

*“The Mid-IR Fibers and Devices Company”*



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## FC/B<sup>®</sup> Connector FC Connector at Brewster Angle

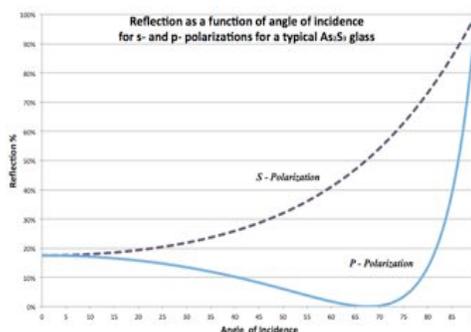
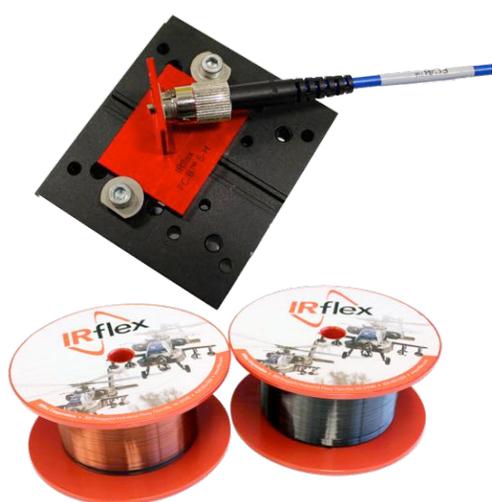
Chalcogenide  $\text{As}_2\text{S}_3$  and  $\text{As}_2\text{Se}_3$  glass fibers offer broad transmission range with low propagation loss from  $1.5\mu\text{m}$  to  $6.5\mu\text{m}$  and from  $1.5\mu\text{m}$  to  $10\mu\text{m}$  relatively, with high non-linear coefficient, small and negative index change with temperature ( $dn/dT$ ), excellent power handling capability, and are chemically stable.

Transmission cables using these fibers can be fabricated with the known terminations such as: SMA, FC/PC and FC/APC. However, due to the high refractive index of chalcogenide glasses ( $\sim 2.4$  for  $\text{As}_2\text{S}_3$ , and  $\sim 2.7$  for  $\text{As}_2\text{Se}_3$ ), the fibers experience a large Fresnel reflection (17% and 21%) at the input and output faces.

For cables with SMA or FC/PC termination, this reflection at the input could cause undesirable effects on lasers or other optical components. For applications where this reflection needs to be eliminated isolators must be used. FC/APC termination with  $8^\circ$  angle at the input face does not alleviate the back reflection problems. However, the above termination will still experience lower power being transmitted because of the power loss due to these reflections.

IRflex's FC/B<sup>®</sup> termination allows the input beam to be nearly fully transmitted at the input face, which means in addition to eliminating undesirable back reflections, more power is being coupled into the fiber.

Our FC/B<sup>®</sup> connector achieves nearly full transmission and no reflection at the input face by making use of the Brewster angle feature of transmissive materials. Light incident on a material at its Brewster angle will experience no reflection for light with its electric field parallel to the plane of incidence; this is called TM or P-polarization. Light with TE or S-polarization will still experience reflection; as such this angle is also called the polarizing angle.



*Figure 1: Reflection as a function of incident angle for S- and P-polarizations for an air-to- $\text{As}_2\text{S}_3$  interface. It can be seen that for a certain angle the P-polarization experiences 0% reflection.*

IRflex Corporation is the only U.S. company totally dedicated to the development and manufacture of mid-infrared fibers and devices for wavelength from 1.5 to 11 micron.

IRflex has several patents on specialty optical fibers and expertise in specialty optical fiber design and development. A suite of patents relating to chalcogenide glass based fiber optics has been licensed to IRflex from the U.S. Naval Research Laboratory (NRL). These strong patent portfolio and intellectual know-how, coupled with advanced manufacturing processes are the core competencies, which enable IRflex to sustain its leadership in the mid-infrared industry and provide cutting-edge products for mid-infrared applications.

IRflex's FC/B<sup>®</sup> connector is polished at a predetermined angle that permits the incident light to arrive at the Brewster angle when used in conjunction with the custom-made FC/B<sup>®</sup> holder. Normally, light incident at the Brewster angle will be transmitted at an angle with respect to the surface normal, and this angle is not along the fiber's axis that allows the incident beam to escape to the cladding and not be guided. FC/B<sup>®</sup>'s polish angle, together with the holder, allows the input beam to be incident at the Brewster angle and be transmitted along the axis of the fiber to achieve a successful coupling. For nearly full transmission at the input, the beam needs to be in the TM or P-polarization state, as seen in Figure 2.



Figure 2: Diagram showing the input beam polarization for maximum transmission. Additionally the relevant angles are shown

The FC/B<sup>®</sup> connector polish angle was determined such that for all input light within a cone with NA of 0.21 experiences 5% or less reflection. Additionally this also gives good tolerances on the alignment of the incoming beam. See Figure 3 for coupling setup.

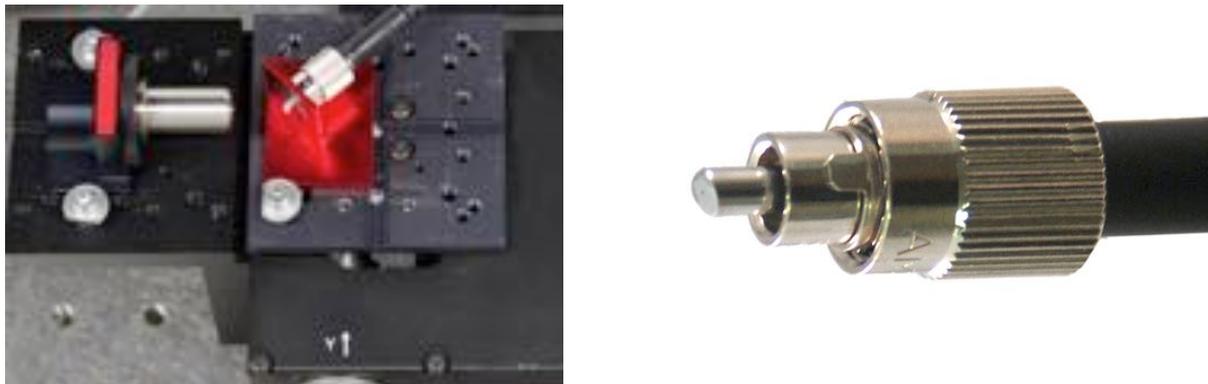


Figure 3: Setup for coupling into the FC/B<sup>®</sup> connector end using the FC/B<sup>®</sup> holder

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