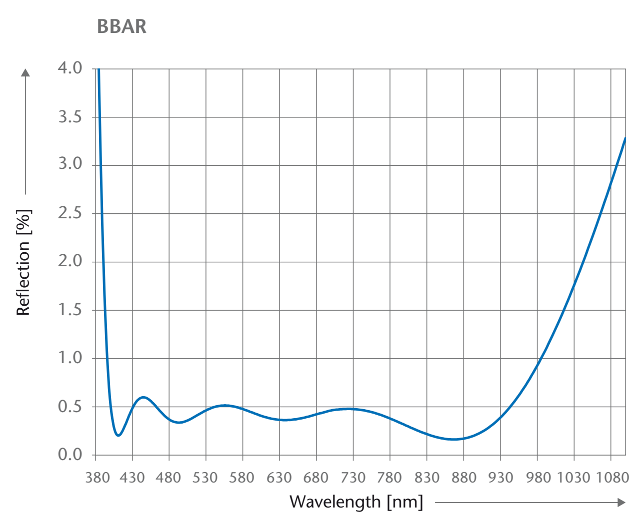
Coating materials	hard metal oxide
Available performance shifted in range	350 – 1000 nm
Spectral values	
Reflectance ρ	420 – 680 nm < 0.8 % average
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to 250 °C for several hours
Notes	
Preferred dimensions [mm]	
External dimensions	
Usable area	upon request
Thickness	upon request
Other dimensions upon request	



AR coating Broadband AR-coating

Spectral range 350–1000 nm

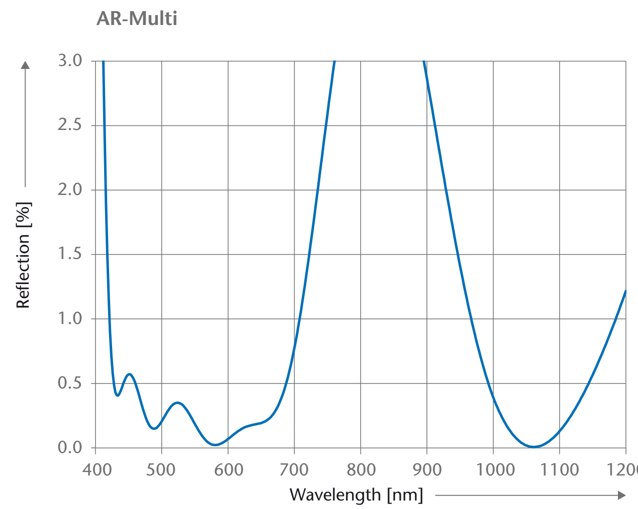
Coating materials	metaloxide + MgF_2
Available performance shifted in range	350–1000 nm
Spectral values	
Reflectance ρ	400–450 nm < 3 % 450–1000 nm < 1.3 % 1000–1100 nm < 3.5 %
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-675 C, para. 4.5.10
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to 250 °C
Notes	
Preferred dimensions [mm]	
External dimensions	up to Ø 200 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	



AR coating Multiband AR-coating

Spectral range 350–1600 nm

Coating materials	metaloxide + MgF_2
Available performance shifted in range	350–1600 nm
Spectral values	
Reflectance ρ	450–650 nm < 1 % average 1064 nm < 1 %
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-675 C, para. 4.5.10
Coating adhesion	MIL-M-13508 C, para 4.4.6
Operating temperature	up to 250 °C
Notes	
Preferred dimensions [mm]	
External dimensions	up to Ø 200 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	



VIS scratch-resistant (hard) AR coating

Spectral range 450 – 700 nm

SCHOTT offers a variety of customized glass products with a special hard coating in reliable and reproducible quality. Using magnetron sputtering and our own proprietary process for hard AR coatings results in both scratch resistance and AR characteristics (also for different angle of incidence possible).

Dimensions

- Up to 590 x 730 mm and thickness < 40 mm

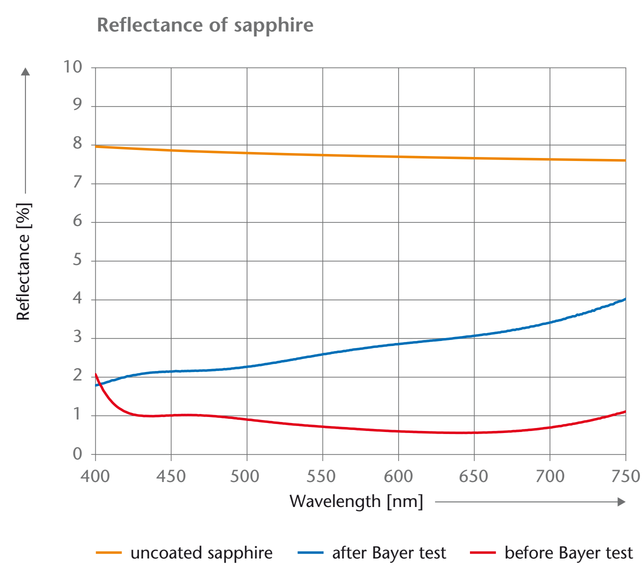
Proof of scratch resistance

Scratch resistance is often measured after performing the so-called Bayer test (often as variation of the original test in ASTM F735) where the hard AR-coated substrate is covered by sand and oscillates many thousand of times with several hundred rounds per minute. The optical performance (e. g. reflection) is measured before and after the Bayer abrasion test.

The graph below shows the result of a sapphire sample substrate (with about 8 % reflection if uncoated) with the following specifications:

- Hard coated AR for 450 nm to 700 nm
- Reflection < 1.5 % @ 450 nm … 700 nm before abrasion test
- Reflection < 5 % @ 450 nm … 700 nm after abrasion test

Example specification	
Available wavelength range [nm]	450 – 700
Substrate	sapphire
Reflectance uncoated substrate	approx. 8 %
Reflectance before abrasion test (450 nm – 700 nm)	< 1.5 %
Reflectance after abrasion test (450 nm – 700 nm)	< 5 %
Other properties	
Scratch resistance	according Bayer test (as variation of the original test in ASTM F735)
Notes	other substrates on request
Preferred dimensions [mm]	
External dimensions	up to 590 x 730 mm
Usable area	
Thickness	< 40
Other dimensions upon request	



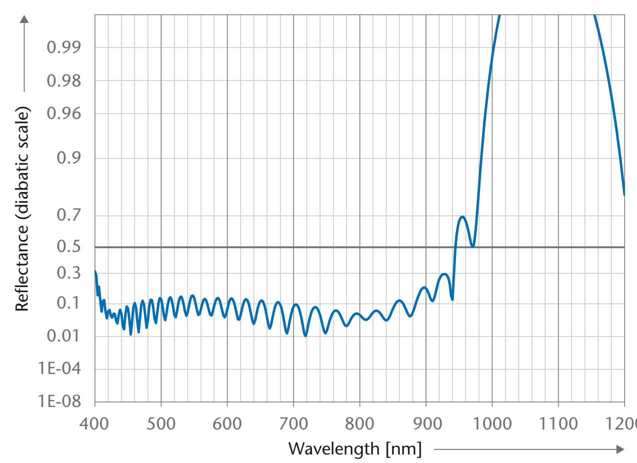
Dielectric (laser) mirror REMAX

Spectral range 300 – 2500 nm

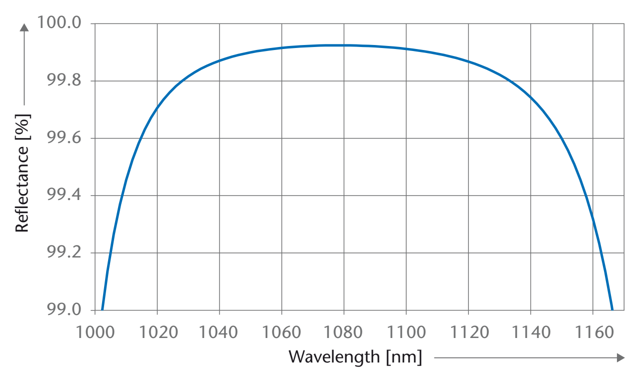
Mirrors of this type consist of dielectric layers with low absorption and are therefore suited for laser applications.

Spectral range	300 – 2500 nm
Type	REMAX
Reflectance ρ	1064 nm < 99.8 % higher reflectivities on request
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 200 °C
Notes	typical application cw-laser power > 50 kW
Preferred dimensions [mm]	
External dimensions	up to Ø 200 mm
Usable area	
Thickness	upon request
Other dimensions upon request	

REMAX



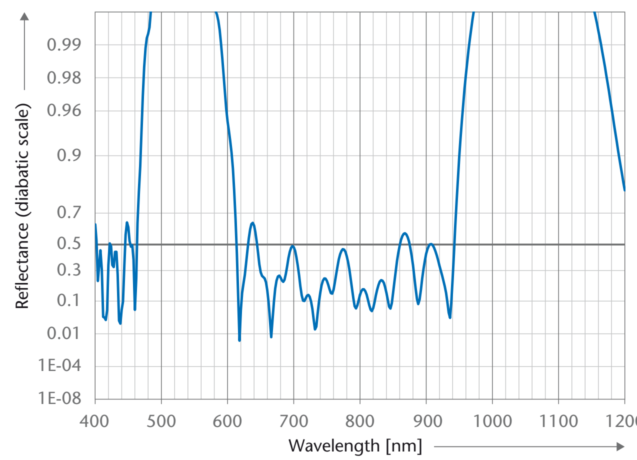
REMAX



Dielectric (laser) mirror REMAX 2 band

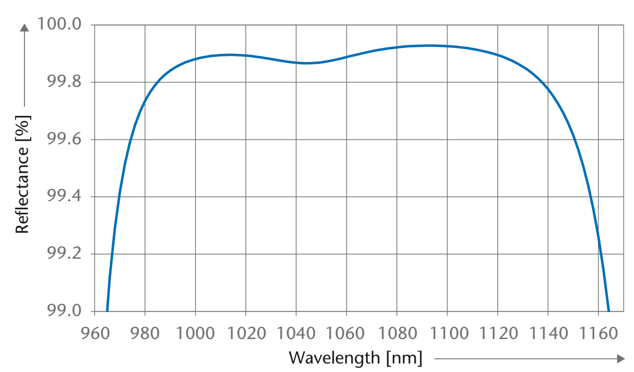
Spectral range 300 – 2500 nm

REMAX 2 band



Reflectance ρ	1064 nm < 99.8 % higher reflectivities on request
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 5 cycles
Operating temperature	up to 200 °C
Notes	typical application cw-laser power > 50 kW
Preferred dimensions [mm]	
External dimensions	up to Ø 200 mm
Usable area	
Thickness	upon request
Other dimensions upon request	

REMAX 2 band

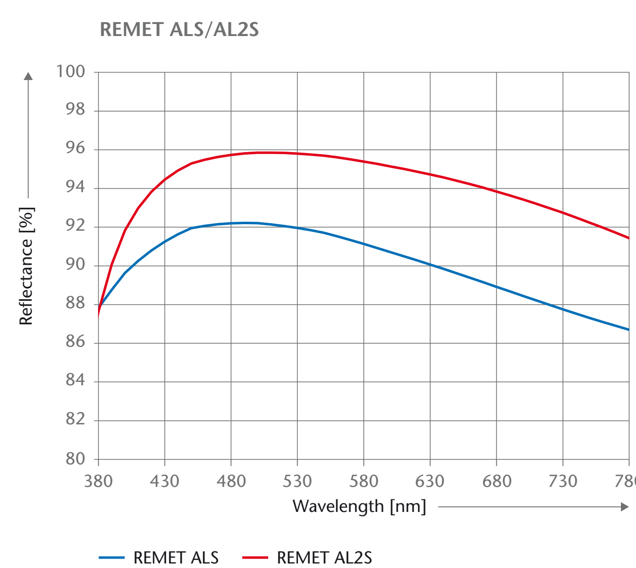


Metallic mirrors REMET ALS

Spectral range 400 – 800 nm

Mirrors of this type consist of a metallic layer and if needed with a SiO_2 protective layer.

Angle of incidence	0 – 45°
Available in wavelength range	400 – 800 nm
Available article variants	
Protected Aluminum mirror:	REMET ALS
Dielectric enhanced Aluminum mirror	REMET AL2S
Reflectance	
REMET ALS: reflectance ρ	400 – 700 nm > 85 % average
REMET AL2S: reflectance ρ	400 – 700 nm > 90 % average
Other properties	
Adhesion	DIN 58196 – K1
Rubbing test	DIN 58196 – H25
Operating temperature	up to 70 °C for several hours up to 100 °C for short periods
Notes	
Preferred dimensions [mm]	
External dimensions	up to Ø 300 mm
Thickness	upon request
Other dimensions upon request	



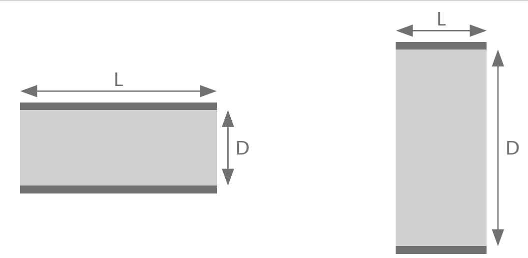
Transparent conducting oxide coating (TCO)

Spectral range 400–5000 nm

A transparent conducting coating (TCO) ensures both electrical conductivity and optically transparency. SCHOTT uses ITO (indium-tin-oxide) for this purpose.

Transparent conductive oxides (TCO) combine transparency in the visible spectrum, infrared reflectivity and electrical conductivity. Indium Tin Oxide (In_2O_3:Sn) is the most common.	
Available article variants	
	ITO single layer ITO with AR coating ITO with AR coating and flexible connectors structured ITO for touch screens
Optical sheet resistance can be adapted:	7–5000 Ω/square
Typical sheet resistances/ tolerances	10+/–4 Ω/square 100+/–10 Ω/square 300+/–30 Ω/square
Reflectance ρ	
Reflection if AR-coating is applied on top of ITO:	450–650 nm <1 % average other ranges on request
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Operating temperature	up to 200 °C for several hours
Notes	Flexible connectors can be applied by conductive epoxy
Preferred dimensions [mm]	
External dimensions	up to 590 x 730 mm (sputtering) up to 150 x 150 mm (EB)
Usable area	upon request
Thickness	upon request
Other dimensions on request	
Sheet resistance (Rs) is specified for transparent conductive thin films. The spectral transmission/reflection and electrical conductivity depend on TCO-material and coating thickness.	
$Rs = \frac{\text{Resistivity}}{\text{filmthickness}}$ [Ω/square] no units of area!	
Resistivity ρ is a property of bulk material – sheet resistance is a property of thin films for example: $\rho = 3 \times 10^{-4}$ Ω cm, film thickness 300 nm, then Rs = 10 Ω/square	

If a voltage is applied to electrodes on opposites edges of the film, the resistance Re is given by the length L and the distance D of the electrodes and the sheet resistance:

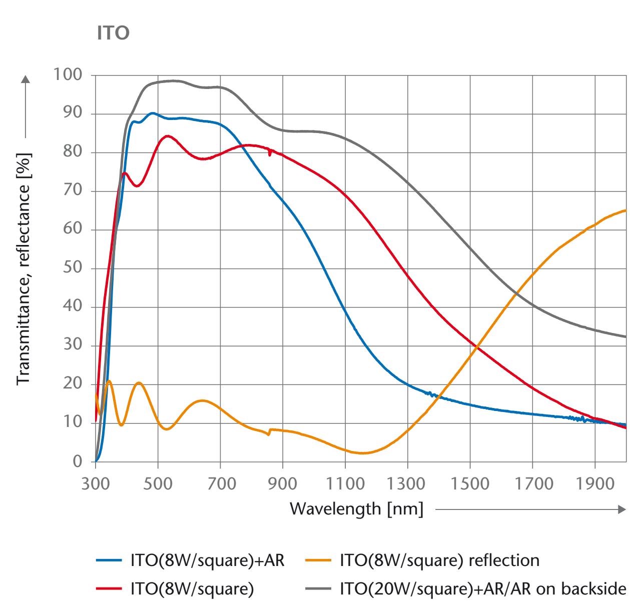


example: Rs = 10 Ω/sq and L = 5 x D

$R_e = 10\ \Omega/\text{sq.x}\ \frac{D}{L} = 2\ \Omega$

example: Rs = 10 Ω/sq and L = D/5

$R_e = 10\ \Omega/\text{sq.x}\ \frac{D}{L} = 50\ \Omega$

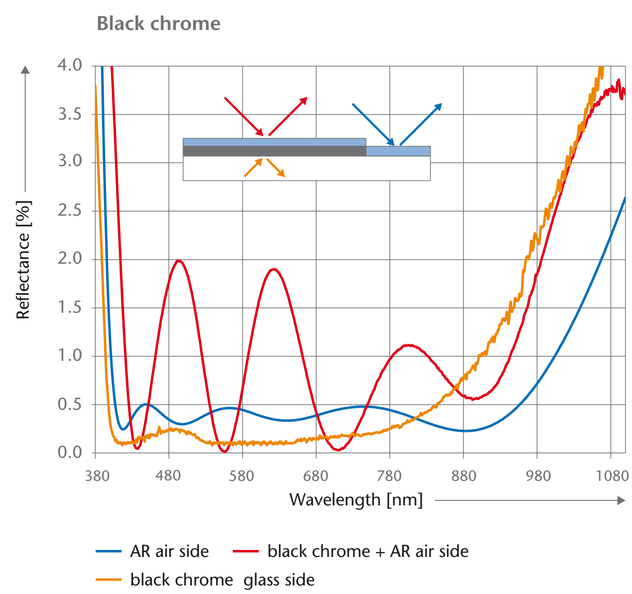


Black chrome coating for light absorption

Spectral range 400 – 1000 nm

This coating absorbs light and can be used for masking.

Available with λ_m in range	400 – 1000 nm
Substrate materials	Glass, fused silica
Spectral values	
Reflectance ρ (incidence from air side)	420 – 1000 nm < 3 % average
Optical density	> 3.5
Other properties	
Operating temperature	up to 300 °C for several hours
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Coating abrasion resistance	MIL-C-14806 A, para. 3.7
Coating adhesion	MIL-M-13508 C, para 4.4.6
Notes	
External dimensions	up to 150 x 150 mm (EB)
Usable area	upon request
Thickness	upon request
Other dimensions on request	



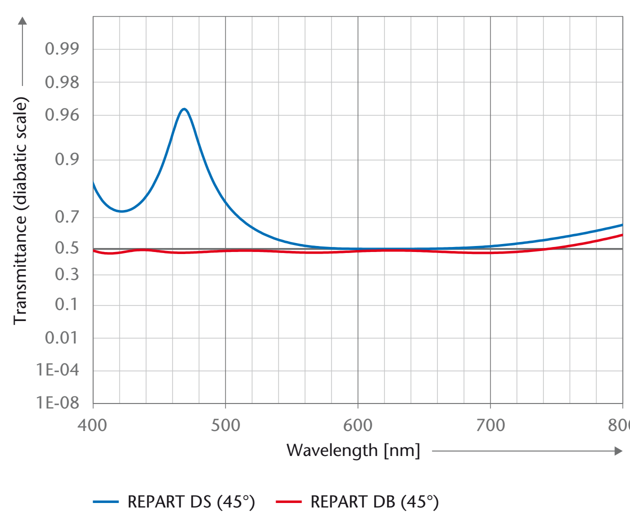
Dielectric beam splitter coating REPART

Spectral range 400 – 1000 nm

Splitting light (power) with different splitting ratio and optimized for a single wavelength or a broad wavelength band can be offered.

Available article variants	
REPART DB	R (450 – 650) = 50 % ± 6 % (a.o.i. 45°)
REPART DS	T(650) = 50 % ± 5 % (a.o.i. 45°)
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Operating temperature	up to 250 °C for several hours
Temperature dependency of λ_m : $\Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.007
Notes	
Preferred dimensions [mm]	
External dimensions	up to 150 x 150 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	

Repart (oblique incidence)

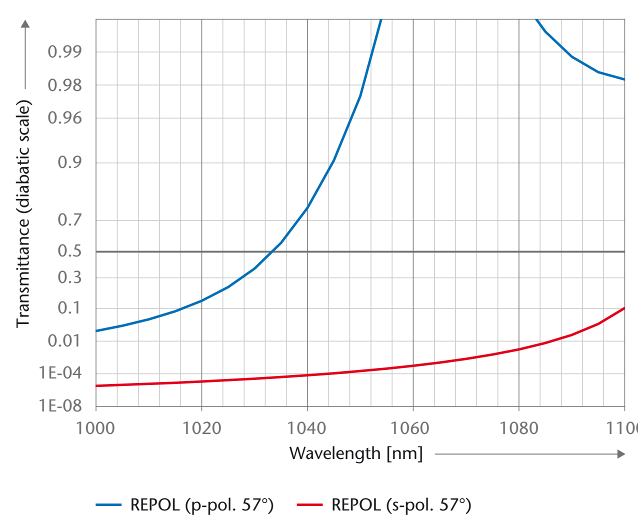


Polarization beam splitter coating
Spectral range 300 – 2500 nm

Here the s-polarization (TE polarization) and the p-polarization (TM polarization) are separated from each other at a specific wavelength. The polarization beam splitter plate must be aligned under an angle of 45°.

Type	REPOL
Available article variants	
REPOL (e.g. 1064 nm)	Tp(1064 nm) > 97 %
	Ts(1064) < 1 %
	a.o.i. = 57°±2°
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Operating temperature	up to 250 °C for several hours
Temperature dependency of $\lambda_m : \Delta\lambda_m/\Delta T$ [nm/K]	approx. +0.007
Notes	
Polarizing beamsplitters are available in a broad range of wavelengths and can be adapted to different angles of oblique incidence.	
Preferred dimensions [mm]	
External dimensions	ca. 60 x 60 mm
Usable area	upon request
Thickness	upon request
Other dimensions upon request	

REPOL (Brewster angle 57°)



Notch (up to triple notch) filter

Spectral range 400 – 2000 nm

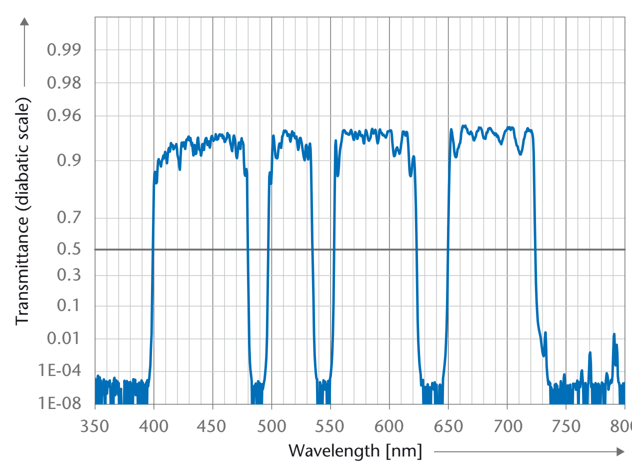
Notch filters provide versatile solutions concerning half widths, center wavelengths and blocking properties typically needed in Raman spectroscopy, fluorescence excitation and emission in bio-photonic, medical analytical, chemical, forensic, and pharmaceutical applications.

SCHOTT offers steep notch wavelengths and high blocking at selectable wavelengths. Highly selective notch wavelengths can be adapted to the customer's specifications. Designs can range from single notch to triple notch.

This type of filter is made according to customers' specification. An example specification for a triple notch filter is as follows:

Notch wavelength λ_S	400 – 2000 nm
Spectral values	
τ_{ave}	≥ 0.90
τ_{SM}	≤ 10^{-5}
Other properties	
Humidity resistance	MIL-Std-810C, method 507, proc. 1 : 10 cycles
Operating temperature	up to approx. 350 °C
Notes	All specs per customers' request
Preferred dimensions [mm]	
External dimensions	Ø < 25
Usable area	Ø < 24
Thickness	≤ 5
Other dimensions upon request	

Example of a triple notch filter (no backside AR)



9. Optical filters for color and brightness measurements: SFK 100A, SFK 101B, SFK 102A

Color measurements using the tristimulus method

The measurement of color using the tristimulus method is described by German Industrial Standard DIN 5033, part 6. Color stimulus by measuring the three tristimulus values may be achieved by means of a photometer if the radiation detector's sensitivity is adjusted to definite spectral valuation functions with the aid of appropriate optical filters. If the measurement results are expected to directly provide the tristimulus values within the CIE 1931 standard colorimetric system, the precision filters' spectral transmission factors $\tau_x(\lambda)$, $\tau_y(\lambda)$ and $\tau_z(\lambda)$ have to meet the requirements given by:

$$\tau_x(\lambda) = \frac{c_x \cdot \bar{x}(\lambda)}{S_1(\lambda)},\ \tau_y(\lambda) = \frac{c_y \cdot \bar{y}(\lambda)}{S_2(\lambda)},\ \tau_z(\lambda) = \frac{c_z \cdot \bar{z}(\lambda)}{S_3(\lambda)}$$

where $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ are the color-matching functions for the CIE 1931 standard colorimetric observer (see Fig. 1), and where $S_1(\lambda)$, $S_2(\lambda)$, and $S_3(\lambda)$ are the spectral sensitivities of the detectors receiving the non-filtered radiation, and where c_x, c_y, and c_z are wavelength-independent instrument constants that can be determined empirically.

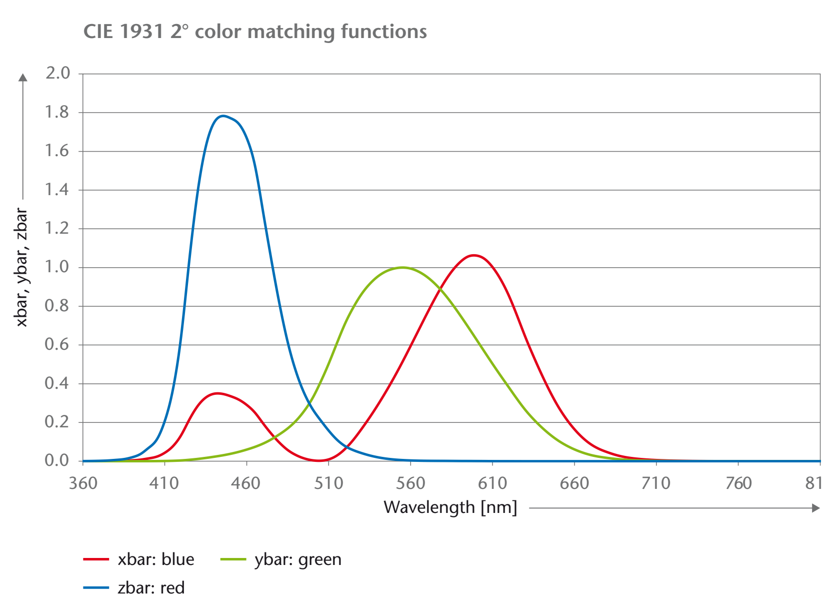


Fig. 1
Color matching functions $\bar{x}(\lambda)$, $\bar{y}(\lambda)$, and $\bar{z}(\lambda)$ for the CIE 2° standard colorimetric observer. The curve $\bar{y}(\lambda)$ is identical to the spectral luminous efficiency function $V(\lambda)$ for photopic vision.

Measurement of brightness

Within the CIE 1931 standard colorimetric system, the color-matching function $\bar{y}(\lambda)$ is identical to the spectral luminous efficiency function $V(\lambda)$. Thus, if a precision filter with a spectral transmission factor $\tau_y(\lambda)$ is used, brightness measurements may also be carried out alone (determination of the tri stimulus value Y).

Filter design

SCHOTT's range of products includes optical filter glass combinations which, given the below simplifications, allow an approximate determination of the tristimulus values and brightness, respectively, to be performed:

1. The sensitivity curve a typical silicon detector $S(\lambda)$ has been taken as a basis.
2. Since the curve of the color-matching function $\overline{x}(\lambda)$ consists of two adjacent, bell-shaped curves, it can be represented by two selective precision filters, with the following approximation:

$$a_1 \cdot \tau_{x1}(\lambda) + a_2 \cdot \tau_{x2}(\lambda) \approx \frac{\overline{x}(\lambda)}{S(\lambda)},$$

   where $\tau_{x1}(\lambda)$ describes the curve of transmission of the short-wave band, while $\tau_{x2}(\lambda)$ describes that of the long-wave band. Appropriately, the wavelength-independent constants a_1 and a_2 are determined empirically.
3. The $\overline{y}(\lambda)$, and $\overline{z}(\lambda)$ curves are similar so that but only one filter has been computed for each of both curves.

The conditions set forth below apply to optical filter glass combinations SFK 100A, SFK 101B and SFK 102A exhibiting the spectral transmission factors of $\tau_{SFK100A}(\lambda)$, $\tau_{SFK101B}(\lambda)$, and $\tau_{SFK102A}(\lambda)$:

$$a_1 \cdot \tau_{SFK100A}(\lambda) + a_2 \cdot \tau_{SFK100A}(\lambda) \approx \frac{\overline{x}(\lambda)}{S(\lambda)}$$

$$b \cdot \tau_{SFK101B}(\lambda) \approx \frac{\overline{y}(\lambda)}{S(\lambda)} = \frac{V(\lambda)}{S(\lambda)}$$

$$c \cdot \tau_{SFK102A}(\lambda) \approx \frac{\overline{z}(\lambda)}{S(\lambda)}$$

with the wavelength-independent constants a_1, a_2, b, and c to be determined.

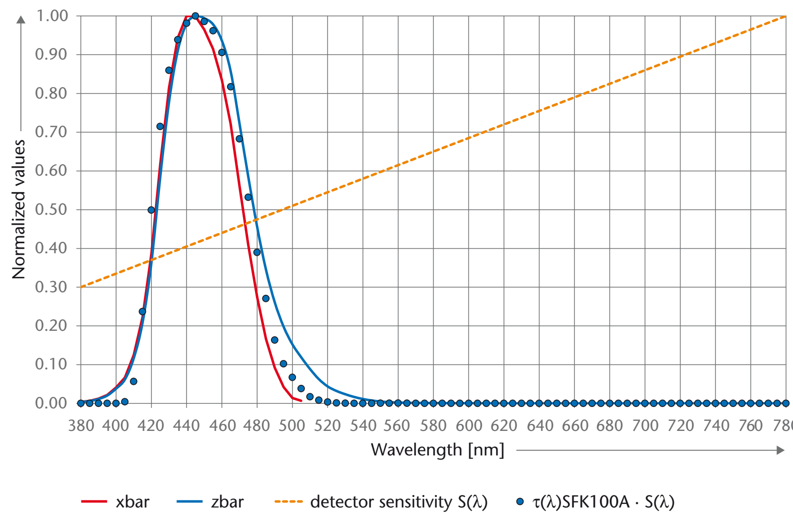


Fig. 2
Optical filter glass combination SFK 100A with $\tau_{max} \approx 0.43$ (all curves are normalized to 1).

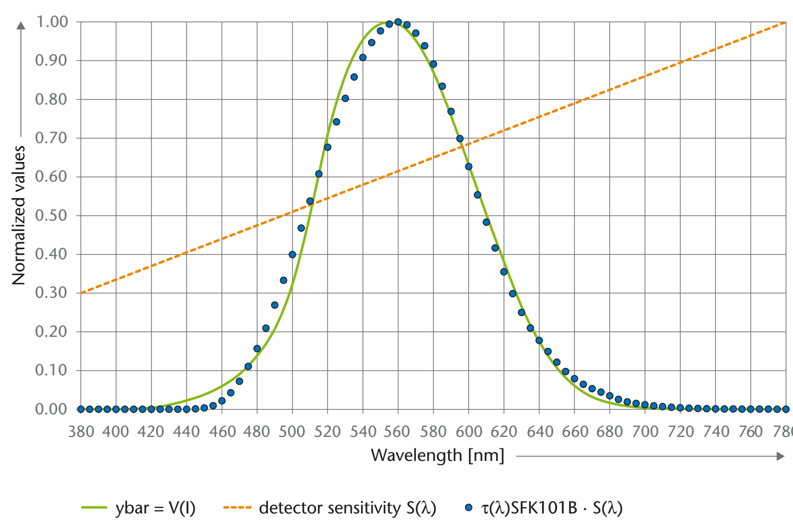


Fig. 3
Optical filter glass combination SFK 101B with $\tau_{max} \approx 0.39$ (all curves are normalized to 1).

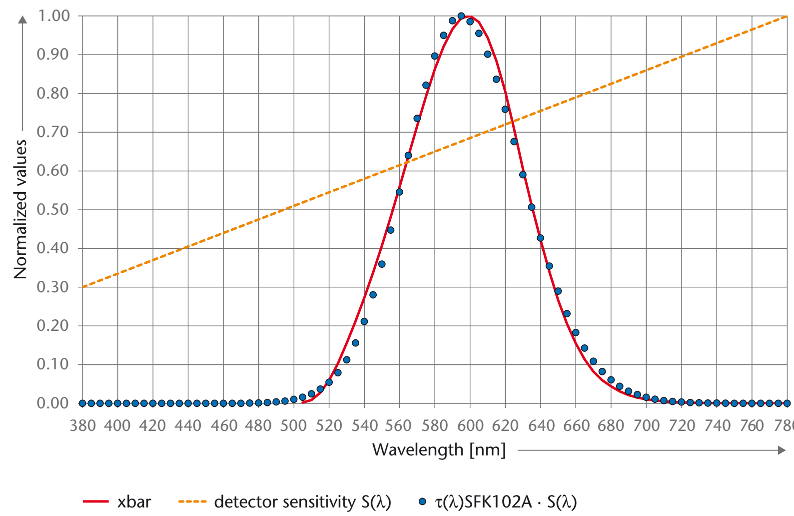


Fig. 4
Optical filter glass combination SFK 102A with $\tau_{max} \approx 0.08$ (all curves are normalized to 1).

Filter properties

The optical filter glass combinations' typical degree of adjustment is evident from Figs. 2–4, that also show the curve of spectral sensitivity of the silicon detector. The transmission curves apply to 20 °C temperature, and there is a relatively low and mostly negligible temperature dependence. First-rate glass melts are chosen for manufacturing of the filters, and great attention is paid to the blocking of sensitivity ranges not desirable outside the spectral regions marked. Each of the glass filter combinations is cemented with the aid of epoxy resin. The liners withstand temperatures up 70 °C, and can be exposed to up to 100 °C for a short time.

In cases of high levels of atmospheric humidity, the use of protective glasses and the embedding in mountings are recommended.

Delivery and dimensions

Glass filter combinations for colorimetry: SFK 100A, SFK 101B, SFK 102A (these three filters make up one set).

Glass filter combination for brightness measurements: SFK 101B.

Standard dimensions: 50 x 50 mm and 50 mm in diameter.
Dimensional tolerances: + 01 – 0.3 mm
Max. dimension: 100 x 100 mm
Min. dimension: 10 mm in diameter
Max. thickness: 11 mm

10. Your global contacts

Africa, Europe & Middle East

Africa:
Advanced Optics
SCHOTT AG
Hattenbergstrasse 10
55122 Mainz, Germany
Phone +49 (0)6131/66-1812
Fax +49 (0)3641/2888-9047
info.optics@schott.com
www.schott.com/advanced_optics

Austria:
SCHOTT Austria GmbH
Ignaz-Köck-Strasse 10
1210 Wien, Austria
Phone +43 (0)1 290 1748-0
Fax +43 (0)1 290 1748-20
info.optics@schott.com
www.schott.com/austria

Benelux:
SCHOTT Benelux B.V.
Randweg 3 A
4104 AC Culemborg, Netherlands
Phone +31 (0)344/670911
Fax +31 (0)344/621802
info.optics@schott.com
www.schott.com/advanced_optics

Eastern Europe:
SCHOTT Division PP
113/1 Leninsky Prospect, E-210
117198 Moscow, Russia
Phone +7 (495)933-51-53
Fax +7 (495)933-51-53
info.russia@schott-export.com
www.schott.com/advanced_optics

France, Spain, Portugal:
SCHOTT France SAS
6 bis rue Fournier
92110 Clichy, France
Phone +33 (0)1/40873900
Fax +33 (0)1/42707322
info.optics@schott.com
www.schott.com/france

Germany:
Advanced Optics
SCHOTT AG
Hattenbergstrasse 10
55122 Mainz, Germany
Phone +49 (0)6131/66-1812
Fax +49 (0)3641/2888-9047
info.optics@schott.com
www.schott.com/advanced_optics

Israel:
SCHOTT Glass Export GmbH
Representative Office
Top Rasko Bld.
40 Ha`atzmaut St.
P.O. Box # 98
56304, Yehud, Israel
Phone +972-3-5361711
Fax +972-3-5361710
info.optics@schott.com
www.schott.com/advanced_optics

Scandinavia and Baltics:
SCHOTT Scandinavia A/S
Lyngby Port
Lyngby Hovedgade 98, stuen – K16
2800 Kgs. Lyngby, Denmark
Phone +45 (0)43 43 6030
Fax +45 (0)43 43 3566
info.optics@schott.com
www.schott.com/scandinavia

Switzerland, Italy, Liechtenstein:
SCHOTT Suisse SA, Yverdon
2, Rue Galilée
1401 Yverdon-les-Bains VD, Switzerland
Phone +41 (0)24/423-9900
Fax +41 (0)24/423-9910
info.optics@schott.com
www.schott.com/advanced_optics

UK, Ireland:
H.V. Skan Ltd., Solihull/GB
Phone +44 (0)121/733-3003
Fax +44 (0)121/733-1030
info@skan.co.uk
www.skan.co.uk

Asia

China:
SCHOTT (Shanghai)
Precision Materials & Equipment
International Trading Co., Ltd.,
Unit 301, RND Tower
No. 1801 Hong Mei Road
Shanghai, PRC (200233), China
Phone +86 (0)21 33678000
Fax +86 (0)21 33678080/33678886
info.china@schott.com
www.schott.com/china

India:
SCHOTT Glass India Pvt. Ltd.
DYNASTY "A" Wing, 303/304
3rd FI., Andheri-Kurla Road, Andheri
400059 Mumbai, India
Phone +91 (0)22/4094-7000
Fax +91 (0)22/4094-7001
pti-bombay@schott.com
www.schott.com/advanced_optics

Japan:
SCHOTT Nippon K.K.
7, Honshio-cho, Shinjuku-ku
Tokyo 160-0003, Japan
Phone +81-3-5366-2492
Fax +81-3-5366-2482
sn.info@schott.com/japan
www.schott.com/japan

Korea:
SCHOTT Korea Co., Ltd.
5th Floor BK Tower, 434 Samseong-ro
Gangnam-gu, Seoul, Korea 135-845
Phone +82-2-3456-0325
Fax +82-2-3456-0301
info.kr@schott.com
www.schott.com/korea

Malaysia:
SCHOTT Glass (Malaysia) SDN. BHD.
2024 Tingkat Perusahaan 6
Zon Perindustrian Bebas 2
13600 Perai/Penang, Malaysia
Phone +60 4-3898100
Fax +60 4-3993861
schott.mypen@schott.com
www.schott.com/advanced_optics

Singapore:
SCHOTT Singapore Pte. Ltd.
8 Admiralty Street
#05-01 Admirax
Singapore 757438
Phone +65-64882366 (Main line)
Fax +65-62860838 (General Fax)
sales.singapore@schott.com
www.schott.com/advanced_optics

Taiwan:
SCHOTT Taiwan Ltd.
8F-3, No. 126, Sec. 4
Nanking E. Road
Taipei 105, Taiwan
Phone +886 (0)2 2570 9626 ext. 11
Fax +886 (0)2 2570 9628
info.taiwan@schott.com
www.schott.com/advanced_optics

Australia & New Zealand

SCHOTT Australia Pty. Ltd.
Unit 1, 4 Skyline Place
Frenchs Forest
NSW 2086, Australia
Phone +61 (0)2 8426 1600
Fax +61 (0)2 8426 1666
info.australia@schott.com
www.schott.com/advanced_optics

North America

Advanced Optics
SCHOTT North America, Inc.
400 York Avenue
Duryea, PA 18642, USA
Phone 1-570-457-7485
Fax 1-570-457-7330
info.optics@us.schott.com
www.us.schott.com/advanced_optics

Advanced Optics
SCHOTT North America, Inc.
400 York Avenue
Duryea, PA 18642
USA
Phone +1 570/457-7485
Fax +1 570/457-7330
info.optics@us.schott.com
www.us.schott.com/advanced_optics

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