

New...IR Polarization Rotator, Page 4

2020



IR & Vis Isolators



IR & Vis Polarizers



IR & Vis Coupling Lenses



IR & Vis Fiber Collimators





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Mid-IR Isolators

Our **Mid-IR Optical Isolators** eliminate the annoying effects of feedback in quantum cascade laser applications and systems, operating at specific wavelengths from 4 μm to beyond 14 μm .

Standard wavelengths in stock are:

4.5 μm , 8.0 μm , 10.6 μm

These can be tuned more than $\pm 10\%$ of center λ

Other wavelengths available. Please inquire.



It's the IR that makes IR isolators difficult. The critical component in any isolator is the magneto-optic material that performs the rotation of the plane of polarization in the magnetic field. Whereas in the VIS and NIR there are many candidate magneto-optic materials, in the infrared the choices are greatly reduced. In our Mid-IR Isolators we utilize a very small family of highly specialized materials that demonstrate low absorption and acceptable Verdet Constant at the wavelength of operation.

The other critical component is the polarizer, and again, there are few choices in the infrared. See **POLARIZERS** (pages 5-6) for descriptions of our **IR Polarizers**.

Escape Window option allows monitoring of feedback that is rejected by the Isolator. When ordering, specify Escape Window on Input or Out-put Polarizer.

Catalog Number	Aperture	Transmittance	Isolation	Total Length	Power Rating
FIO-5- λ	4.5 mm	75-86%	$\gg 1000:1$	~ 6 "	inquire

λ : When ordering, specify wavelength between 4 μm and 14 μm .

Temporarily not available

4.5 μm Isolators, 4 mm aperture

This high performance, utility-sized Isolator economizes on space requirement while utilizing novel design features that greatly reduce production costs, thus enabling a selling price that is far below competing products. Inquire.

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FEATURES

Temporarily not available

Wavelength Tunable +/-10%
Transmission 75% to 86%
Isolation 10,000:1 (40 dB)

Other wavelengths available in utility-sized package.



The high transmission, high extinction polarizer is a size-reduced version of our PGC-5 WideBand IR Polarizer (see page 6). This Polarizer is characterized by extremely low insertion loss and extremely high extinction ratio.

<u>Catalog Number</u>	<u>Aperture</u>	<u>Transmittance</u>	<u>Isolation</u>	<u>Length</u>	<u>Power Rating</u>
FIO-4-4.5	4.0 mm	75-86%	>10,000:1	~ 2"	Discuss

WideBand IR POLARIZER 2 μm – 12 μm

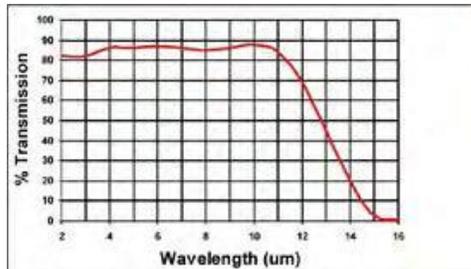
InnPho's unique **Wideband IR Polarizer** utilizes two precision polished Germanium plates at Brewster's angle in "chevron" orientation. Low deviation, <10 seconds, with very high extinction and transmittance.

Cell length, 2.2". See also **ShortCell IR Polarizer** below.

<u>Catalog Number</u>	<u>Aperture</u>	<u>Transmittance of P-Ray</u>	<u>Power Rating</u>	<u>Extinction of Crossed Pair</u>
PGC-4	4 mm	≥ 98%	100 MW/cm ²	2x10 ⁵
PGC-5	5 mm	≥ 98%	100 MW/cm ²	2x10 ⁵
PGC-4	15 mm Diameter x 36 mm long			
PGC-5	1-inch long x 2.2 inches long			

ShortCell IR POLARIZER 3 μm – 11 μm

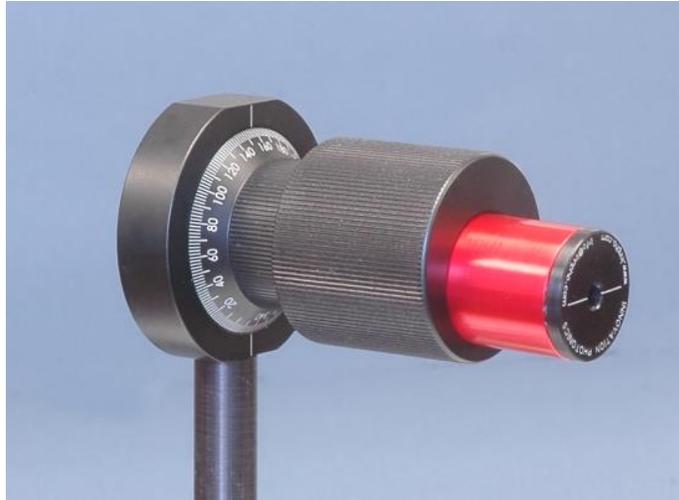
InnPho's **ShortCell IR Polarizer** is used when short package length is important. Because of the delicacy of wire-grid polarizers, we have improved the mounting cell so that the hyper-delicate grid coating is protected from external contact. Cell is 12 mm thick.



<u>Catalog Number</u>	<u>Aperture</u>	<u>Transmittance</u>	<u>Extinction of Crossed Pair</u>	<u>Power Rating</u>
PSP-5	5 mm	70%	100:1	Discuss

INFRARED POLARIZATION ROTATOR

Broadband Achromatic, VIS to 9 μm *
***10.6 μm under development**



Continuous Rotation Manual Control Rotary Scale Readout 0°- 360°

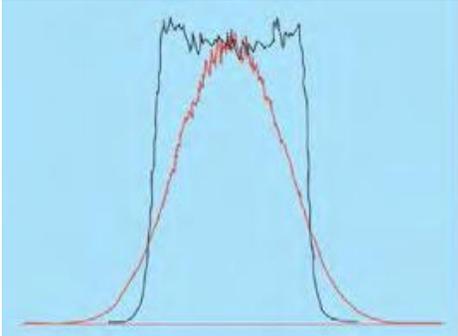
- Rotates POP (Plane of Polarization) to any angle.
- Continuous Transmission VIS to 9 μm
- Coaxial Input-Output beams

<u>Number</u>	<u>Description</u>
RF- 4	Infrared Polarization Rotator
RF-1/2	1/2-Wave, Double Fresnel Rhomb, mounted
RF-1/4	1/4-Wave Fresnel Rhomb, mounted

Contact InnPho for more information.

Flat-Top Beam Expander

InnPho's Flat-Top Beam Expanders convert a Gaussian laser beam input into an output that has a flat-top profile. The conversion is caused by an Engineered Diffuser™, manufactured by RPC Photonics, Inc.



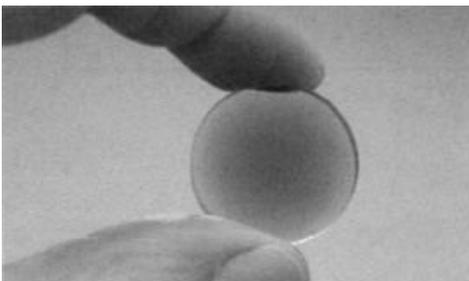
- Spectral Range 350 nm to 2 μ m
- Cross section uniformity \pm 5-10% (neglecting speckle)
- Laser damage threshold 20 J/cm², 1054 nm, 1 ns pulse

Optimum performance of the apodizing element (Engineered Diffuser™) is achieved when the input beam diameter is 3-4 mm, using our GCE-9.

Part

<u>Number</u>	<u>Description</u>
ELG-10- λ	Flat-Top Beam Expander, 10 mm dia collimated output
ELG-20- λ	Flat-Top Beam Expander, 20 mm dia collimated output
ELG-45- λ	Flat-Top Beam Expander, 45 mm dia collimated output
GCE-9	Flat-Top Converter element, mounted

λ : When ordering, specify wavelength for AR coatings.



GAUSSIAN COMPENSATING PLATE

See www.innpho.com for update on Our Gaussian Compensating Plate.

Catalog

<u>Number</u>	<u>Dimensions</u>
WCG-25	1" dia x 1/4" thick
WCG-51	2" dia x 1/4" thick

FIBER-OPTIC COUPLING LENSES

Coupling Lenses for VIS-NIR

InnPho's Fiber-Optic Coupling Lenses are mounted in the industry standard **RMS Threaded Mount** favored in most laboratories. Transmittance of these AR-AR coated Lenses exceeds 96% at the peak wavelength. Performance is diffraction limited when Maximum Beam Diameter is not exceeded; see below.

<u>Catalog Number</u>	<u>Focal Length</u>	<u>Working Distance</u>	<u>Numerical Aperture</u>	<u>Maximum Beam Dia</u>	<u>Magnification</u>
LFO-2-4- λ	4.0 mm	3.6 mm	0.19	1.5 mm	40X
LFO-2-6- λ	6.0 mm	5.2 mm	0.17	2.0 mm	27X
LFO-2-9- λ	9.0 mm	8.1 mm	0.50	2.0 mm	18X
LFO-3-12- λ	12.0 mm	10.9 mm	0.30	2.5 mm	13X
LFO-3-15- λ	15.0 mm	13.4 mm	0.53	2.5 mm	11X

Antireflection Coatings

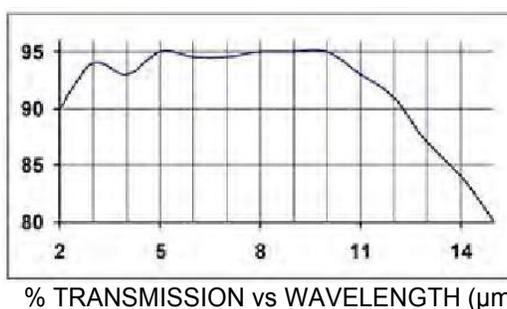
<u>Max T Spectrum</u>	<u>Order as</u>
380 - 640 nm	- VIS
600 - 990 nm	- NIR
970 - 1100 nm	- YAG
1100 -1550 nm	- IR
1.9 - 2.15 μ m	- HoYAG



MID-IR FOCUSING OBJECTIVES 2 μm to 12 μm

InnPho's Mid-IR Focusing Objectives are designed for maximum efficiency in coupling the output from a mid-IR source into single-mode or multimode IR transmitting fibers.

- ZnSe MicroLens
- AR-AR in Mid-IR
- Diffraction limited
- Easy alignment using HeNe
- Mounting RMS thread
- 2 μm to 12 μm



<u>Catalog Number</u>	<u>Clear Aperture</u>	<u>Numerical Aperture</u>	<u>Working Distance</u>	<u>Focal Length</u>
LFO-5-6	5 mm	0.25	5.3 mm	6 mm
LFO-5-12	5 mm	0.13	11.5 mm	12 mm
LFO-5-18	5 mm	0.08	17.5 mm	18 mm

-----FOCAL SPOT DIAMETER (μm)-----

<u>Beam Dia (mm)</u>	<u>Focal Length (6, 12, 18 mm)</u>								
	<u>6</u>			<u>12</u>			<u>18</u>		
2.0 mm	15	30	46	23	46	69	30	61	91
3.0 mm	14	20	30	15	30	46	20	41	61
4.0 mm	32	15	23	32	23	34	32	30	46
	$\lambda = 4 \mu\text{m}$			$\lambda = 6 \mu\text{m}$			$\lambda = 8 \mu\text{m}$		

TRANSMISSION

The ZnSe lens in LFO-Series Objectives is Broadband AR (BBAR) coated on both sides. Transmission from 2 μm to 12 μm is 90% to 96%. See graph above.

FIBER-OPTIC COLLIMATORS

Twist-On Collimators for VIS-NIR (425 nm - 1550 nm)

Twist-On Collimators connect quickly to FC or SMA connectorized fiber cables to produce a collimated beam.

Twist-On Collimators contain a micro lens that is designed for diffraction-limited performance. Both surfaces of the lens are antireflection coated, with >98% transmission at the peak wavelength.

Focal compensation for different wavelengths is achieved by a simple hand adjustment of the fine-threaded spring loaded focusing barrel.



<u>Catalog Number</u>	<u>Focal Length</u>	<u>Output Beam Diameter</u>	<u>Clear Aperture</u>	<u>Numerical Aperture</u>
FCC-2- λ	2 mm	0.5 mm	1.5 mm	0.30
FCC-5- λ	5 mm	1.0 mm	2.3 mm	0.25
FCC-8- λ	8 mm	1.6 mm	3.3 mm	0.22

λ : When ordering, specify wavelength for AR coatings

Twist-On Collimators are available with a choice of different focal length Lenses as follows:

<u>Connector</u>	<u>Focal Length</u>	<u>Fiber Type</u>	<u>Best Collimation Distance at</u>
FC	2 mm	SM	2 cm to 50 cm
FC	5 & 8 mm	SM	5 cm to 1 m
SMA	5 & 8 mm	MM	1 cm to 2 m

MID-IR FIBER COLLIMATORS

MID-IR Collimators for SMA Connectors (2 μm to 12 μm)

The same AR-AR coated ZnSe micro-lens used in our **Mid-IR Focusing Objectives** (see page 11) is used in our **Mid-IR Collimators**. These are designed to connect to SMA connectorized IR fiber cables.

Our **Mid-IR Collimators** are focusable so as to compensate for different wavelengths. These are available “as is” or mounted in the 1-inch diameter Cell, which in turn mounts into our any 1-inch laboratory X-Y stage.



Catalog Number	Focal Length	Clear Aperture	Numerical Aperture
FCR-6- λ	6 mm	0.5 mm	0.25
FCR-12- λ	12 mm	1.0 mm	0.13
FCR-18- λ	18 mm	1.6 mm	0.08

λ : When ordering, specify wavelength for AR coatings.

A comment on Numerical Aperture...think of the NA of the fiber as a cone or a funnel...if the light rays are at an angle that is smaller than the cone angle, the light will get through the fiber.

$$2NA = d/f \quad d = \text{laser beam diameter, } f = \text{focal length of lens}$$



IR Fiber Cables

InnPho IR Fiber Cables are complete from **laser in** to **collimator out**. On the input end of an **IR Fiber** is a fully adjustable and stable **InnPho Laser Port** that can attach to a laser or mount remotely to provide stable coupling of the laser output into the **IR Fiber Cable**. On the output end is a focusable **InnPho Collimator** that contains an AR coated ZnSe micro-lens (see Page 10).



<u>Core Diameters (μm)</u>	<u>Spectral Range</u>	<u>Standard Lengths (m)</u>
Chalcogenide: 100 μm	1.5 – 6.0 μm	0.5, 1.0, 1.5, 2.0 meter
Hollow Core: 300, 1000 μm	2.5 – 12.0 μm	0.5, 1.0, 1.5, 2.0 meter

IR FIBER CABLES, complete from input to output, SMA

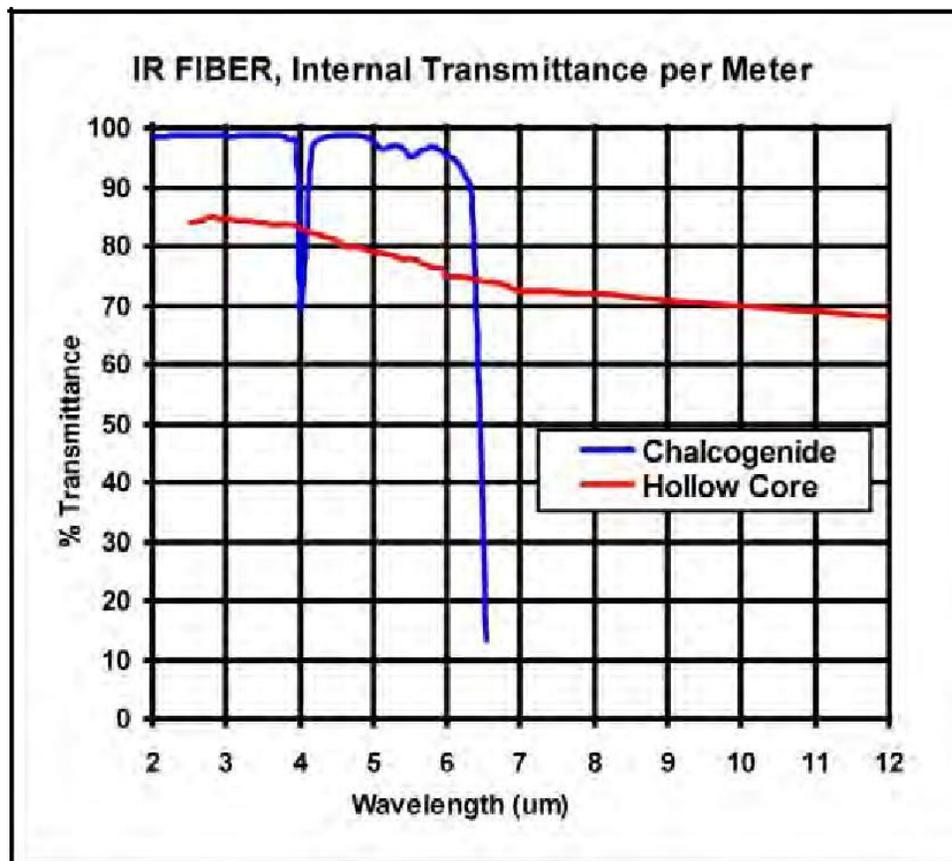
<u>Catalog Number</u>	<u>Description</u>	<u>Core Diameter (μm)</u>
FCM-C-100- <i>l</i>	IR Fiber Cable, chalcogenide	100 μm
FCM-H-300- <i>l</i>	IR Fiber Cable, hollow core	300 μm
FCM-H-1000- <i>l</i>	IR Fiber Cable, hollow core	1000 μm

l: When ordering, specify Length (meters), for example, FCM-H-1000-1.5.

See CHARACTERISTICS next page

IR Fiber Cables, characteristics

InnPho IR Fiber Cables are available in **chalcogenide core** or **hollow core**, depending upon the wavelength of operation. See below.





Terms & Conditions

TERMS & CONDITIONS apply to any Order for the delivery of goods, supplies or products manufactured and/or sold by INNOVATION PHOTONICS, or for services, whether (a) "custom" (specially manufactured to INNOVATION PHOTONICS or customer design and specifications), (b) "semi-custom" or modification of a standard or off-the-shelf product, or (c) at the discretion of INNOVATION PHOTONICS, to be subject to these T&C, whether standard, off-the-shelf product or otherwise.

In confirming Orders with INNOVATION PHOTONICS, Inc., customers hereby accept INNOVATION PHOTONICS "**TERMS & CONDITIONS**".

1. INNOVATION PHOTONICS accepts Purchase Orders by mail, e-mail or fax. Telephone orders are accepted, but must be followed with hard copy by mail, e-mail or fax. In addition to normal information, the following is required on all orders:

- INNOVATION PHOTONICS Quotation Number or catalog reference
- Customer Contact: Name, Phone, fax, e-mail

2. **MINIMUM ORDER** is \$200 on account.

3. **PAYMENT TERMS** are net 30 days from the date of invoice. LATE PAYMENT INTEREST of 2% is charged on overdue balances past 30 days.

4. **SHIPMENTS** are generally via UPS or FedEx, unless another carrier is requested. Insurance charges may be appended if the package value warrants. International shipping charges are quoted individually and are based upon the order value, negotiated payment terms, and the required mode of shipment. Unless otherwise instructed, INNOVATION PHOTONICS prepays shipping costs and adds them to the invoice. Minimum shipping & handling: \$5.00.

5. **INNOVATION PHOTONICS GUARANTEES** advertised or quoted specifications of all products. INNOVATION PHOTONICS will replace any non-conforming items, provided the customer advises INNOVATION PHOTONICS of discrepancies, within 30 days of receipt of items. INNOVATION PHOTONICS bears no responsibility for breakage or damage of materials provided by the customer for further processing or for installation by INNOVATION PHOTONICS into product ordered.

6. **INNOVATION PHOTONICS WARRANTIES** all products to be free from defects in material and workmanship for six months from the date of delivery. This warranty is limited to servicing, adjusting, replacing, or repairing INNOVATION PHOTONICS manufactured parts (except semiconductor devices, laser diodes, fuses, or batteries) provided the product is returned by the original purchaser, with transportation charges prepaid. INNOVATION PHOTONICS shall examine returned items to determine to our satisfaction that it was defective and not damaged as a result of user error.

7. **ORDER CANCELLATION, REDUCTION IN QUANTITY OR EXTENSION OF DELIVERY** of any item(s) on an Order must be accepted by INNOVATION PHOTONICS. An amount that accounts for INNOVATION PHOTONICS' investment at date of notification will be assessed on the balance of undelivered items, whether for custom or standard items.

8. **NON-CONFORMANCE CLAIMS** must be made within 30 days of the date of shipment from INNOVATION PHOTONICS (45 days on international orders). If returned to INNOVATION PHOTONICS, product must be in original condition. See paragraph 9 below for instructions on returns.

9. **AN INNOVATION PHOTONICS RETURN AUTHORIZATION NUMBER (RA#)** and explanatory documentation are required for return of any item for any reason. Items that are returned without an RA# may be returned to sender at the sender's expense. Custom or specially designed products are generally not returnable.



