

CATALOG 2011

LAYERTEC®
OPTICAL COATINGS · OPTICS

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COMPONENTS FOR OPTICAL PARAMETRIC OSCILLATORS (OPOs)

Mirrors for OPOs are optimized for a good separation of the pump laser, signal and idler wavelengths as well as for a broad reflectance band of the signal wavelengths and a wide range of high transmittance for the idler wavelengths. Moreover, most of the optics show smooth group delay (GD) and group delay dispersion (GDD) spectra. Thus, wide tuning ranges for the signal and the idler wavelengths can be achieved. Moreover, this enables to operate OPOs with fs pulses. Broadband output couplers are also available. Centre wavelength and tuning range can be adjusted according to customer specifications.

MIRRORS

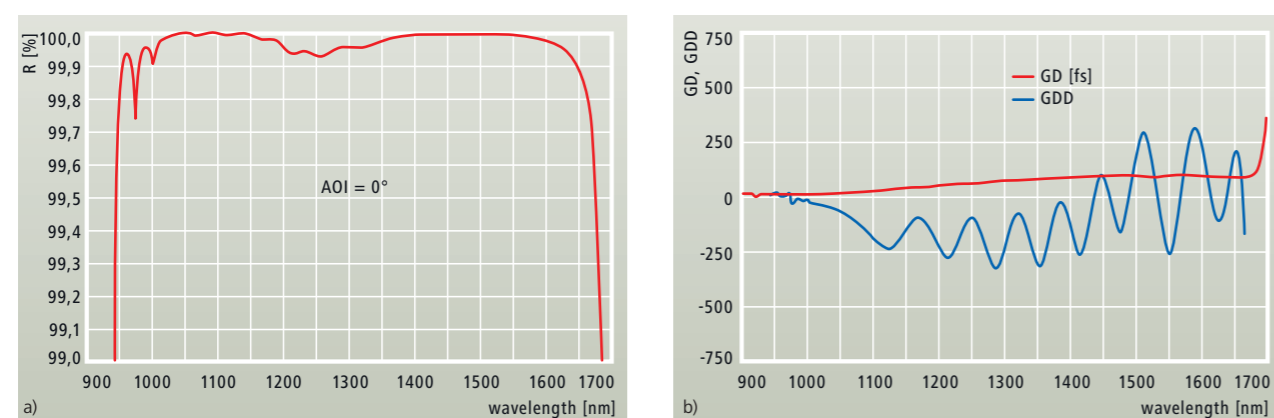


Figure 1: Reflectance (a), GD and GDD (b) spectra of a broadband HR mirror for the signal wavelength:
HR(0°, 1000 – 1600 nm) > 99.9%

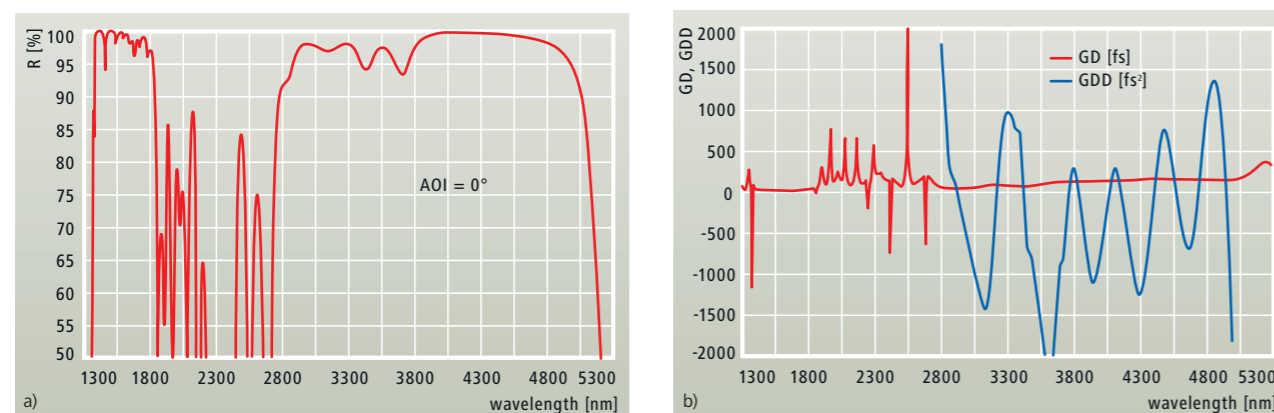


Figure 2: Reflectance (a), GD and GDD (b) spectra of a dual HR mirror for the signal and idler wavelengths:
HR(0°, 1400 – 1800 nm) > 96% + HR(0°, 2900 – 4900 nm) > 93%

This dual mirror shows smooth GD spectra for signal and idler, while only the broadband mirror for the idler wavelengths is GDD optimized.

All OPO coatings are produced by magnetron sputtering. This guarantees that the optical parameters are thermally and climatically stable, because the coatings are dense, free of water and adhere strongly to the substrate in spite of the extreme coating thickness in the order of 20–30 μm. This makes sputtered OPO coatings ideal for application in harsh environments.

500 – 5000 nm

PUMP MIRRORS AND SEPARATORS

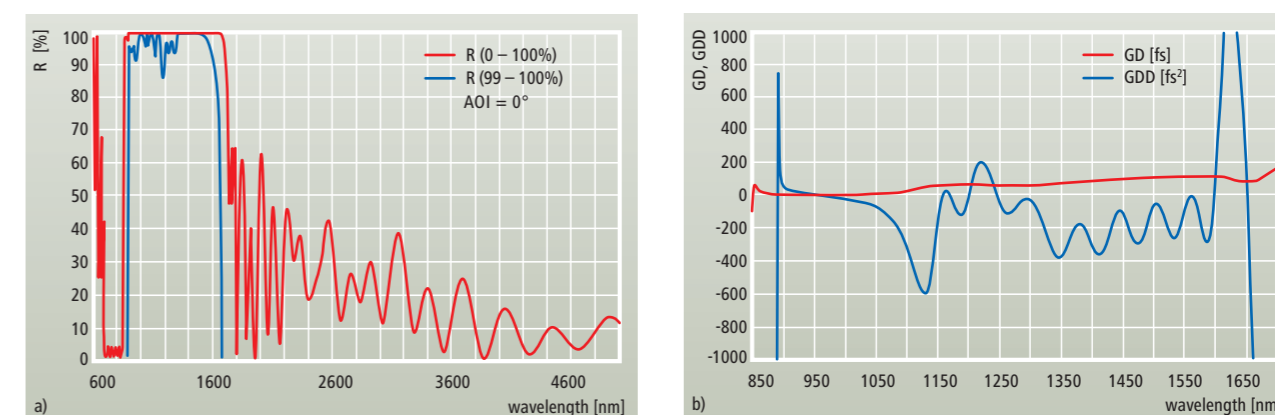


Figure 3: Reflectance (a), GD and GDD (b) spectra of an OPO pump mirror

This type of mirrors separates the pump and signal wavelengths while suppressing the idler wavelength:
R(0°, 700 – 850 nm) < 10% + HR(0°, 900 – 1600 nm) > 99.8% + R(0°, 1800 – 5000 nm) < 60%

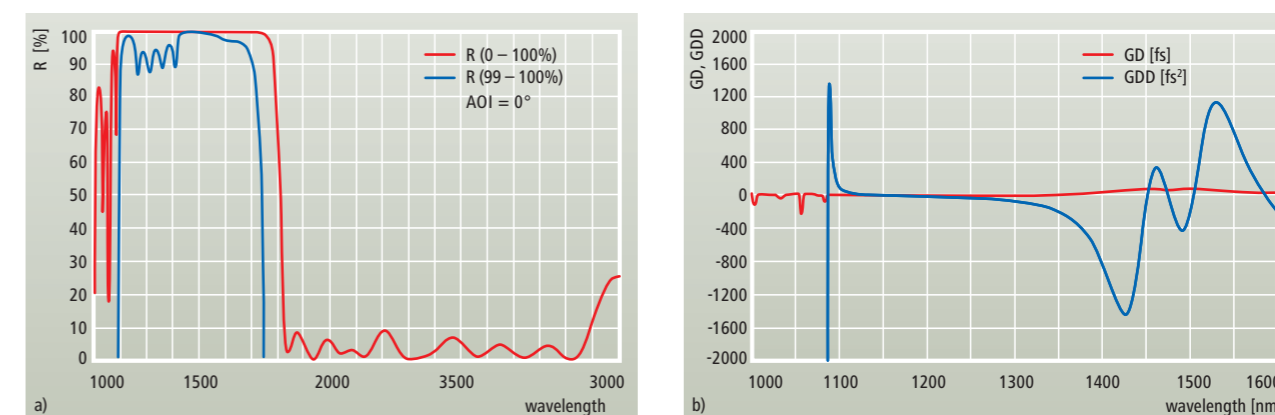


Figure 4: Reflectance (a), GD and GDD (b) spectra of a separator for the signal and idler wavelengths

- Edge filters separating signal and idler wavelengths can be used as broadband outcoupling mirrors for the idler: HR(0°, 1100 – 1600 nm) > 99.8% + R(0°, 1730 – 2900 nm) < 10%
- These filters can also be provided with a band of high reflectance or high transmission for the pump wavelengths or for the second harmonic of the signal wavelengths
- We recommend undoped YAG or sapphire as substrate material if high transmission for the idler wavelengths is required (see also page 15 for transmission curves)

COMPONENTS FOR OPTICAL PARAMETRIC OSCILLATORS (OPOs)

OUTPUT COUPLERS AND BEAM SPLITTERS

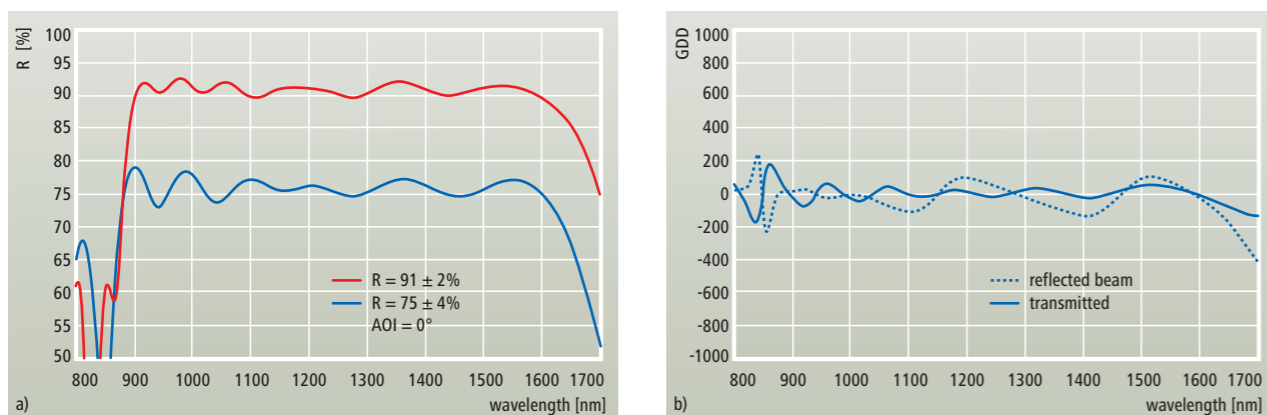


Figure 5: Reflectance (a) and GDD (b) spectra of different broadband output couplers for the signal wavelengths

The reflectivity of output couplers and beam splitters can be adjusted according to customer specifications. Please note the smooth GDD spectra. The GDD spectra shown are

calculated for the 75% output coupler, but the spectra for other reflectivities are very similar.

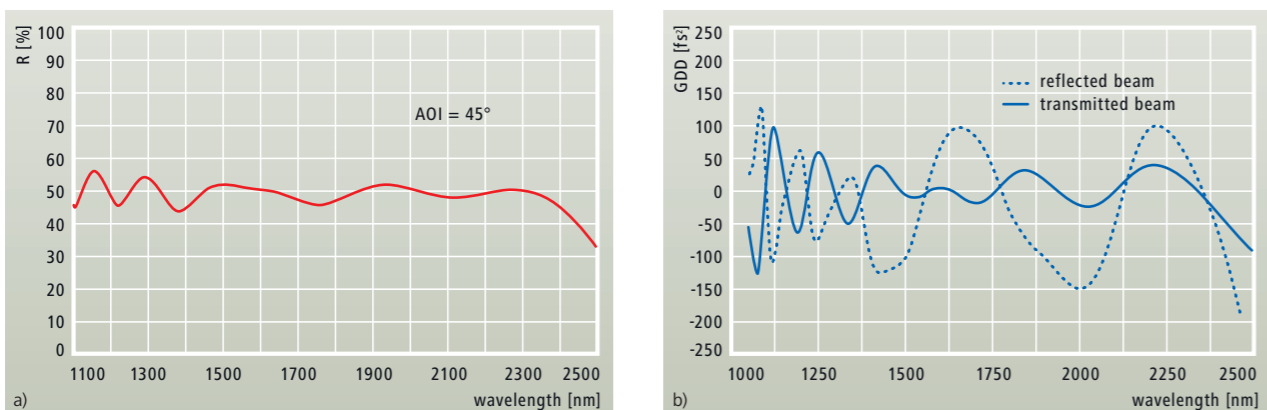


Figure 6: Reflectance and GDD-spectra of a broadband beam splitter for p-polarized signal and idler radiation: $R_p(45^\circ, 1100 - 2400 \text{ nm}) = 50 \pm 5\%$

COATINGS ON NONLINEAR OPTICAL CRYSTALS

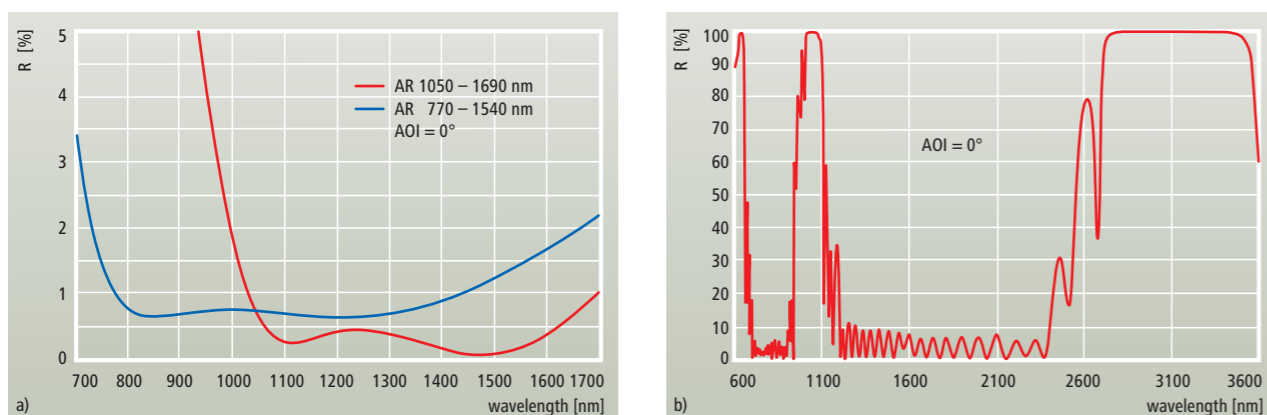


Figure 7: Reflectance spectra of different broadband AR coatings (a) and of a double reflector with two regions of high transmittance (b) on lithium niobate

(a): AR(0° , 770–1540 nm) < 1.5%; AR(0° , 1050–1690 nm) < 1%

(b): HR(0° , 1010–1075+2750–3450 nm) > 99.8% + R(0° , 700–900+1200–2400 nm) < 10%

All coatings according to customers specifications.

500 – 5000 nm

TURNING MIRRORS AND SEPARATORS

Turning mirrors and separators for pump wavelengths, signal and idler are key components of OPOs. In the following we present some examples of such optics. The spectral position of the reflection and transmission bands can be

adjusted according to customers specification. Please note that the GD and GDD can only be optimized for s- or for p-polarization while the reflectivity is usually very high for both polarizations.

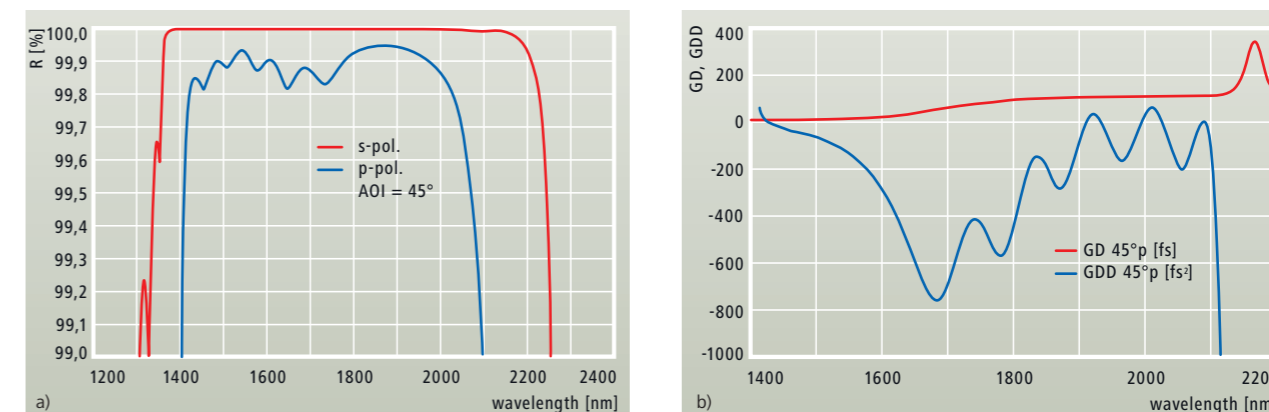


Figure 8: Reflectance (a), GD and GDD (b) spectra of a turning mirror HRp(45° , 1450–2000 nm) > 99.8%

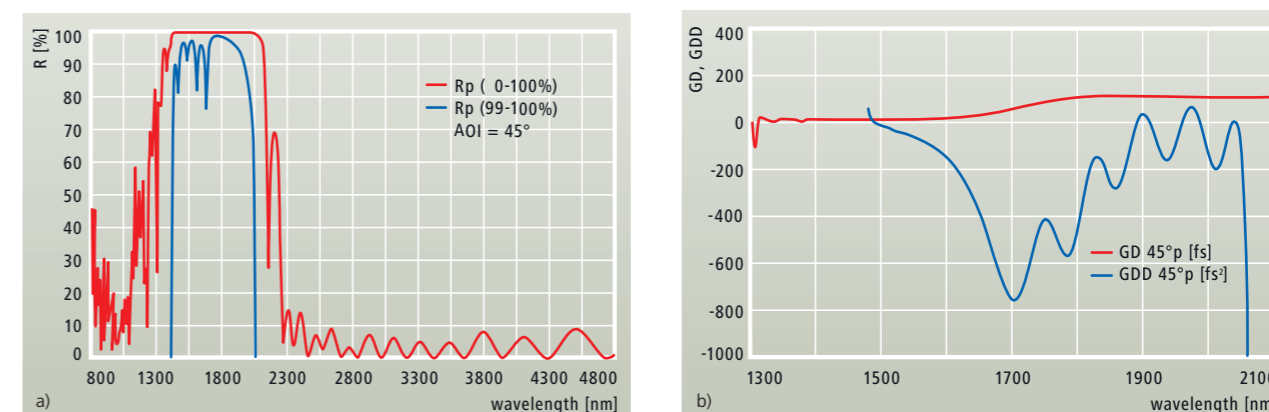


Figure 9: Reflectance (a), GD and GDD (b) spectra of a separator for signal and idler

A broad reflectance band for the signal wavelengths is combined with a broad transmission band for the idler: HRp(45° , 1450–2000 nm) > 99.8% + Rp(45° , 2250–4000 nm) < 10%.

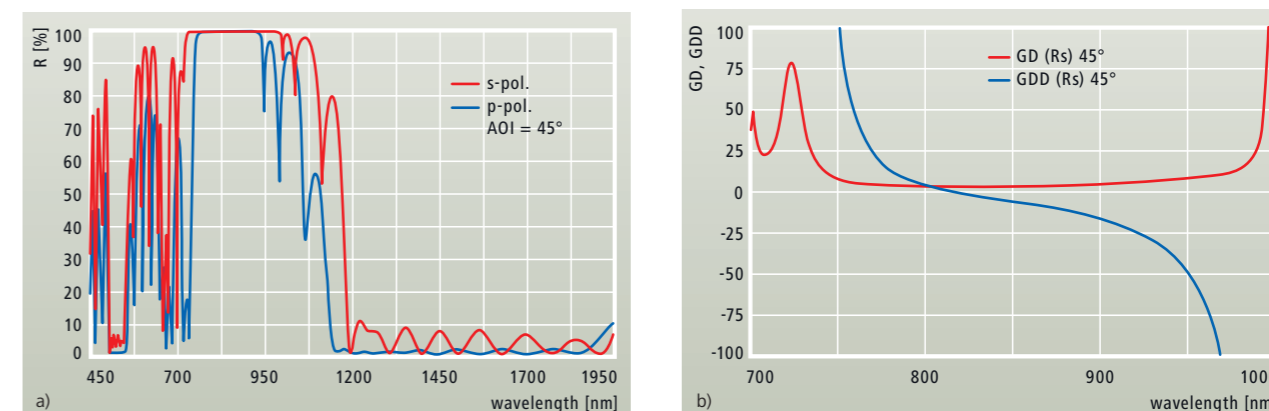


Figure 10: Reflectance (a), GD and GDD (b) spectra of a separator for the signal and idler with high transmissions for the pump radiation

This separator can also be used as incoupling mirror for the pump radiation: HRs(45° , 770 – 930 nm) > 99.8% + Rp(45° , 510–550 nm) < 1% + Rp(45° , 1160–1900 nm) < 10%.

COMPONENTS FOR OPTICAL PARAMETRIC OSCILLATORS (OPOs)

ULTRA BROADBAND COMPONENTS

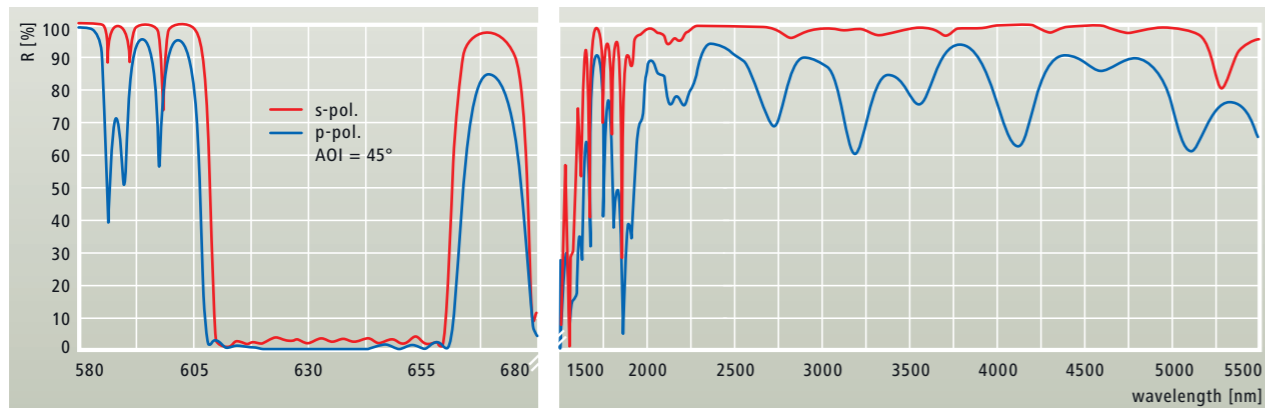


Figure 11: Reflectance spectrum of an ultra broadband beam combiner HRs(45°, 2000 – 5000nm) > 98% + Rp(45°, 633nm) < 2%

This beam combiner can be used to couple a pilot laser into the beam line. Please note the very low reflectivity at 620 – 650 nm.

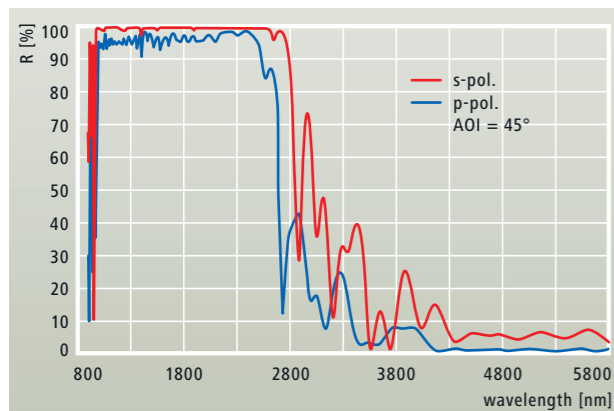


Figure 12: Reflectance spectrum of an ultra broadband separator for signal and idler wavelengths HR(45°, 1000 – 2500nm) > 98% + Rr(45°, 4400 – 5000nm) < 5%

EDGE FILTERS

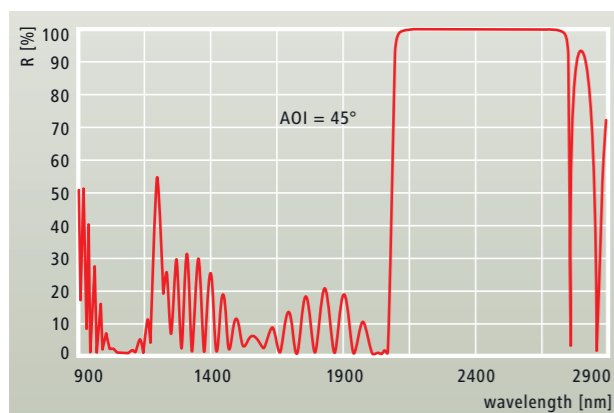


Figure 13: Edge filter for the idler and signal wavelength range with high transmission for the pump wavelength:
HRs(45°, 2150–2700nm) > 99.9%+
Rs(45°, 2000–2070nm) < 10%+
Rs(45°, 1064nm) < 1%

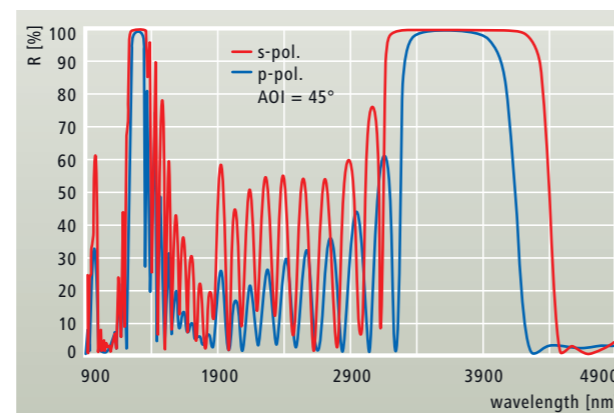


Figure 14: Broadband edge filter for the idler wavelength range with high transmission for the pump wavelength:
HRs(45°, 3300–4200nm) > 99.9%+
Rs(45°, 4500–4900nm) < 6%+
Rs+p(45°, 1064nm) < 5%

500 – 5000 nm

SPECIAL MIRRORS

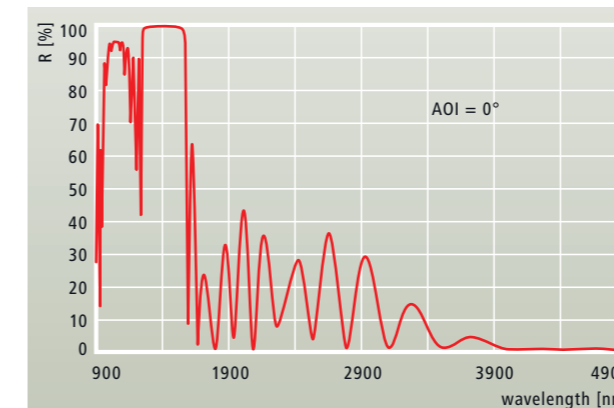


Figure 15: Special pump mirror: PR(0°, 1064nm) = 94 ± 2% + HR(0°, 1360 – 1460nm) > 99.9%

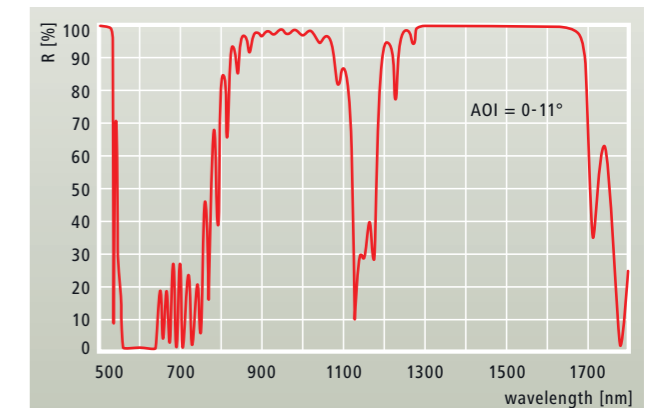


Figure 16: Special mirror: R(11°, 565–620nm) < 1% + PR(11°, 900–1000nm) = 98% + HR(11°, 1280–1600nm) > 99.9%

SPECIAL OUTPUT COUPLERS

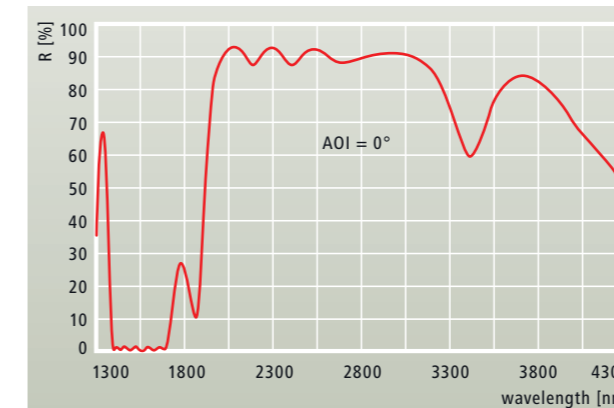


Figure 17: Special output coupler: R(0°, 1400–1700nm) < 3% + PR(0°, 2000 – 3150nm) = 90%

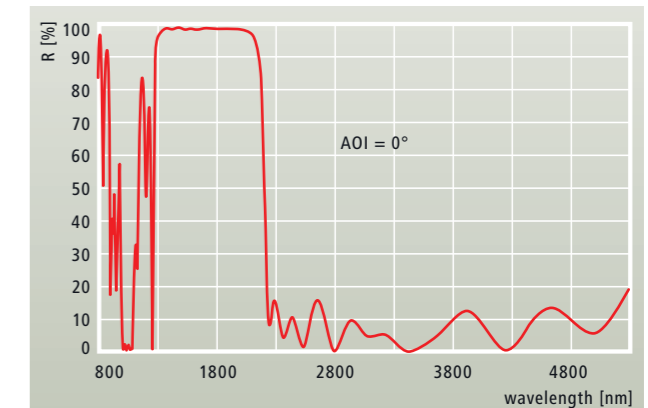


Figure 18: Special output coupler: R(0°, 1000–1100nm) < 3% + PR(0°, 1350–2000nm) = 98% + R(0°, 2200–5000nm) < 20%

The output couplers for the signal wavelengths (figure 17) can suppress the idler and vice versa (figure 18). These output couplers may also have a pump window.

BROADBAND AND SCANNING MIRRORS

LAYERTEC produces broadband and scanning mirrors according to customers specifications. Both full dielectric and metal-dielectric coating designs are used. In the fol-

lowing we present some examples which are designed for very broad wavelength regions or extremely wide ranges of incidence angles.

BROADBAND MIRRORS

Broadband mirrors are widely used to reflect light of lasers emitting in a broad wavelength range such as e.g. Ti:Sapphire lasers, dye lasers, or for combination of different diode lasers.

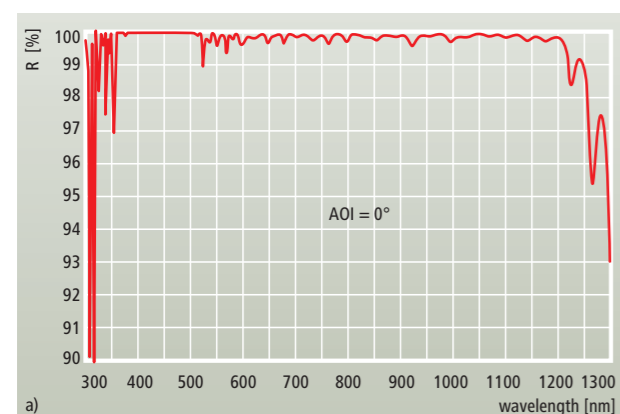
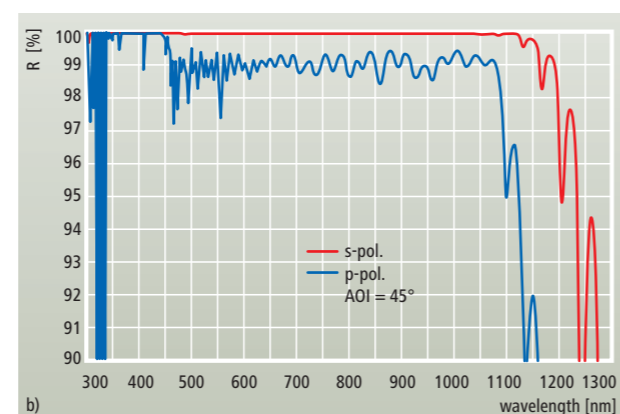


Figure 1: Reflectance spectra of an ultra broadband mirror for the NUV, VIS and NIR:
a) $R(0^\circ, 360 - 1200 \text{ nm}) > 99\%$
b) $R_s(45^\circ, 350 - 1150 \text{ nm}) > 99\%$ + $R_p(45^\circ, 350 - 1050 \text{ nm}) > 97\%$

Special mirrors are also available which cover the whole visible spectrum, the near ultraviolet and considerable parts of the near infrared spectral regions. We recommend such mirrors as universal turning mirrors for nearly all types of laser diodes.



Broadband mirrors for the NIR range are especially useful for reflecting the idler wavelengths of optical parametric oscillators or for special fs-application. In combination with fused silica as substrate material a wide blocking range from 2300 – 6000nm can be achieved. Other NIR materials

such as sapphire and YAG are possible alternatively, but can be especially used for high power applications to control the thermal conductivity if the absorption of water around $2.8 \mu\text{m}$ or the coating material itself leads to an increase of the temperature.

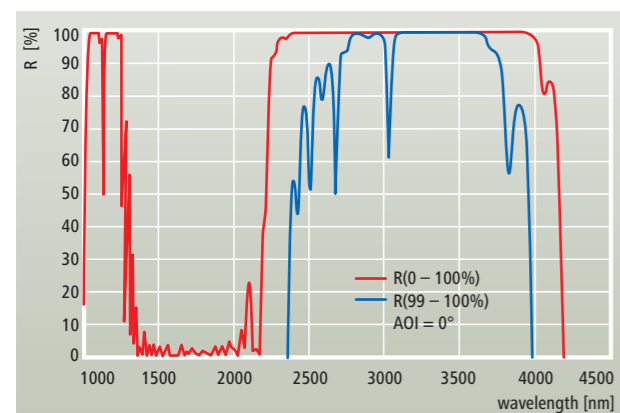


Figure 2: Reflectance spectra of a broadband mirror for the NIR:
 $HR(0^\circ, 2300 - 4000 \text{ nm}) > 99\%$

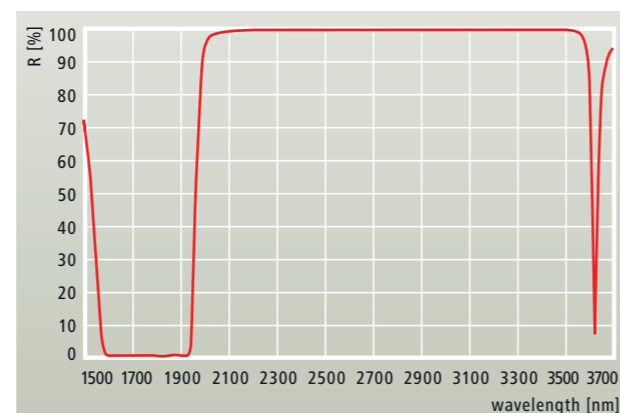


Figure 3: Reflectance spectra of a broadband mirror for the NIR:
 $HR(0^\circ, 2050 - 3500 \text{ nm}) > 99\%$ + $HT(0^\circ, 1600 - 1930 \text{ nm})$

300 – 5000 nm

SCANNING MIRRORS

LAYERTEC offers scanning mirrors for high power laser application as well as for special demands on the wavelength spectra and the angular range. Scanning mirrors are optimized for high reflectance for one wavelength or a certain wavelength region at a wide range of incidence

angles. Our coating technology provides industrial solutions for weight-reduced scanning mirrors but also special mirrors with uncommon sizes up to 500mm for the research with cw and pulsed high power lasers.

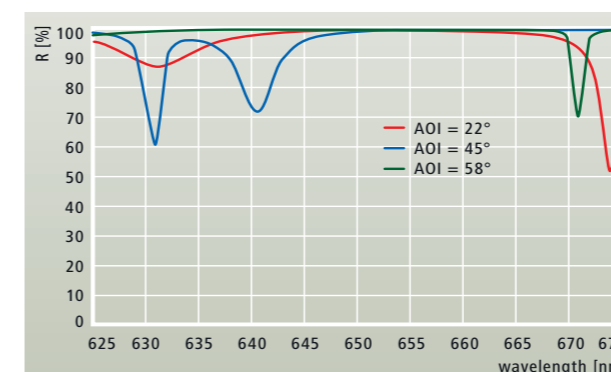


Figure 4: Reflectance spectra of a silver based scanning mirror with enhanced wavelength range for laser diodes in the NIR:
 $HRr(22^\circ - 58^\circ, 800 - 1000 \text{ nm}) > 99\%$ + $PRr(22^\circ - 58^\circ, 630 - 670 \text{ nm}) > 50\%$

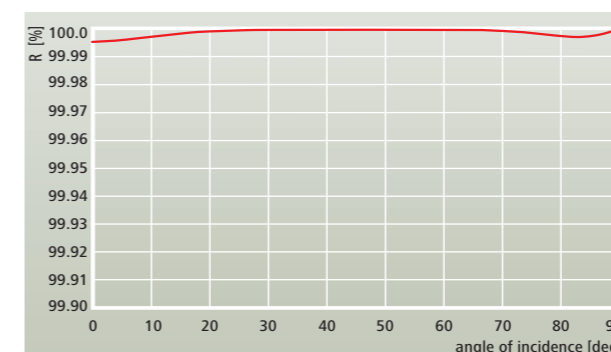
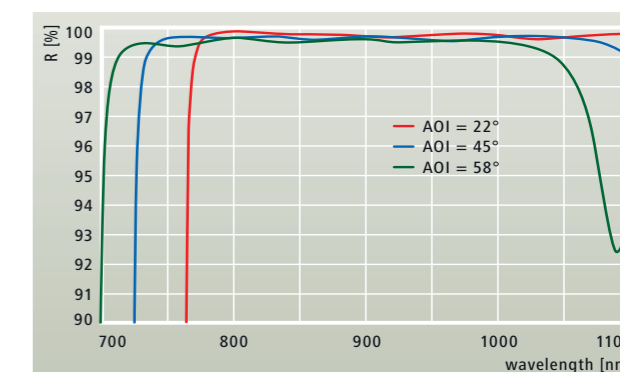


Figure 5: Reflectance vs. AOI of a wide angle scanning mirror for polarized Nd:YAG laser radiation: $HRs(0^\circ - 90^\circ, 1064 \text{ nm}) > 99.9\%$

These mirrors are ideal as scanning mirrors for s-polarized light or to enhance the reflectivity of optical gratings.

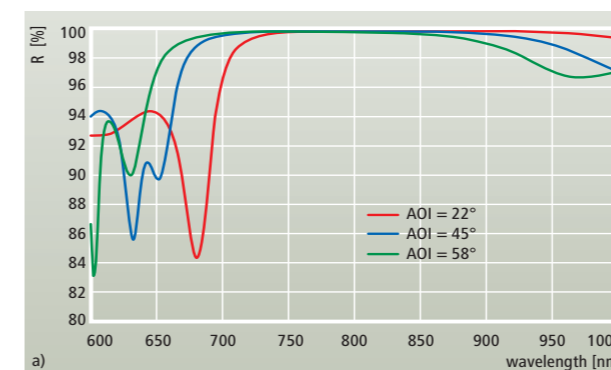
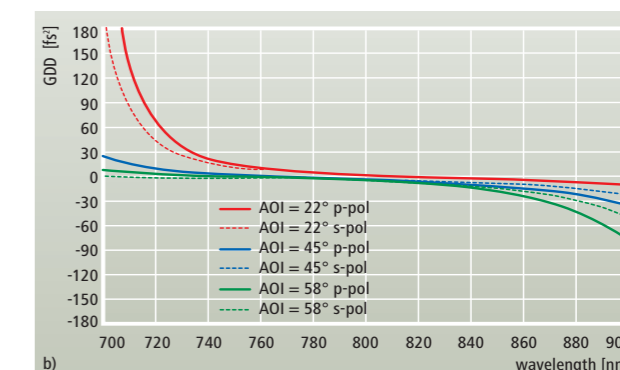


Figure 6: Reflectance (a) and GDD (b) spectra of a scanning mirror for femtosecond laser pulses from a Ti:Sapphire laser:
 $HRr(22^\circ - 58^\circ, 750 - 850 \text{ nm}) > 99.5\%$, $GDD < 20 \text{ fs}^2$



The broad low GDD wavelength range of these mirrors makes it possible to use them in femtosecond laser applications.

For more information or more examples on broadband and scanning mirrors please see pages 40 – 43 (optics for Ti:Sapphire and diode lasers), pages 62 – 69 (femto second laser optics) and, especially for scanning mirrors, page 102 – 103 (silver mirrors).

FILTERS FOR LASER APPLICATIONS

ANGLE TUNING OF NARROW BAND FILTERS

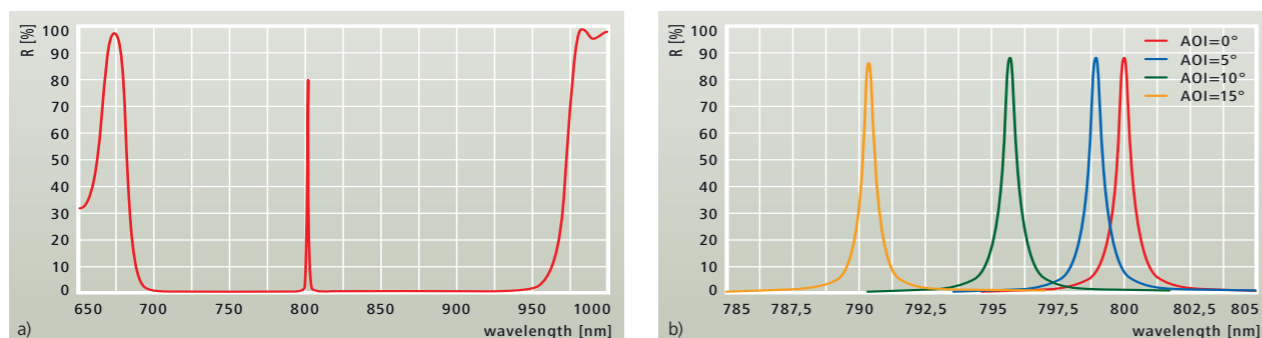


Figure 1: Transmission spectra of a narrow band filter for ~800nm; a) spectral overview, b) transmission at AOI = 0°, 5°, 10° and 15°

- Narrow band filters with FWHM of 1nm and maximum transmission of $T > 80\%$
- An FWHM of 50pm with maximum transmission of $T = 50\%$ was demonstrated
- Blocking: $T < 10^{-3}$, block band: ~200nm in the Ti:Sapphire range
- Especially useful to select one wavelength from the spectrum of the Ti:Sapphire laser
- Spectral tolerance 1% of centre wavelength
The spectral position of the transmission band may vary

by 1% between the coating runs while the bandwidth remains unchanged. The spectral performance of the filter can be optimized by tilting the filter. Tilting results in a shift of the edge towards shorter wavelengths. Thus, the spectral position of a filter with the transmission band at longer wavelengths than required can be adjusted for its best performance by angle tuning.

- If angle tuning is possible, the specifications for the filter can be less stringent which increases the output and reduces the price

VARIABLE FILTERS FOR LASER APPLICATIONS

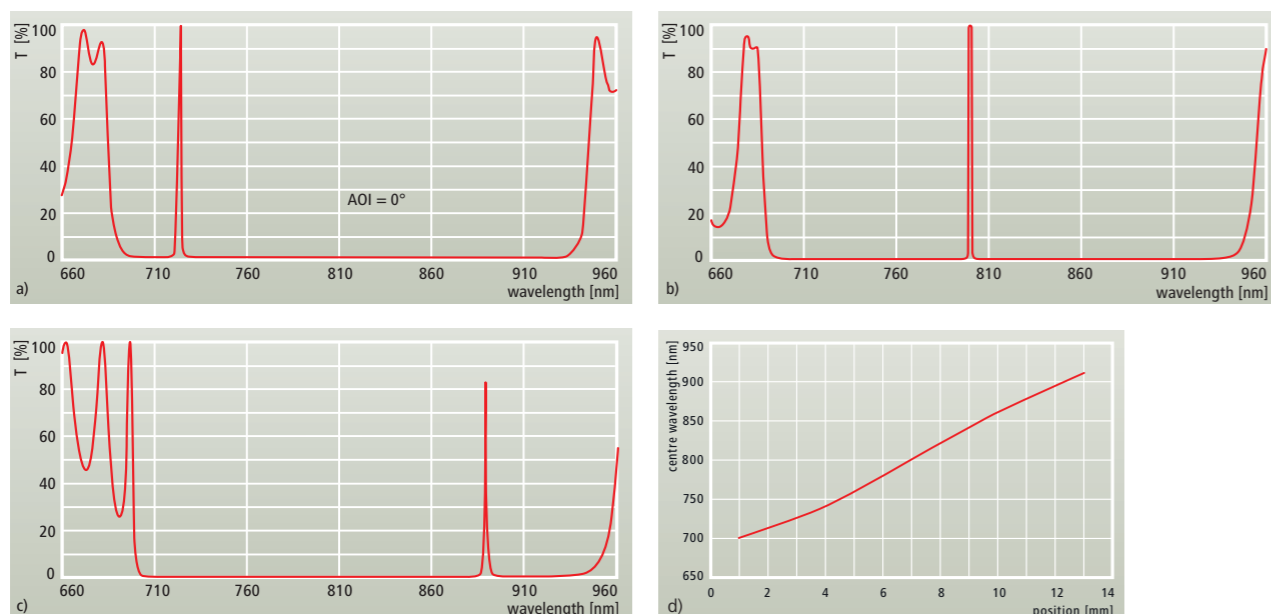


Figure 2: Transmittance spectra of a laterally variable filter for the wavelength range of the Ti:Sapphire laser taken on the short wavelength side (a), in the centre (b) and on the long wavelength side of the filter (c). Centre wavelength vs. position on the filter (d)

Special features:

- Linear variation of the filter wavelength with the position on the filter
- Similar designs for the VIS range (400–700 nm) and for the NIR range (up to 1800 nm)
- Blocking: $T < 10^{-3}$; block band: ~200 nm in the Ti-Sapphire range
- Maximum transmittance: 90%; FWHM: 1 nm
- Shape: rectangular; size: 10 ... 20 mm long, 5 ... 10 mm broad

400 – 1800 nm

STEEP EDGE FILTERS

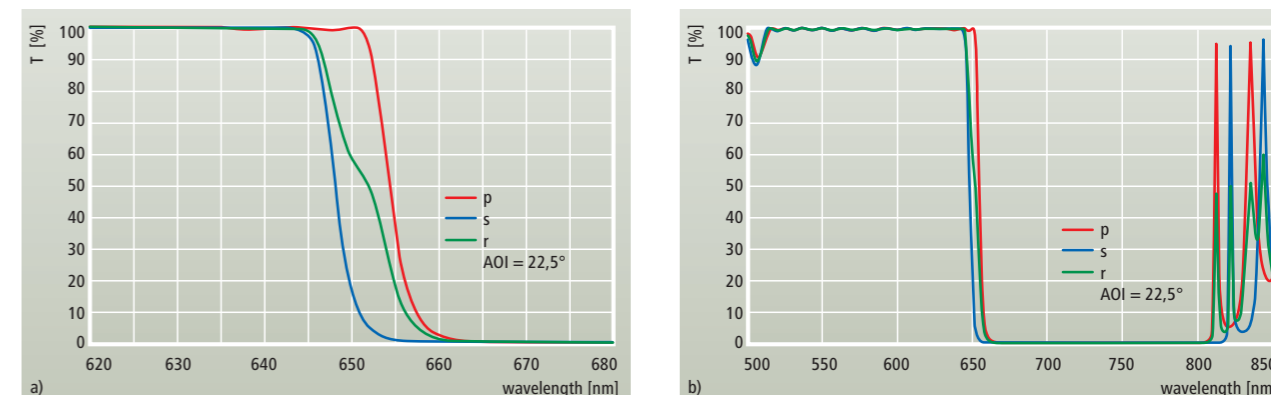


Figure 3: Transmission spectra (detail (a) and spectral overview (b)) of a steep edge short wavelength pass filter for use as combiner for laser diodes at 635 nm and 670 nm (HRr(22.5°, 670 nm) > 99.9% + HTr(22.5°, 635 nm) > 98%, rear side AR coated)

For more information on **combiners for diode lasers** see pages 42 – 43.

For steep edge filters used as **pump mirrors** for solid state lasers on the basis of Yb-doped materials (e.g. Yb:YAG, Yb:KGW, Yb-doped fibers) see pages 44 – 45.

NARROW BAND REFLECTANCE FILTERS

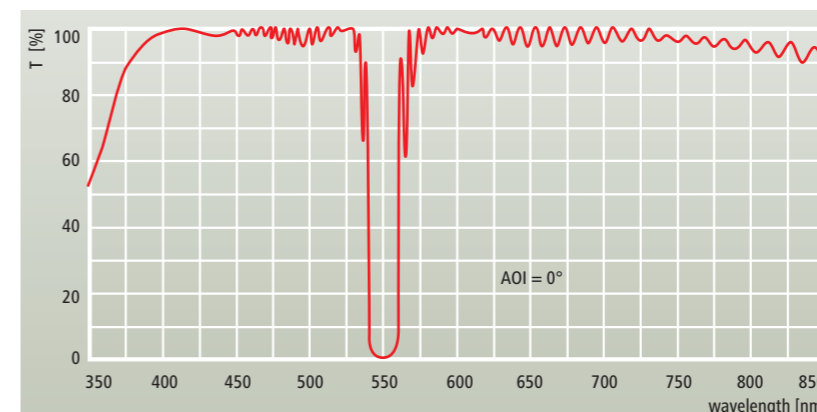


Figure 4: Transmittance spectrum of a narrowband reflectance filter for 550 nm

Filters of this type are ideal for the blocking of a single laser line while preserving a high and relatively constant transmission over the whole visible range.

Special features:

- Spectral width of the reflectance band: 3% (e.g. $T < 1\%$ from 543 – 559 nm)
- $T < 0.1\%$ at the centre wavelength
- $T > 90\%$ throughout the visible spectral range

PRODUCTION OF SPECIAL FILTERS FOR LASER APPLICATIONS

- Filters for laser applications require excellent spectral quality and high damage thresholds
- Spectral position of cut on/cut off wavelengths or reflectance bands according to customer specification
- Sizes and shapes:
Edge filters can be produced on round or rectangular substrates up to diameters of 38.1 mm (1.5 inch). Also

- the production of miniature size filters (e.g. $3 \times 3 \text{ mm}^2$) is possible. Narrow band reflectance filters are limited to diameters of 25.4 mm (1 inch)
- High thermal and climatical stability

THIN FILM POLARIZERS

TECHNICAL TERMS

To answer some frequently asked questions and to help our customers to specify thin film polarizers we first want to give the definitions of the most important technical terms. Light is a transversal wave, i.e. the vector of the electric field oscillates perpendicular with respect to the propagation direction of the light. Natural light (from the sun or from a lamp) is mostly "unpolarized" or "random polarized". This means that the oscillation planes of the electric field

To explain the meaning of the terms "s-polarization" and "p-polarization" one must first determine a reference plane (see figure 1). This plane is spanned by the incident beam and by the surface normal of the mirror (or polarizer). "**S-polarized light**" is that part of the light which oscillates perpendicularly to this reference plane ("**s**" comes from the German word "senkrecht" = perpendicular). "**P-polarized light**" is the part which oscillates parallel

vectors of the single light waves are randomly distributed, but always transversal with respect to the direction of propagation. The term "linear polarized light" means, that there is only one plane of oscillation. There are different optics which can polarize light, e.g. crystal polarizers which split the light into an unpolarized "ordinary beam" and a polarized "extraordinary beam" or thin film polarizers.

to the reference plane. Light waves whose plane of oscillation is inclined to these directions can be described as a p-polarized and an s-polarized part.

As can be seen from figure 1, the reflectivity for s-polarized light increases with increasing angle of incidence while the reflectivity for p-polarized light decreases first, reaches $R=0$ at "Brewster angle" and increases for angles of incidence beyond Brewster angle. In principle, the same is true for

dielectric mirrors. Thin film polarizers separate the s-polarized component of the light from the p-polarized component using the effect that the reflectivity for s-polarized light is higher and the reflection band is broader than for p-polarized light. Thus, there is always a wavelength range, where R_s is close to 100% while R_p is close to zero. Special coating designs are used to make this wavelength range as broad as possible and to maximize the polarization ratio T_p/T_s . Very low values of T_p (<0.5%) can be measured very exactly using a special cavity ring down setup. The TFP is inserted into a cavity thus introducing additional losses which are equal to $100\% - T_p$. Using this method one can also determine the most favourable AOI for each TFP.

Thin film polarizers (TFPs) are key components in a wide variety of applications, e.g. in regenerative amplifiers. LAYERTEC produces thin film polarizers on plane substrates (dimensions according to customer specifications) for wavelengths between 260nm and 2500nm. All TFPs are optimized for high laser induced damage thresholds. Although there's no certified measurement available, we know from several customers that the LIDT of a TFP is approximately one third of the LIDT of a high reflecting mirror for the same wavelength which is coated using the same technology.

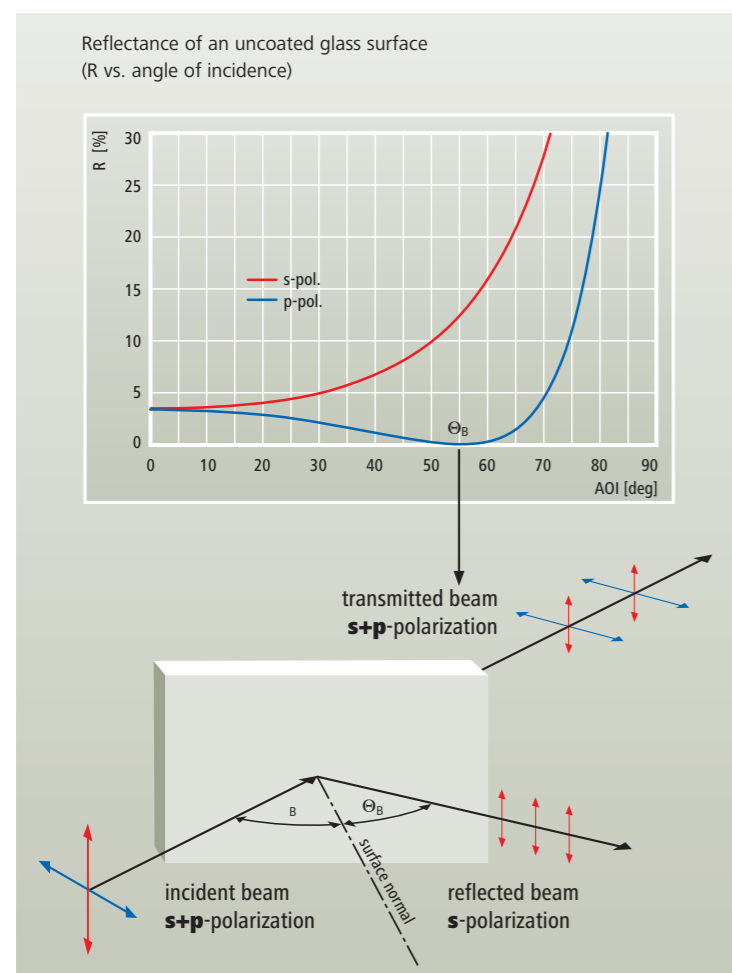


Figure 1: Explanation of the terms "s-polarized light" and "p-polarized light" and reflectance of an uncoated glass surface vs. angle of incidence for s- and p-polarized light

260 – 2500 nm

STANDARD THIN FILM POLARIZERS

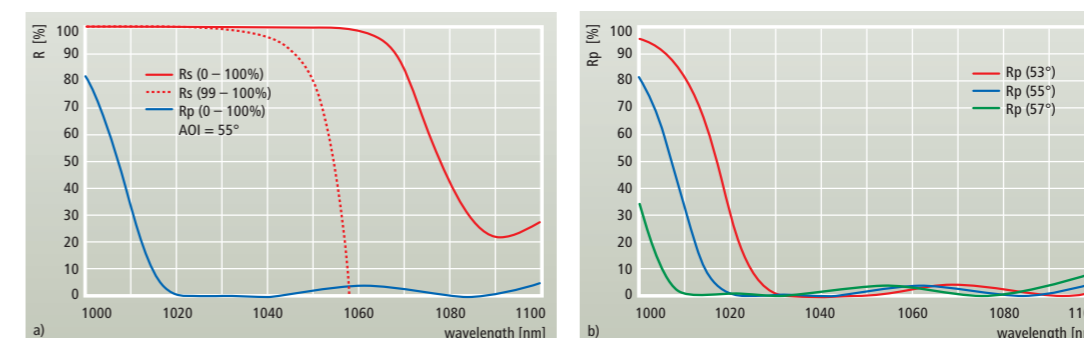


Figure 2: Reflectance spectra of a standard TFP for 1030nm and AOI = 55 (Brewster angle) for s- and p-polarized light (a), reflectance spectra of the same design for AOI = 53°, 55° and 57° (angle tuning lowers R_p at 1030nm from 0.25% to <0.1% thus giving the chance to optimize the polarization ratio)

- TFPs can be produced for AOI > 40°, but polarization is most efficient and appears in a broad wavelength range if AOI = 55° (Brewster angle) is used
- Typical polarization ratios T_p/T_s : standard: > 500 (AOI = 45° or 55°)
- An extended wavelength range of polarization which shows, however, a limited polarization ratio can be obtained by choosing AOI beyond Brewster angle
- Special designs with a polarization ratio of T_p/T_s up to 10000 are possible
- High laser induced damage thresholds (useful for intra cavity applications)
- It is favourable to design the laser so that the polarizers can be tilted by $\pm 2^\circ$ to adjust the polarizer for its best performance
- The standard design can be applied for wavelengths between 260nm and 2500nm (please see examples on pages 44 – 58)

SPECIAL THIN FILM POLARIZERS

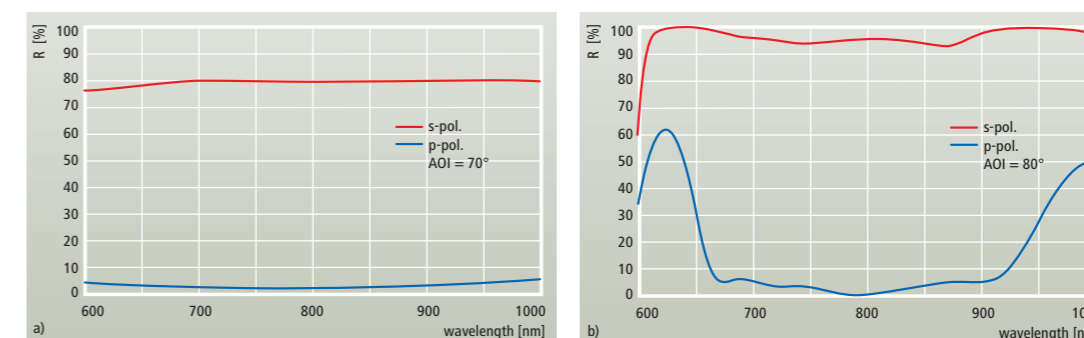


Figure 3: Broadband TFPs for the wavelength range of the Ti:Sapphire laser with different bandwidths and different polarization ratios, working at AOI = 70° (a) and AOI = 80° (b)

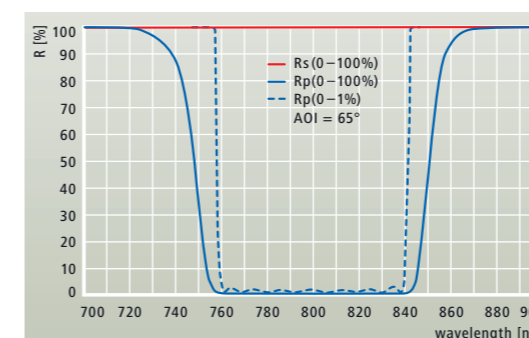


Figure 4: Broadband TFP for the 800nm region

This special design provides an extremely broad polarizing wavelength range (~10% of the centre wavelength) with $T_p/T_s = 300 \dots 1000$.

LOW LOSS OPTICAL COMPONENTS

HR MIRRORS

- $R > 99.99\%$ in the VIS and NIR spectral range
- $R > 99.999\%$ was demonstrated at several wavelengths between 1000 ... 1600 nm
- Mirrors with defined transmission (e.g. $T = 0.002\%$)
- For cavity ring down time spectroscopy it is favourable to adjust the transmission to the value of the scattering and absorption losses ($T = S + A$), see figure 1
- All mirrors for CRD experiments are delivered with rear side AR coating. Wedged substrates on request.
- Special polished plane and spherically curved fused silica substrates (see page 13)
 - rms - roughness: $\leq 1.5 \text{ \AA}$
 - Surface quality: 10-5 scratch-digs (MIL-O-13830), 5/1 x 0.016 (DIN 10110)
- Coating technique: magnetron sputtering, ion beam sputtering
- Optical parameters are stable against changes of temperature and humidity
- Attractive prices for small and medium numbers of substrates per coating run
- Very high reflectivities also for complex coating designs, e.g. GTI laser mirrors with $R > 99.95\%$ (see pages 82 – 83)
- Vacuum packaging or packaging under nitrogen cover gas in dust free boxes

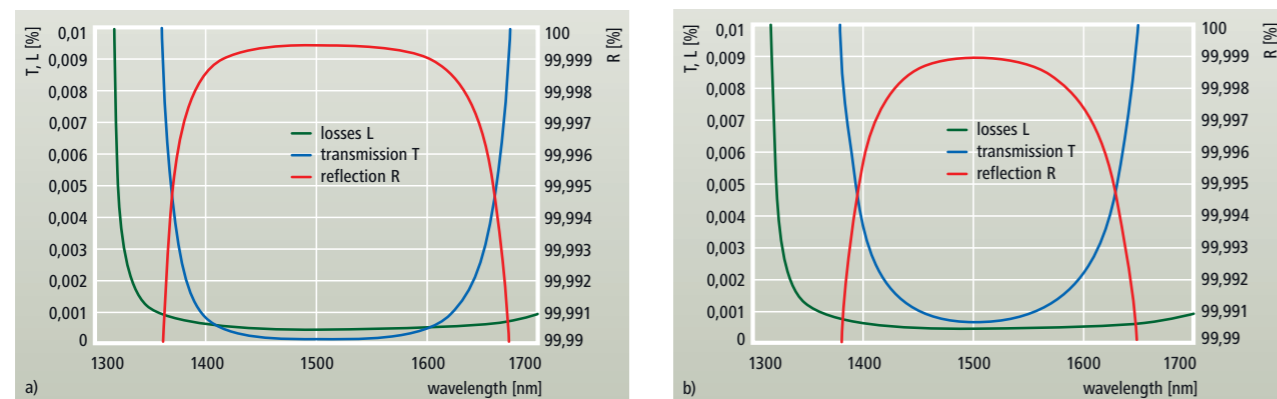


Figure 1: Reflectance, transmittance and loss spectra of low loss mirrors for 1550 nm, optimized for highest reflectance (transmission ~ 0) (a) and designed for $T \approx S + A$ (b)

Please note that the reflectivity of the mirrors in figures 1a and 1b is nearly the same. However, the extremely low

transmission of the mirror in figure 1a makes CRD measurements very difficult.

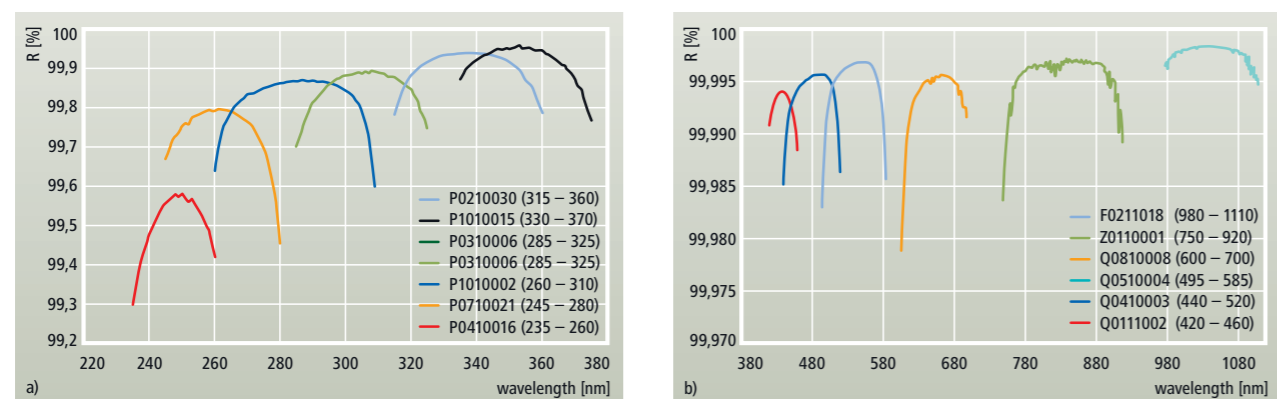


Figure 2: Reflectance spectra of a variety of low loss mirrors for the UV (a) and for the VIS-NIR spectral range (b); all measurements were performed at the CRD setup which is described on pages 26 – 28. Please note that these mirrors are specially designed for relatively high transmission.

Direct measurements of optical losses

Type of losses	VIS	NIR
Scattering	typical: 20–30 ppm measured: 15 ppm @ 633 nm*, 20–30 ppm @ 532 nm**	<10 ppm
Absorption	10–20 ppm***	<10 ppm***
Total	<50 ppm	<20 ppm

* Measurement performed at Jenoptik L.O.S. GmbH, Jena

** Measurement performed at Fraunhofer Institut IOF Jena

*** Measurement performed at Institut für Photonische Technologien (IPHT) e.V. Jena

CAVITY RING DOWN TIME MEASUREMENTS AND REFERENCE DATA

Wavelength	R [%]	T [%]	L [ppm] $L = 1 - R - T$	Measured at
266 nm	99.7	0.025	2750	LAYERTEC GmbH
320 nm	99.8	0.012	1880	Universität Jena, Germany
355 nm	99.98	0.005	150	LAYERTEC GmbH
405 nm	99.988	0.002	100	LAYERTEC GmbH
532 nm	99.994	0.001	50	LAYERTEC GmbH
633 nm	99.992	0.006	20	Westfälische Technische Hochschule Zwickau, Germany
660 nm	99.992	0.006	20	Universität Heidelberg, Germany
798 nm	99.995	0.003	10	LAYERTEC GmbH
1030 nm	99.9990	0.0002	8	LAYERTEC GmbH
1392 nm	99.9985	0.0007	8	TIGER OPTICS, USA (R measurement) Layertec GmbH (T measurement)
1550 nm	99.999	0.0002	8	IPHT Jena, Germany
2350 nm	99.995	0.002	30	University of Grenoble, France
3250 nm	99.928	0.012	600	University of Grenoble, France
4000 nm	99.9			Universität Bielefeld, Germany

Table 1: Reflectivity and transmission values of LAYERTEC low loss mirrors; Reflectance measured by Cavity Ring-Down time spectroscopy, AOI = 0°

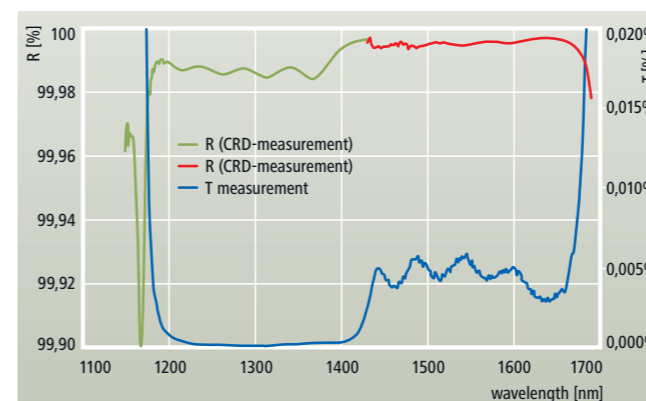


Figure 3: Reflectance and transmission spectra of a broadband mirror for the wavelength range 1100 – 1600 nm

COATINGS ON CRYSTAL OPTICS

Laser applications using crystal optics have reached a high standard in industry and research. Optical coatings on crystals are an essential part of modern laser designs and cover the wide range from single wavelength AR coatings on laser and nonlinear optical crystals up to complex multilayer coatings providing several high-reflectance and high-transmittance wavelength ranges and thus replacing external laser mirrors.

LAYERTEC has a lot of experience in coatings on laser crystals. Our coatings are used in industrial high power Q-switch and cw lasers of several laser manufacturers. The quality of coatings on crystals depends on the coating technique as well as on the surface quality of the crystal. All coatings are produced by magnetron sputtering thus showing very low straylight losses and a high thermal and climatical stability of the optical parameters.

The rapid progress in crystal growth techniques resulted in a wide variety of new crystals for laser applications, e.g. laser

crystals as several tungstanates and vanadates or nonlinear optical crystals as RTP. Every crystal requires optimized polishing procedures and coating techniques. Besides the optical properties, especially the thermal expansion coefficients and the surface quality after storage and transport influence the coating quality. Especially hygroscopic crystals like LBO or BBO require special pretreatments to achieve high damage thresholds and long lifetime of the coatings. Thus, coatings on new crystals always require experimental investigations to find the best coating procedures. Using the special LAYERTEC coating technology also coatings on crystals with extraordinary dimensions and difficult sizes are possible.

The following table gives an overview about the crystals which have already been coated at LAYERTEC and about the types of layer systems which have been tested successfully.

Crystal Type	AR/BBAR	single HR optional with HT	double HR/BBHR optional with HT
a-SiO ₂	x	x	x
BBO	x		
BIBO	x	x	
CaCO ₃	x		
CTA	x		
Nd:GdVO ₄	x	x	x
Nd:GGG	x	x	
Nd:Cr:GSGG	x	x	
KTA	x	x	
KTP	x	x	x
Yb:KGW, Yb:KYW	x	x	x
LBO	x		
LiNbO ₃	x		
LMA	x		
Nd:LSB	x	x	x
RDP	x		
Ruby	x	x	
Ti:Sapphire	x	x	
Spinell	x	x	x
Cr:YAG	x	x	
Er:YAG	x	x	
Ho:YAG	x	x	
Nd:YAG, Yb:YAG	x	x	x
Nd:YALO (YAP)	x		
YLF	x	x	x
Nd:YVO ₄	x	x	x
ZGP	x		
ZnSe	x	x	

340 – 3000 nm

Every coating run will be performed with detailed measurement data sheets. Do not hesitate to contact us for a discussion or an offer of your special coating problem.

COATINGS ON DOPED LASER CRYSTALS

Sputter coatings on laser rods, discs and slabs with

- High laser induced damage thresholds for critical industrial applications of Q-switch and cw lasers
- Low residual reflectivities (e.g. $R < 0.1\%$ at 808nm on Nd:YAG)
- Broadband and multiple wavelength AR coatings

- Complex HR and HR/HT-coatings for compact laser designs, (e.g. HR(532+1064nm)+HT(808nm) on Nd:YVO₄ for diode pumped and frequency doubled „green“ lasers)
- Coating of crystals with variable or extraordinary sizes and shapes
- Coating of the full aperture of small crystals

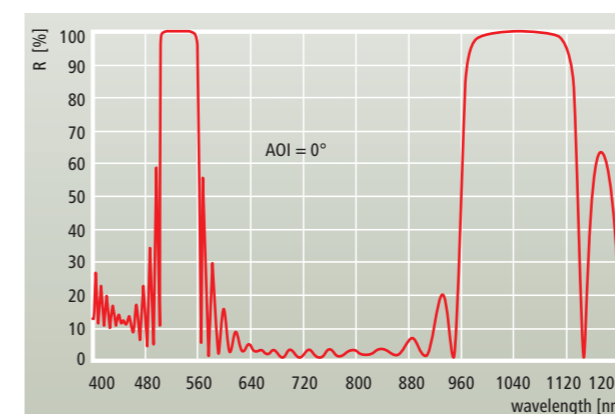


Figure 1: Calculated reflectance spectrum of a dual HR mirror for 532nm and 1064nm with a HT region around 808nm for pumping with a laser diode (on Nd:YAG)

COATINGS ON NONLINEAR OPTICAL CRYSTALS

- AR coatings even on slightly hygroscopic nonlinear optical crystals (e.g. LBO)
- Broadband and multiple wavelength AR coatings
- Complex HR and HR/HT-coatings for compact laser designs, (e.g. HR(1064nm) + HT(532nm) on KTP for frequency doubled Nd:YAG or Nd:YVO₄ lasers)

- Coating of crystals with variable or extraordinary sizes and shapes
- Coating of the full aperture of small crystals

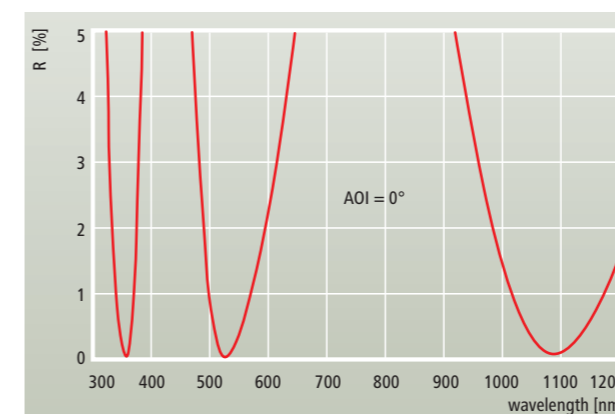


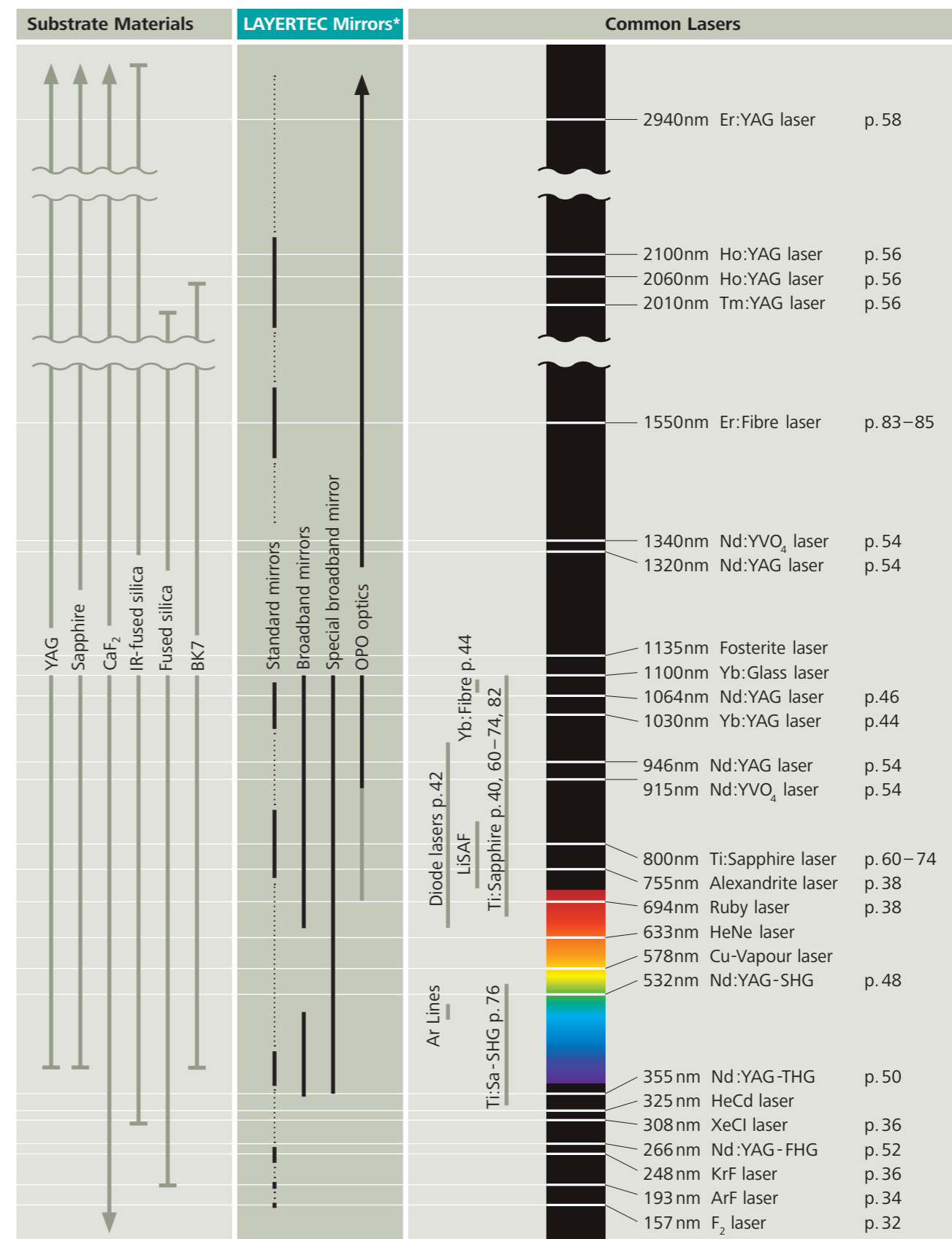
Figure 2: Calculated reflectance spectrum of a triple AR coating for 355nm, 532nm and 1064nm on LBO

REGISTER

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Yb:YAG	44–45, 100

LAYERTEC MIRRORS



*Bandwidths of selected LAYERTEC mirrors

Interference Optics



The plumage colours of some kinds of hummingbirds result from interference effects. These effects are also the active principle of optical coatings.

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