

Thin Film Polarizers

Description

Polarizers are used in polarization separation. In addition to both common Glan Taylor polarizers made of calcite or α -BBO and cube polarizers, so-called thin film polarizers based on glass substrates are used for the highest of all power densities.

Features / Characteristics

Compared to other common types of polarizers (such as Glan Taylor, Cube Polarizers, ...) the thin film polarizers have some different features and characteristics:

- **LIDT:**
Thin film polarizers are suitable for very high power. Although TFP's can stand high power it is not easy to give general LiDT-values as those values strongly depend on:
 - the type of TFP
 - the chosen coating technology
 - the complexity of the design
 → for LiDT-values please contact our sales team.
In general it can be said, that LiDT-values for s-pol are higher than for p-pol
- **Less Material:**
Less material in transmission compared to other polarizers. This can be an advantage regarding bulk absorption and dispersion.
But a beam offset for transmitted p-pol beam has to be considered.
- **Extinction Ratio:**
The extinction ratio is smaller than for other types of polarizers.
To increase extinction ration it is possible to adjust the TFP's to the optimum angle.
- **Types of TFPs:**
There are different types of thin film polarizers:
 - adjustment free thin film polarizers
 - broadband thin film polarizers
 - 45° thin film polarizers
 → for more detailed characteristics: see chapter "Specifications and Simulations"



- **Wavelength:**
LASER COMPONENTS can manufacture TFPs in the range of 355 nm – 2.1 μm .
Normally the TFPs are working well for one wavelength. But there are techniques to expand the wavelength range (broadband polarizers, polarizers for different wavelength, see below).

Applications

Thin film polarizers are used to separate the polarization states of light waves. They can also be used to combine the radiation of different sources with the same wavelength but different polarization. These optics are well suited for high laser powers and UV wavelengths. A common application is for laser attenuation in combination with waveplates.

Specifications and Simulations

Adjustment-free Thin Film Polarizers

LASER COMPONENTS offers adjustment-free thin film polarizers with a consistently high extinction ratio for the entire AOI-range of $56^\circ \pm 2^\circ$.

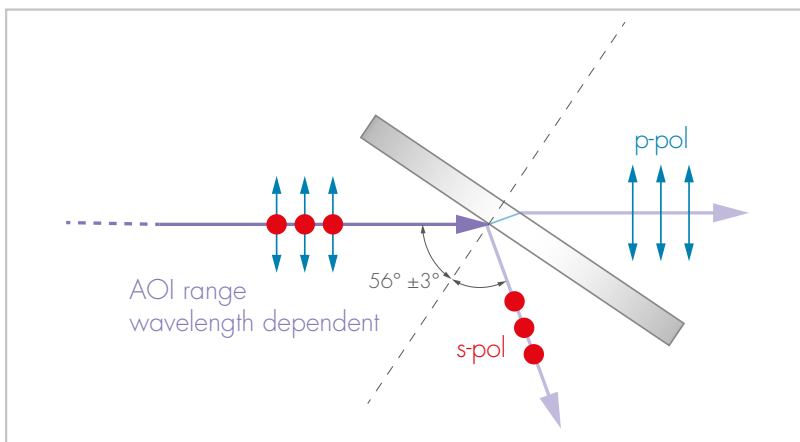


Fig. 1: Adjustment-free Thin Film Polarizer

Function

Ideally, adjustment-free thin film polarizers should be installed at the Brewster angle at approximately 56° to achieve an extinction ratio without having to adjust the incident angle. The components introduced above are equipped with a dielectric coating on one side. This special coating features a high reflection of s-polarized light at a simultaneously high transmission of p-polarized light. Because these polarizers are used at the Brewster angle, the back side does not need to be coated.

An anti-reflection coating on the rear side is not necessary. The polarizer can only be used in one direction along the optical axis. Due to the TFP coating on the front side a good extinction ratio can be achieved.

Specifications

Angle of incidence	AOI = $56^\circ \pm 2^\circ$ No adjustment necessary.	
Reflection	$R_s > 99,5\%$	
Transmission	532; 1064 nm:	$T_p > 97\%$
	355 nm:	$T_p > 93\%$
	On average at an angle of $54^\circ - 58^\circ$	

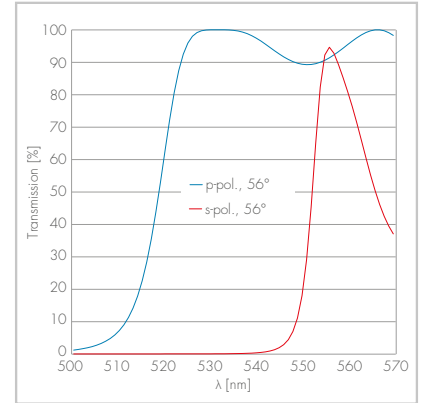


Fig. 2: TFPB-532; AOI 56° ; IBS

Broadband Plate Polarizers

The dispersion-free, broadband thin film polarizer, TFPK, is available for applications with ultrashort pulse lasers. These polarizers have a very high spectral bandwidth of over 150 nm, but at the cost of the extinction ratio.

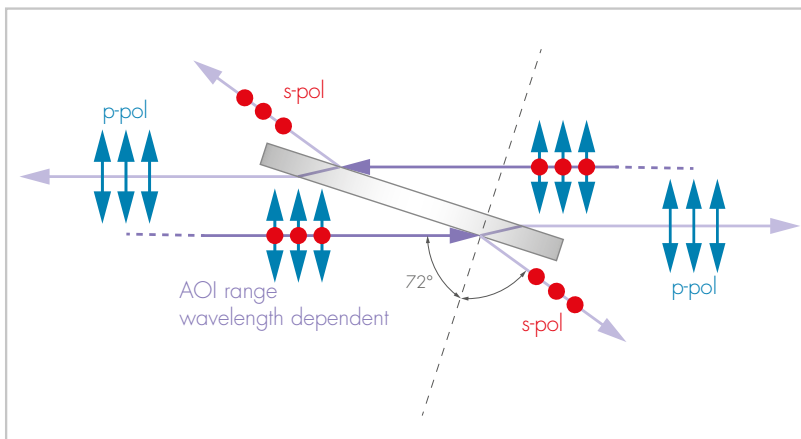


Fig. 3: Broadband Thin Film Polarizers

Function

The plate polarizers are assembled at an angle of $\approx 72^\circ$ to the incident beam.

Specifications

Angle of incidence	$72^\circ \pm 2^\circ$ To reach the best possible extinction ratio, the angle has to be adjusted within this range.
Transmission	$T > 98\%$ per surface for p-pol
Reflection	$R > 75\%$ per surface for s-pol Higher values can be reached in reflection; however, this increase causes the transmission value to decrease for p-pol light.

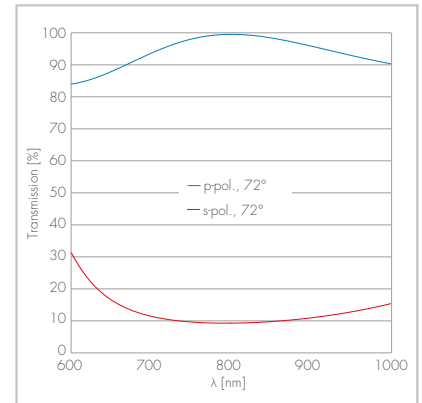


Fig. 4 : TFPK-800 one side only; AOI 72°; e-beam

Broadband plate polarizers with low dispersion are particularly well-suited for polarization separation of broadband systems such as Ti:sapphire fs lasers. They are coated on both sides and can therefore be used in dual directions.

For the system development it is important to keep in mind that the p-polarized beam is slightly offset and that the s-polarized beam is deflected by $\approx 144^\circ$.

The coating for broadband plate polarizers has been optimized for low dispersion, similar to the cw/fs-coatings.

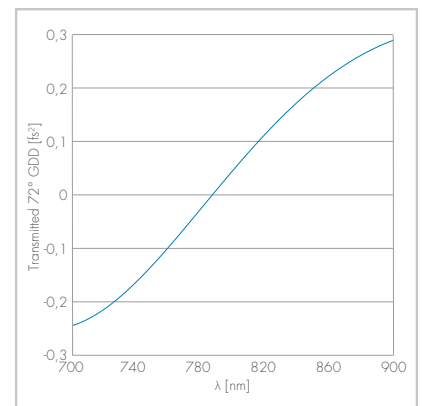


Fig. 5: GDDp-T for TFPK-800; AOI 72°; e-beam

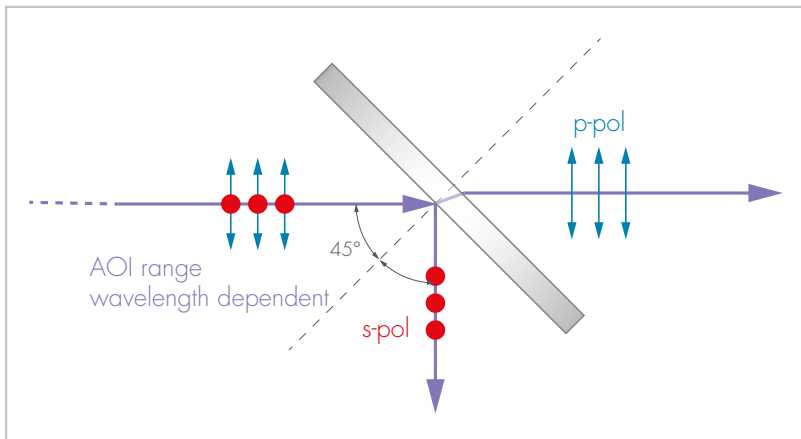
Special Thin Film Polarizers

LASER COMPONENTS manufactures also customized thin film polarizers that are suitable for your individual application. Pretty common are thin film polarizers @AOI = 45°, but also thin film polarizers for two or three wavelengths as well as TFP'S which combine with other optical functions are possible.

Please find some examples in the following text.

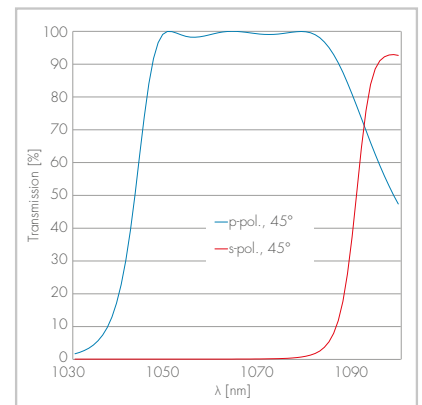
Example 1:**45° Thin Film Polarizers**

Polarizers for an angle of incidence (AOI) of 45° can be easily integrated into optical setups. In a 45° thin film polarizer the s-pol beam is deflected by 90°. Thus, standard mounts can often be applied. These special optics are typically manufactured with an AR coating on the rear side, since their AOI does not correspond to the Brewster angle.

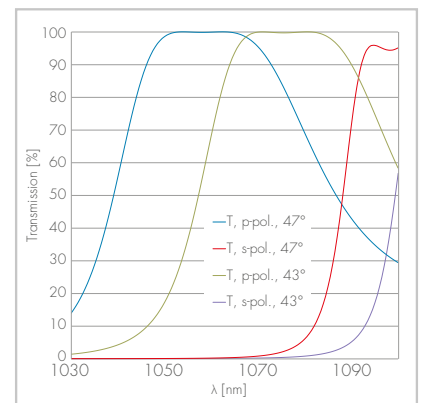
**Fig. 6:** 45° Thin Film Polarizer**Function**

These polarizers are used at an angle of incidence of 45°. This facilitates a simple and often inexpensive system setup: Since the reflected s-pol beam is deflected by 90°, standard mounts for 90° bending mirrors can be used.

The back side of 45° polarizers features an AR coating that is optimized for p-pol.

**Fig. 7:** TFPB-1064-45; at 45°; IBS**Specifications**

Angle of incidence	45 ± 1° No adjustment is necessary.
Reflection	1064 nm: $R_s > 99.5\%$
Transmission	1064 nm: $T_p > 95\%$
Standard wavelengths	1064 nm Further wavelengths are available upon request.

**Fig. 8:** TFPB-1064-45; at AOI 43° and 47°; IBS

Example 2:**Thin Film Polarizers for more than one wavelength**

LASER COMPONENTS also manufactures thin film polarizers for two or three wavelengths.

For Example Polarizers for 3 wavelength (and AOI = 45°)

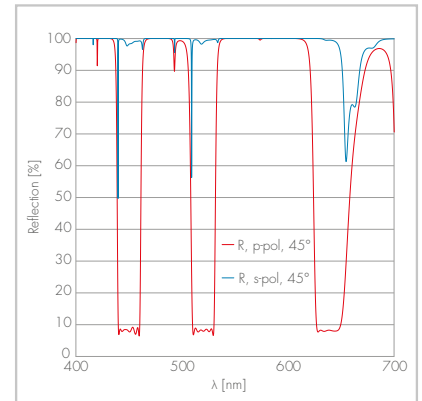


Fig. 9: TFPB 450+520+640 45° IBS1

Example 3:**TFP+HR - Thin film polarizers that combine with additional high reflective wavelength range**

Upon request, we also check the possibilities of integrating other optical functions into your thin film polarizers - for example, additional HR or HT areas or a beam splitter function.

Example: 3035618 - TFPB-1572HR1064/55/CAR

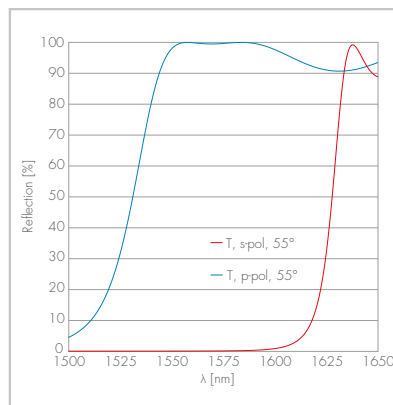
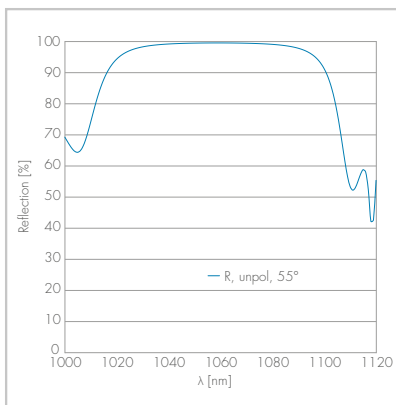


Fig. 10: TFPB-1572HR1064 55° IBS1, u-pol spectral range 1000 – 1120nm
 Fig. 11: TFPB-1572HR1064 55° IBS1, s+p-pol spectral range 1500 – 1650nm

Good to Know

- Beam offset for transmitted p-pol beam
- LiDT for s-pol is higher than for p-pol
- Higher extinction rate possible if you have fixed angles of incidence
- Trade Off between TFP's at Brewster angle and 45°-TFP's:

	TFP 56°	TFP 45°
Handling	- s-pol is reflected at 112°	+ s-pol is reflected at 90°
Extinction ratio	+ typ. 300:1	- typ. 200:1
Losses	+ no losses for transmitted p-pol at back side	- more losses at back side, AR coating needed
LiDT	+ coating design is easier -> higher LiDT values achievable	- more complex coating design -> lower LiDT

Customization:

We manufacture customized thin film polarizers that are suitable for your individual application. For a request for special thinfilm polarizers here is a list of specifications we need to know:

- Wavelength
- Angle of incidence
- Tp[%] at which wavelength
- Rs[%] at which wavelength
- Additional reflection?
- Additional transmission?
- Additional other function (BS, ...)
- Laser data (energy density, pulse duration, rep. rate) for s-pol and for p-pol ...

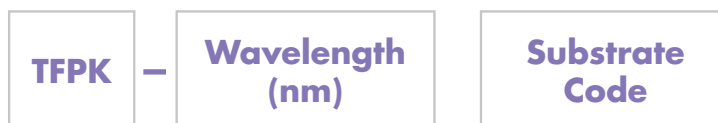
Just fill out the online request or contact us by e-mail or phone.

<https://www.lasercomponents.com/de-en/request/requestform-laser-optics/>

Product Code



For example: TFPB-1064 RW28.6-14.3-3.2C thin film polarizer high power, IAD1



For example: TFPK-800 RW180-60-20UV, broadband low disp.polarizer 180 x 60 mm IAD2