Technical Brief #3

Polarizers

This note is one of a series of technical briefs developed from customer FAQs and intended to answer the majority of questions concerning the operation of Phoenix products. They are targeted at engineers to assist in incorporating Phoenix products into designs. Any detailed technical questions should be forwarded to Phoenix support.

What is a polarizer?

Polarizers filter the **State Of Polarization** (SOP) of the light allowing one polarization mode to pass with virtually no loss whilst the orthogonal mode is highly attenuated.

Polarizers can be used to generate a pure state of polarization from a randomly unpolarized source or they can be used to analyze the SOP of an optical beam by selecting a single state.

Principle of operation

Phoenix Photonics polarizers are based on evanescent field interaction. A small length of cladding is removed and replaced by a material that preferentially attenuates one linear polarization mode in the fiber.

The degree of attenuation depends on:

- The overlay material
- The amount of cladding removed, i.e. level of interaction with the evanescent tail
- Length of fiber over which the interaction occurs
- Fiber parameters

Careful control of each of these parameters enables flexible design of a linear all fiber polarizer.

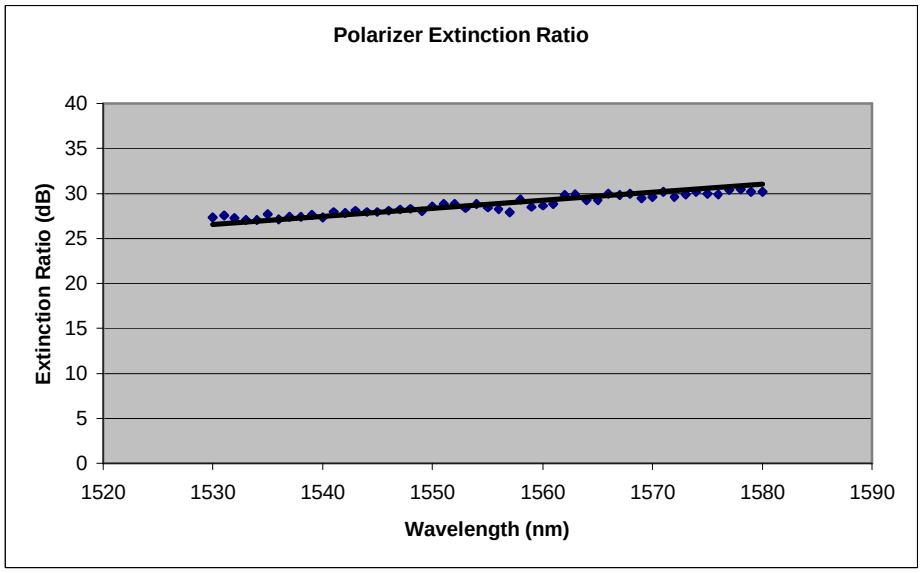
Single mode - single mode (SM/SM) polarizers

The fundamental element for all Phoenix polarizers is the single mode fiber polarizer. The device is fabricated directly onto the single mode fiber, without splices, giving a very low loss and high extinction ratio.

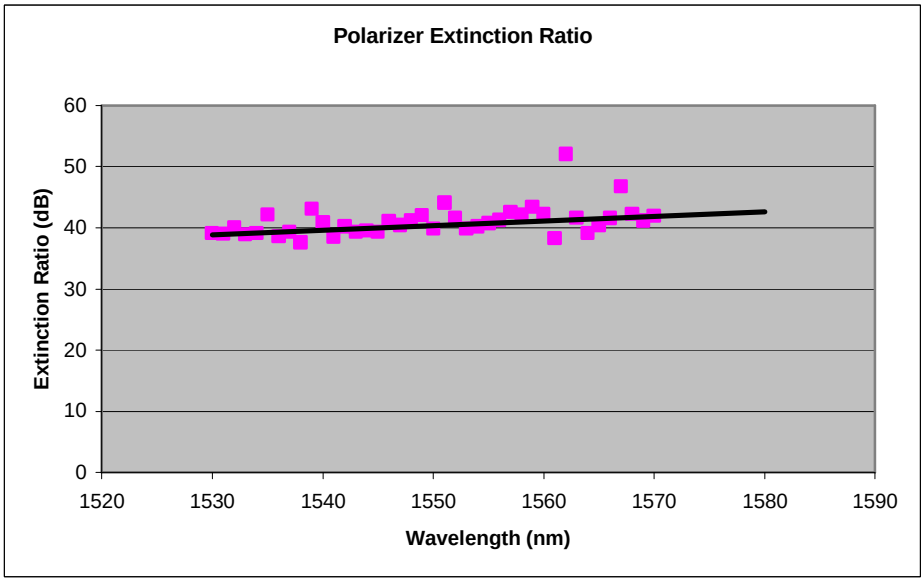
The polarizer is a modal filter transmitting an essentially linear state of polarization, however the intrinsic birefringence of the fiber leads changes the SOP before and after the polarizing section.

In general, **Polarization Dependent Loss** (PDL) is a measure of the ratio of the minimum and maximum power throughput of an element when addressed by all SOPs. For the SM/SM polarizer the PDL is the **Extinction Ratio** (ER) of the component.

The wavelength response for a typical 25dB polarizer is shown below. The points are actual data and the solid line shows the gradient and the typical response of evanescent field device with increasing ER as wavelength increases. Gradient is in the range 0.06dB/nm to 0.09dB/nm.



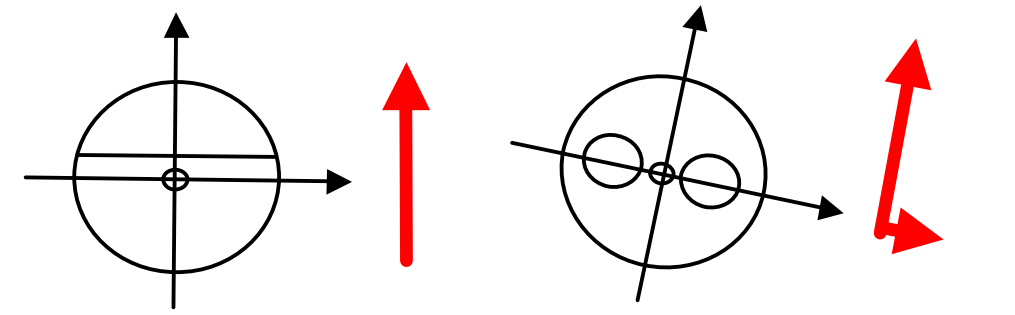
Phoenix engineers have modeled the evanescent field interaction and the graph below shows measured data (points) and data generated from the theoretical model (solid line) showing close correlation.



Single mode – polarization maintaining fiber (SM/PM) polarizers

The polarizer is fabricated on the single mode fiber and the PM fiber is aligned with one of its axes parallel to the polarizer axis and fusion spliced into position. The Phoenix method of fabrication ensures that the SOP cannot change between the polarizing section and the PM fiber.

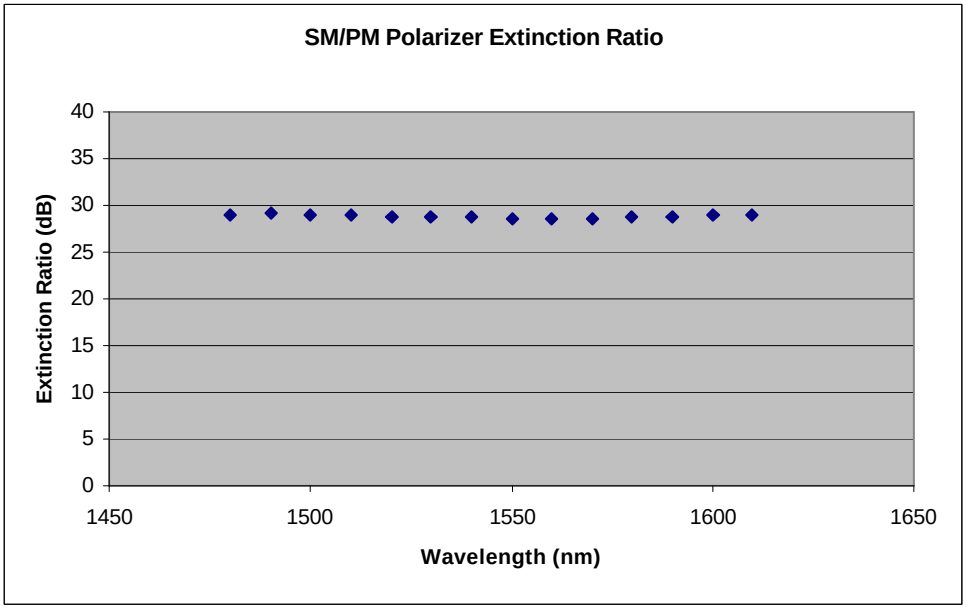
The ER of the polarizing element and the axis alignment of the PM fiber determine the extinction ratio of these devices. In this case the PDL measurement is not equivalent to the ER specification, the extinction ratio is defined as the ratio of the power output between the two PM fiber axes.



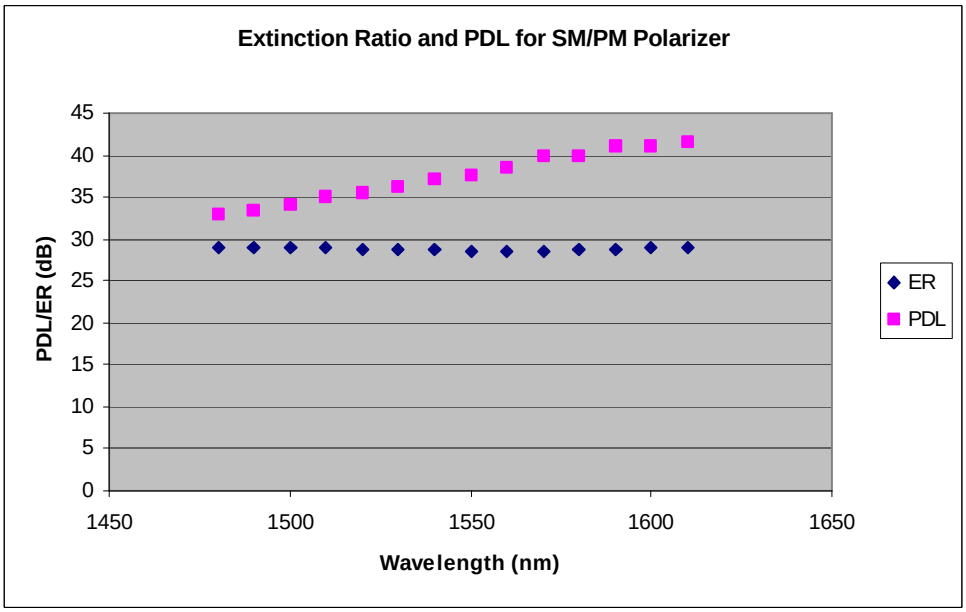
SM polarizer defining high ER linear polarization state.

Slight angle misalignment at splice causes some power to be launched into orthogonal axis of the PM fiber.

The plot below shows actual data from a medium performance SM/PM polarizer. Variation of measured ER is 0.3 dB across the band from 1480 nm to 1610nm.



The difference between the PDL and the ER for an SM/PM polarizer is illustrated below.



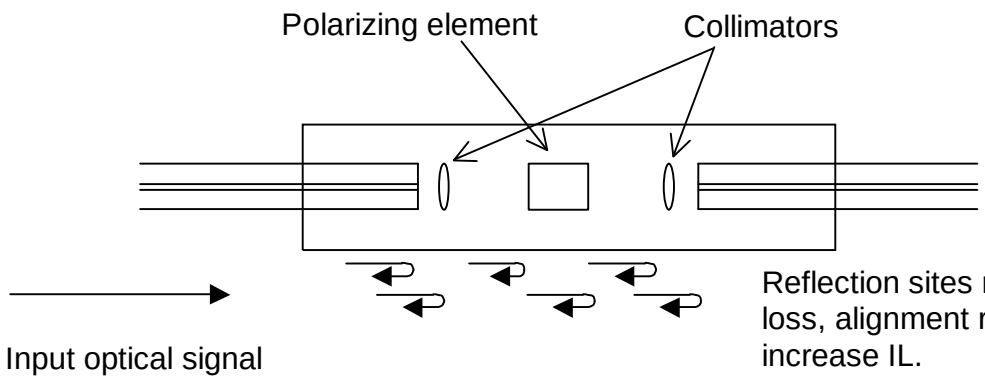
Polarization maintaining fiber – polarization maintaining fiber (PM/PM) polarizers

This range of polarizers is fabricated using the basic polarizing section and attaching two PM fiber tails. The overall ER is determined primarily by fiber alignment and can be different in each direction.

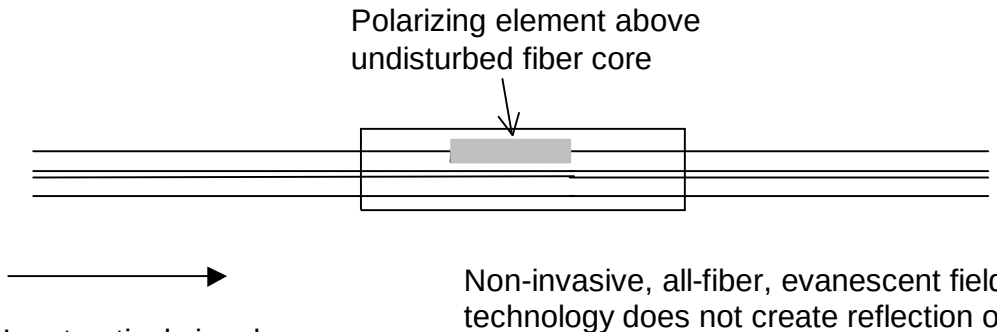
All fiber benefits

The key to an all fiber component is that the transmission path, the fiber core, is not interrupted, which preserves the low loss performance of the optical fiber.

The fundamental difference between the all-fiber, evanescent field polarizer and alternative 'core invasive' hybrid devices is illustrated below.



Reflection sites reduce return loss, alignment requirements increase IL.



Non-invasive, all-fiber, evanescent field technology does not create reflection or absorption sites, increasing return loss and reducing insertion loss. Simple construction easies manufacture.