High Power Fiber Optic Components

OZ Optics Limited

August 2023

OZ Optics
shop.ozoptics.com
www.ozoptics.com

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Company Background

- ***Founded in 1985***
- ***Corporate headquarter located in Ottawa, Canada***
- ***Manufacturing facility in Ottawa / Canada, Izmir / Turkey and Jiaxing / China***
- ***Ten Product Groups:***
  - *Laser-to-Fiber Delivery Systems*
  - *High Power Fiber Optic Components*
  - *Polarization Maintaining Products*
  - *Attenuators*
  - *Opto-Electronic Packaging*
  - *Fiber Optic Test Equipment*
  - *Fiber Optic Sensor Systems*
  - *Fiber Optics Components for Gyroscope*
  - *OCT*
  - *BioPhotonics*
- ***Sales offices in Canada, USA, Europe, Turkey and China***

Ottawa, Canada

Izmir, Turkey

Jiaxing, China

Corporate Statements and Quality Policy

Our Vision

- Capture and expand market share
- Be the preferred supplier of choice
- Maximize shareholder value

Our Mission

To become the leading provider of innovative optical products to telecom and non-telecom sectors

Our Core Values

- Leadership
- Teamwork
- Boldness
- Commitments
- Innovation
- Rewards

Our Quality Policy

Provide our Customers with a competitive advantage, leveraging performance, price and delivery, through a continuous process of Quality advancement in all areas of our Company.

Communicate effectively to our Customers, Suppliers and Shareholders our commitment to Quality, continuous improvement and to abide by any applicable requirements.

Promote opportunities of professional development for all members of our company through education, training and personal challenge.

Company Profile

Over 525 employees worldwide

OZ Canada

263+
Employees

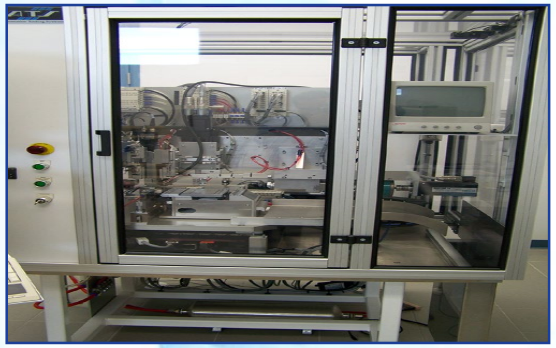
OZ China

97+
Employees

OZ Turkey

165+
Employees

Company Profile



Advanced Proprietary Processing Technology

Canada
Certificate: FM 63463

China
Certificate: FM 577647

Turkey
Certificate: FM 601414

ISO9001:2015 Certified

Broad Patent Portfolio

Company Profile

OZ Optics is Lead by an Experienced Team:

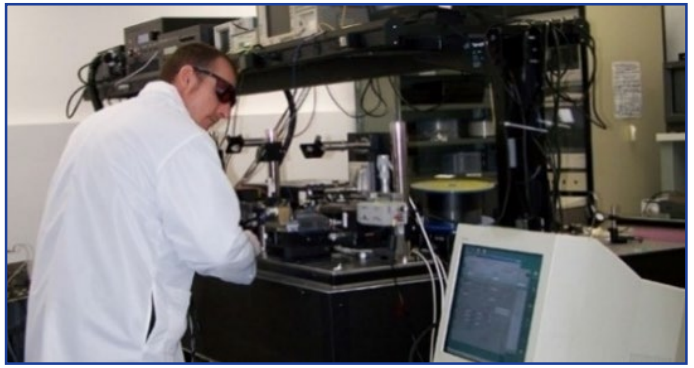
- Ömür Sezerman, Chairman, President & CEO
  - Founder and CEO since inception (39 years)
- Zahide Sezerman, VP of Human Resources
  - With OZ Optics since inception (39 years)
- Garland Best, VP of Components Division
  - 32 years at OZ Optics
- Gordon Youle, VP of Test Equipment Division
  - 25 years at OZ Optics
- Onur Koca, General Manager of OZ Turkey
  - 2 year at OZ Optics
- Bing Li, General Manager of OZ Optics China
  - 20 years at OZ Optics

Company Profile

Experienced and Well-Trained Staff in Following Fields: Optical, Mechanical, Electronics & Software

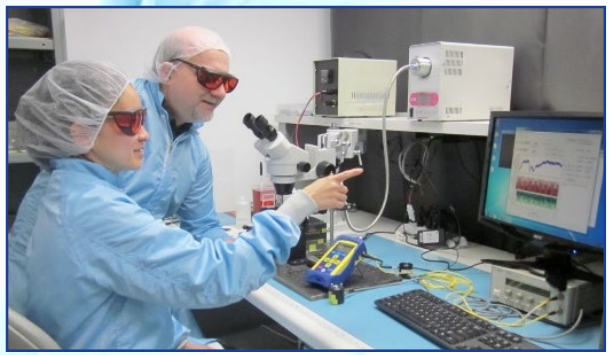
CNC Machine Shop

Femto-Second Laser Lab

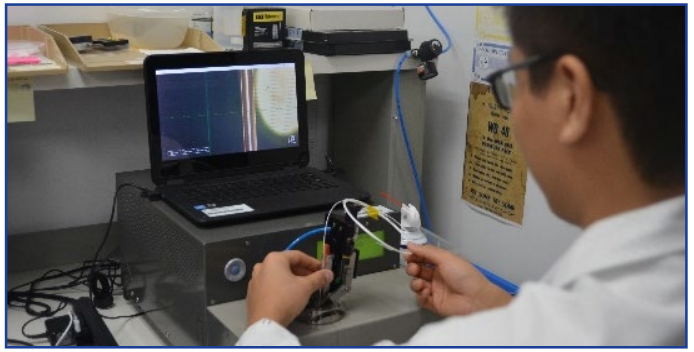


AR Coating

Clean Room



Laser Conditioning/Cleaving

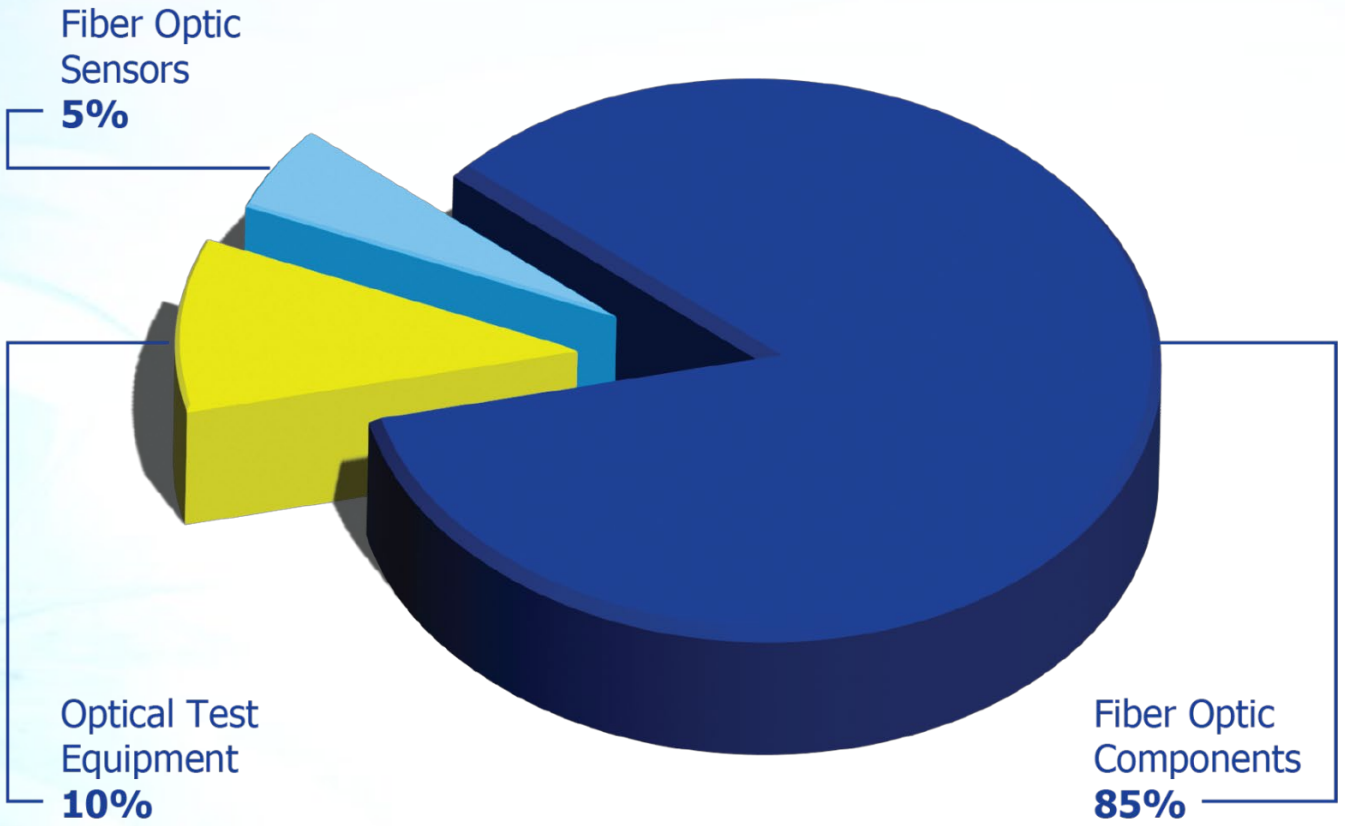


Core Competencies

- Pioneer in Polarization Maintaining (PM) Components
- Leader in Wavelength Flattened,
  High Power & Low PDL Components
- Leader in High Power Fiber Optic Delivery Systems
- Custom Test Equipment, Including Polarization Test Equipment and FTTH Equipment
- Widest Range in Attenuator Product Offering
- Fiber Optic Distributed Strain and Temperature Sensors
- Complete product line for OCT, Gyroscope
  & BioPhotonics applications & 2 Micron
- Now available: Spectrometers and Quantum Light Sources

Leading Technology

› Three Product Groups › Over 1,000 Products › Leading Edge R&D



Leading Technology

Featured Products

World's Largest Online Fiber Optic Catalog

Most Products are in Stock

Delivery Systems

Polarization Maintaining Components

High Power Components

Test Equipment

Optoelectronic Packaging Components

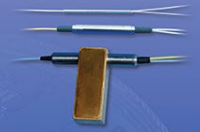
Attenuators

High / Low Power Patchcords

Polarization Maintaining Fiber Optic Components

Patent Numbers: USA 7058275, 7095931, 7295731, China 1672073

Polarization Maintaining Connectors / Patchcords


Polarization Maintaining and Polarizing Splitters / Combiners / Fused Couplers / Switches

All Fiber Manual and Electrically Driven Polarization Controllers / Scramblers

PM Fiber Directional Taps / Power Monitors

Manual / Electrically Controlled PM Fiber Pigtailed Variable Attenuators

Fiber Pigtailed Polarizers

PLC Splitters

PM Fiber Pigtailed Circulators

Laser & Laser Diode to Fiber Delivery Systems

Laser to Fiber Couplers

Bare Fiber Adaptors with Magnetic Clips

Bulkhead Receptacles

Pigtail / Receptacle Style High / Low Power Collimators / Focusers

High / Low Power Patchcords

WDM / RGB Combiners

OCT Modules and 2 micron Components

OEM Laser Diode to Fiber Couplers

Turnkey, Ultra Stable Laser Modules

Fused Fiber Collimators

High Power Fiber Optic Components

Patent Numbers: Canada 2494133, USA 7058275, 7095931, 7295731, China 1672073

High Power / Temperature Connectors & Patchcords

CO_2 Cleaning for High Power Components

High Power Laser to Fiber Couplers / Collimators / Focusers

High Power Mode Field Adapters

High Power Optical Taps / Power Monitors

High Power Isolators

High Power Splitters / WDM's

Shutters / Receptacles / Sleeve Thru Adapters with Sensors

Leading Technology

Featured Products

Fiber Optic Attenuators
for SM, PM, and MM Fibers

Benchtop Digital Variable Attenuators

Multichannel Variable Attenuators

Digital Variable Attenuators

Electrically Controlled Variable Attenuators

MEMS Variable Attenuators

SM / PM / MM Fiber Pigtailed Inline Variable Attenuators

Single/Multi Channel Miniature Variable Attenuators

Reflective Style Variable Attenuators

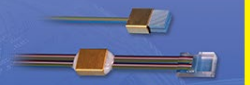
Air Gap Variable Attenuators

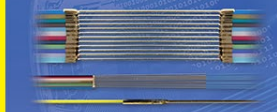
Plug Type Fixed Attenuators

Attenuating Fiber Patchcords

Fiber Optic Components for Optoelectronic Packaging
Hermetically Sealable Patchcords with Glass or Metal Solder

Single Channel


Multi Channel


Metalized Fibers

PM/SM/MM Fiber Pigtailed V-Groove Arrays

Polarization Measurement System for V-Grooves

Tapered / Lensed Fiber Polished / Laser Shaped

Precision Collimator / Focuser Array

Fused Fiber Collimator

Fiber Optic Test Equipment

Handheld Extinction Ratio Measurement Systems

Benchtop Extinction Ratio Measurement Systems

Optical Fiber Length Meters

Back Reflection Meters

Benchtop Digital Variable Attenuators

Handheld Digital Variable Attenuators

Multichannel Variable Attenuators

Powermeters with Smart Detector Heads

High Power Visual Fault Locators

Laser Diode Stable Sources

Fiber Optic Distributed Strain and Temperature Sensors

USA Patent Numbers: 7499151, 7599047, and 9568307

- BOTDA only, BOTDR only, or both BOTDA and BOTDR modules in one unit
- Fast, dynamic measurement of strain and/or temperature up to 200 km sensing range
- Simultaneous measurement of strain and temperature
- Uses standard telecommunications fibers to minimize costs

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Leading Technology

Featured Products

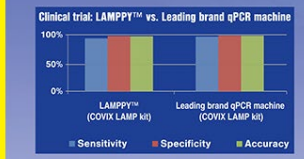
Universal Optical DNA Rapid Detection System for Pathogens Including

COVID-19, SARS, EBOLA, CHOLERA, SALMONELLA, ETC.

LAMPPY™ SERIES

Features:

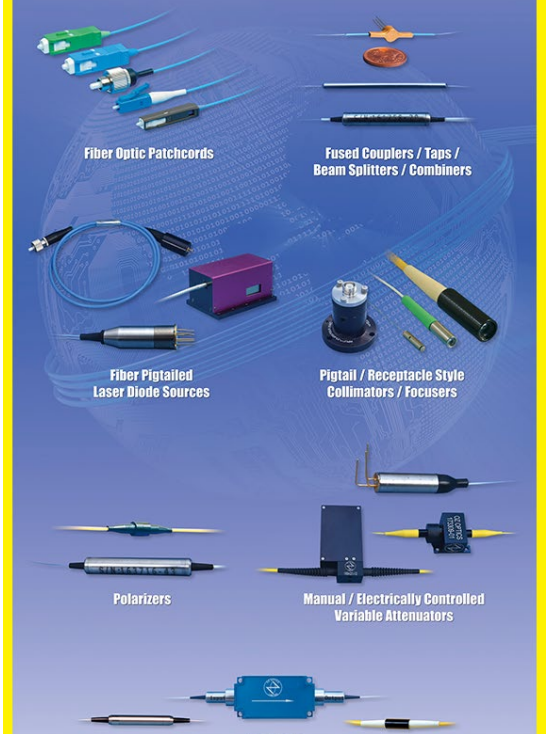
- Use to detect viral, fungal, and bacterial DNA/RNA
- Rapid DNA/RNA detection (as little as 20 minutes)
- Highly sensitive and specific detection of low viral levels
- Intuitive software displays real time data during testing
- Melt analysis available with the included software
- Lid heater prevents evaporation and condensation
- Compact modular design allows for easy cleaning and maintenance
- Pair with an external battery for a portable and field-deployable system
- Test up to 8 samples simultaneously (higher throughput systems with up to 96 samples available upon request)
- Wireless communication to computers and smartphones (coming soon)
- A fraction of the cost of qPCR based systems
- OZ Optics also offers private labelling for volume OEM applications



In a lab study done at Acibadem University using saliva samples taken from patients at the Acibadem Hospitals, LAMPPY™ was compared to a well-known conventional qPCR ma chine in performance and speed. The comparison study was carried out with a sample size of 262 using the COVIX LAMP-based kit on both instruments and then verified with the KrosQuanT SARS-COV-2 (2019 nCOV) Real Time PCR Diagnostic Kit on a leading brand conventional qPCR machine.

Fiber Optic Products for OCT Applications

2 micron Fiber Optic Components for PM and SM Fibers



New Fiber Optic Products

Industry Standards

All Products Manufactured are in Strict Accordance with International Industry Standards:

- ISO 9001:2015 Certified (Canada, China and Turkey)
- REACH Compliance
- RoHS Compliance
- CE Compliance
- Telecordia Compliance
- Controlled Goods Directorate Registered
- Critical supplier for F35 and F18 Project
- TSCA (Toxic Substance Control Act) Compliance
- CHEMSHERPA Compliance
- IEC 61010 Compliance

Marketing Strategy

Application Market

Using our strong direct sales and distributors, we address the following markets:

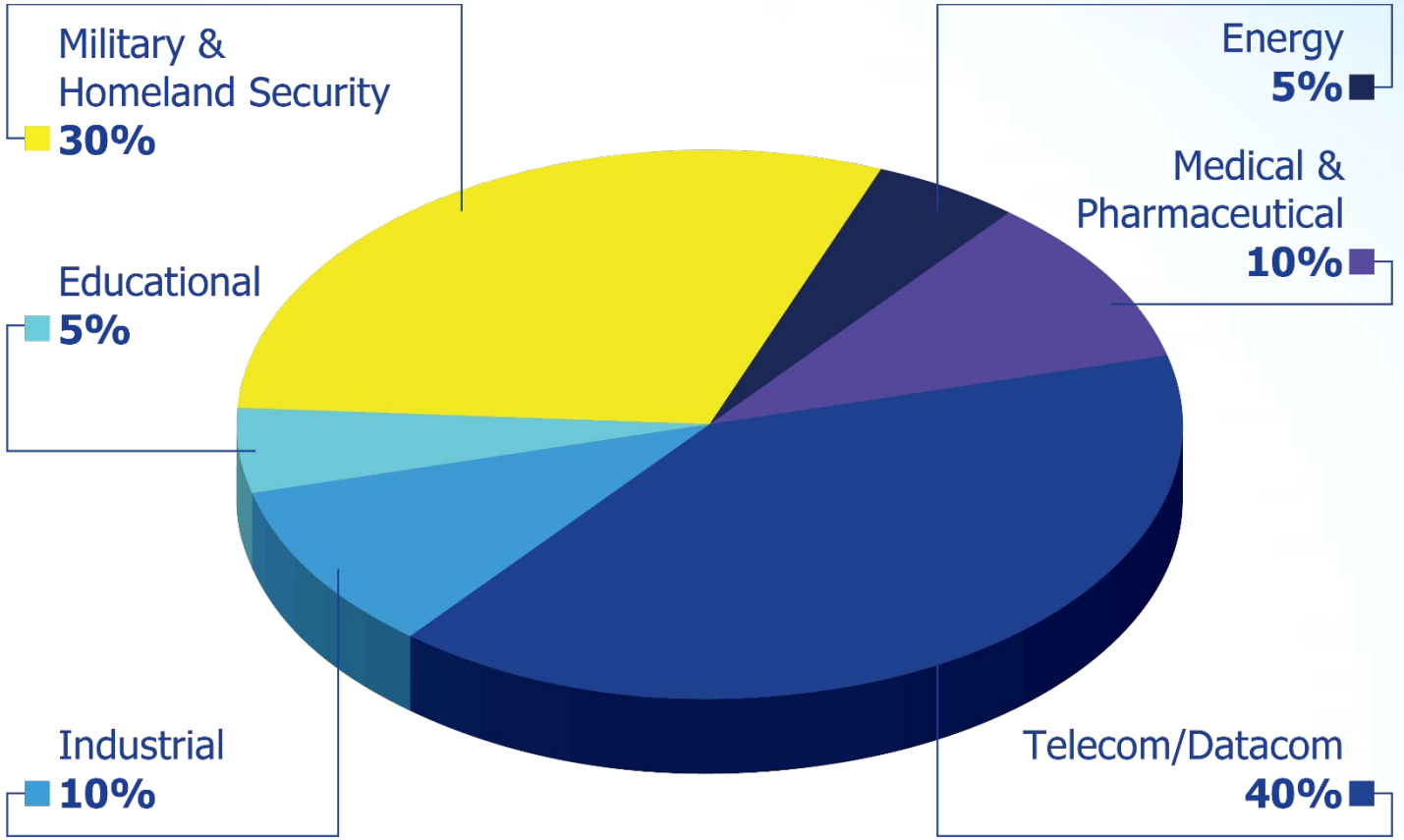
- ***Energy – Oil and Gas***
- ***Military and Homeland Security***
- ***Educational***
- ***Industrial***
- ***Telecom / Datacom***
- ***Medical & Pharmaceutical***

Marketing Strategy

Application Market

By leveraging the technology and expertise gained since its inception, OZ Optics has attracted a broad range of customers in the telecom / datacom, medical, military, security, industrial, construction, aerospace, power utilities, petrochemical and educational sectors.

Revenue Allocation:



Marketing Strategy

Global Sales Network

OZ Optics has resellers and distributors in over 30 Countries and Regions with over 10,000 customers worldwide:

Austria

Belgium

Brazil

Canada

China

Denmark

France

Germany

Greece

Hong Kong

India

Ireland

Italy

Japan

Luxembourg

Netherlands

Norway

Poland

Portugal

Singapore

South Korea

Sweden

Switzerland

Taiwan

Thailand

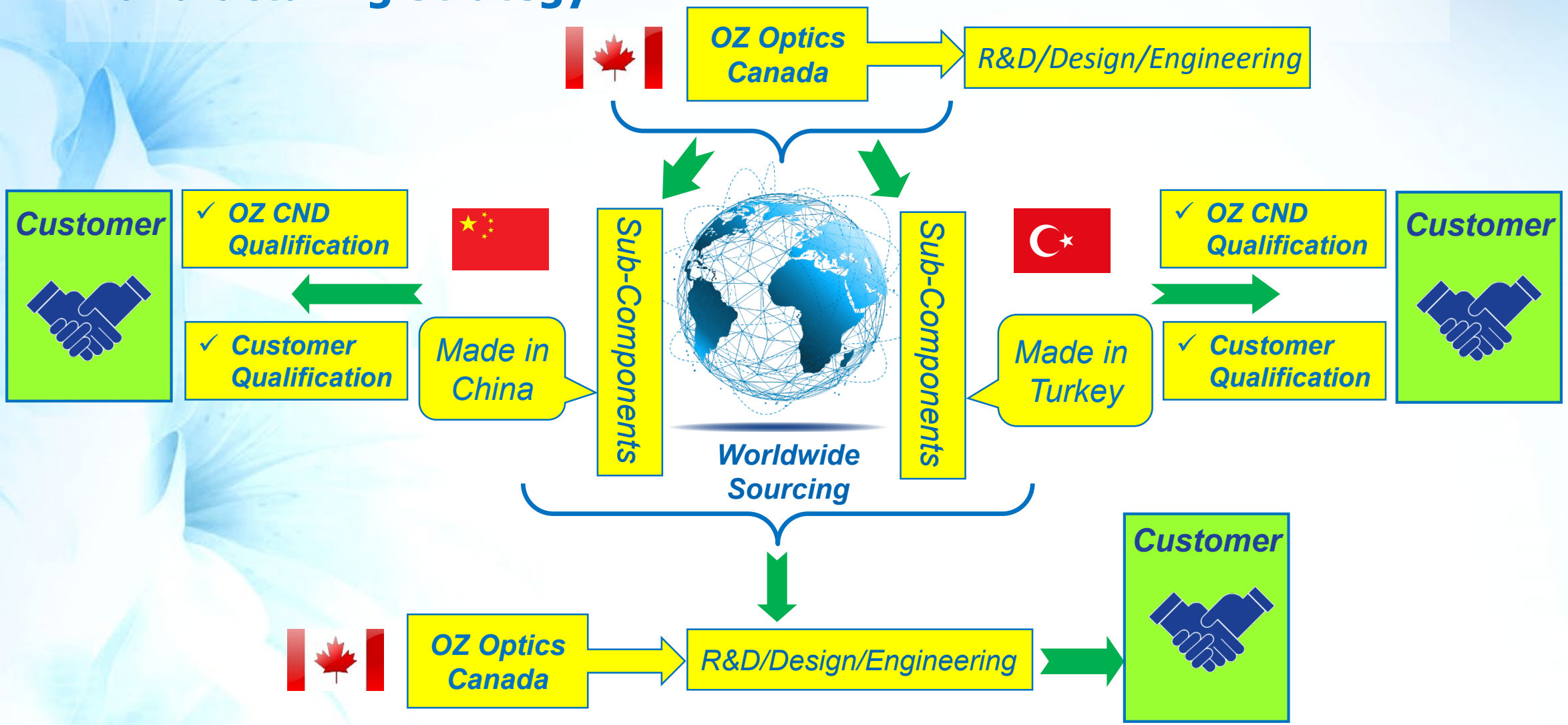
Turkey

United Kingdom

United States

Operation Strategy

Manufacturing Strategy



Marketing & Operation Strategy

Competitive Advantage

- Superior Technology
  Innovative Engineering
- Competitive Pricing
- Global Presence
- Extensive Experience
  in Fiber Optics Manufacturing
- Exceptional Quality and Service

Branch Network

OZ OPTICS CANADA *(Headquarters)*

OZ OPTICS TURKEY *(Turkey Factory)*

OZ OPTICS CHINA *(Jiaxing Factory)*

Branch Network

Facility - Ottawa Headquarters

- 60,000 sq ft. - Manufacturing and R&D Facilities
- 15,000 sq ft. - Admin, Sales and Marketing
- 15,000 sq ft. - Training and Fitness Facilities

Branch Network

Facility - Ottawa Headquarters

Production Area

Training Centre Building

Meeting Room

Swimming Pool

Branch Network

Facility - Turkey Factory (Izmir, Turkey)

- Operational since 2000
- 33,000 sq ft. Manufacturing Facility
- Located in Free Trade Zone
- Low Tax Rates
- Sub Component Parts Manufacturing
- High Quality Labor

Branch Network

Facility - China Factory (Jiaxing, China)

- Operational since June 2010
- Wholly Foreign Owned Enterprise
- Cost Effective Manufacturing
- High Quality Labor
- Supply Chain Integration

Branch Network

Facility - China Factory (Jiaxing, China)

- Located in Economic Development Zone
- 4000+ sq meters - Total Area
  - 500 sq meters – Admin, Sales and Marketing
  - 3500 sq meters – Manufacturing Area
    - √ 500 sq meter – Class 10,000 Clean Room
    - √ 300 sq meter – ESD Working Area

OZ Optics China

Zhejiang OZ Optics Technologies Co., Ltd

- Operational since June 2010
- Wholly Foreign Owned Enterprise
- NPI & Production Line Setup
- On-site Training by OZ CND
- Began Mass Production in September 2010
- Completed Main Facility Expansion in 2019

High Power Fiber

- Power handling of optical fiber is wavelength dependent and dependent upon the structure of the optical fiber
- The shorter the wavelength, the higher the photon energy, and the lower the damage threshold
- The higher the absorption of the fiber, the lower the damage threshold.
- The smaller the core size is, the lower the power handling as damage threshold is in terms of W/mm2

Other Damage Factors

- Pulsed or CW light?
- Focused Spot Size
- Fiber Doping
  - Low OH vs High OH
  - Germanium doped vs Fluorine Doped

Damage Threshold of Fused Silica

Estimated Optical Power Densities on Air / Glass Interface		
Type	**Theoretical Damage Threshold**	**Practical Safe Level**
CW (Average Power)	~1 MW/cm^2	~250 kW/cm^2
10 ns Pulsed (Peak Power)	~5 GW/cm^2	~1 GW/cm

Data given is for wavelengths of 633nm and longer. For shorter wavelengths the power numbers have to be lower.

Typical Damage Thresholds for SM Fibers, Standard Termination

Wavelength	Singlemode Core Size	Damage Threshold
1550nm	9/125	1 Watt
1060nm	6/125	0.5 Watts
830nm	5/125	0.25 Watts
633nm	4/125	0.2 Watts
520nm	3.5/125	0.1 Watts
405nm	3/125	< 50 mW

How To Make Fiber with Higher Power Handling

- **Large Mode Area (LMA) fibers**
- **Enlarge the core diameter, reduce the NA**
  - Examples: Nufern SM-GDF-10/125, BC46585 and PM1060L, BC#37895.
  - Limited by bend sensitivity.

LMA Fibers

- If you make the fiber cores even bigger, you cannot keep reducing the NA.
- Eventually the fibers are no longer truly singlemode. They become low-order multimode (few mode) fibers.
- Examples:

Table 1B: Large Mode Area Fibers

Bar Code	Part Number	Operating Wavelength (nm)	Core Diameter (µm)	Cladding Diameter (µm)	Attenuation (dB/km)	Numerical Aperture	Buffer Diameter (mm)	Buffer Material
36269	SMF-1060-20/125-0.25-L-LMA	1064	20	125	<10	0.10	0.25	Acrylate
35688	SMF-1060-25/125-0.25-L-LMA	1064	25	125	<10	0.10	0.25	Acrylate
35689	SMF-1060-25/250-0.4-L-LMA-DC	1064	25	250	<10	0.06	0.40	Acrylate

LMA Fibers (cont.)

- There are tricks to supress higher order modes.
- Best technique is to use mode field adapters.

Mode Field Adapter

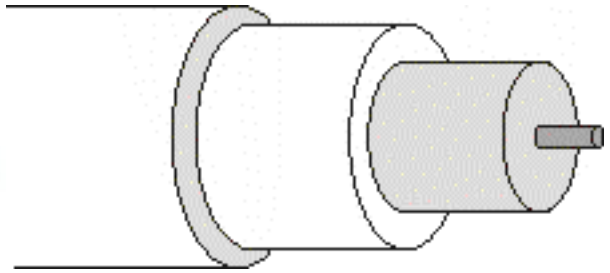
Collimating LMA Fibers

- You need to know the Mode Field Diameter (MFD) of the fundamental mode of the LMA fiber.
- Once you know the MFD, you can use gaussian optics to estimate the collimated beam diameter, divergence, etc.
- The MFD relative to the fiber core size can be calculated from the V-Number (V=pd*NA/l)

$$\frac{w}{a} \approx 0.65 + \frac{1.619}{V^{3/2}} + \frac{2.879}{V^{6}}$$

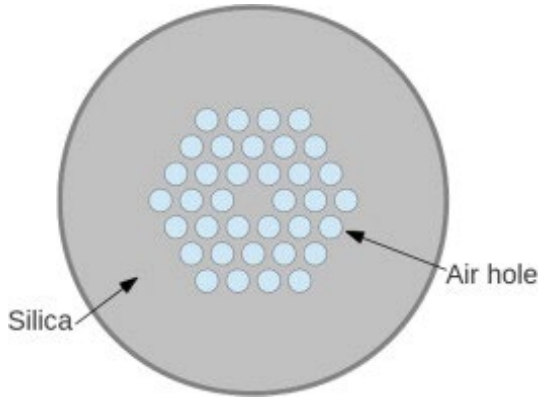
Double Clad Fibers

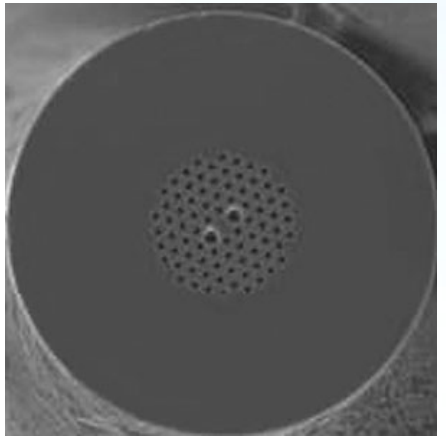
- Parts have an inner core, outer core = inner cladding, and outer cladding.
- Inner core is singlemode, active doping
- Inner cladding acts as multimode fiber, delivers energy to inner core. Usually pure fuse silica.
- Outer Cladding is usually polymer. Sometimes is the outer coating.



Photonic Crystal Fiber

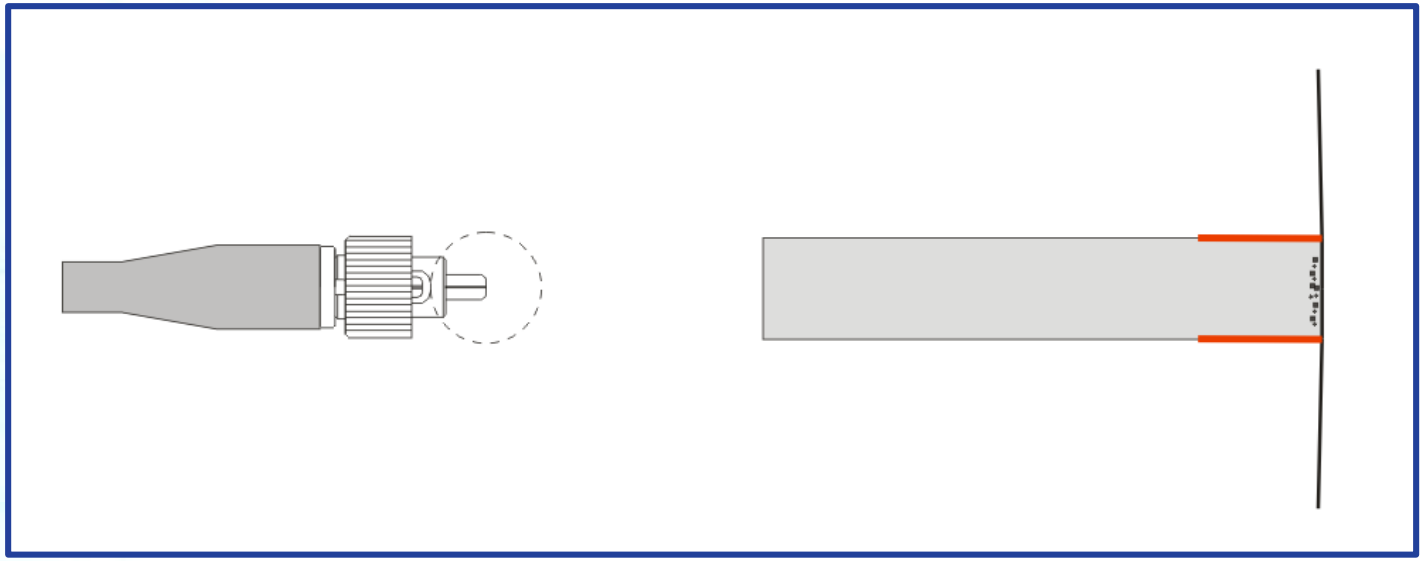
- Sometimes called “Holey Fiber”
- Singlemode and PM fiber Versions
- Very Broad-band singlemode behavior
- Mode Field Diameter almost constant versus wavelength.





Termination failure modes

- Epoxy Outgassing/Burning
- Contamination
- Embedded Polishing Particles

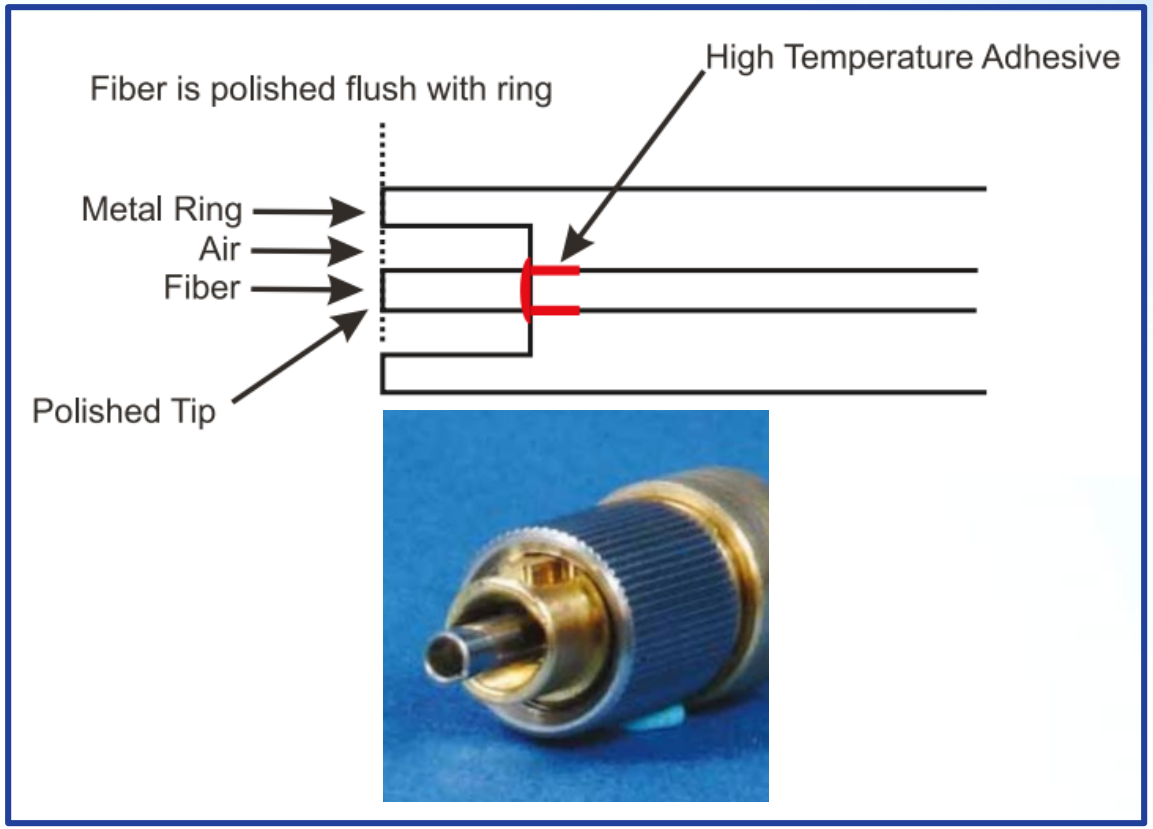


High Power Termination Options

- Regular Termination
- Air-gap Connectors – Polished Fibers
- Air Gap Connectors – Cleaved Fibers
- Air Gap Connectors – Laser Conditioned Fibers
- High Power Connectors with Heat Sinks
- Air Gap Connectors – Endcapped Fibers
- Regular Termination – Endcapped Fibers

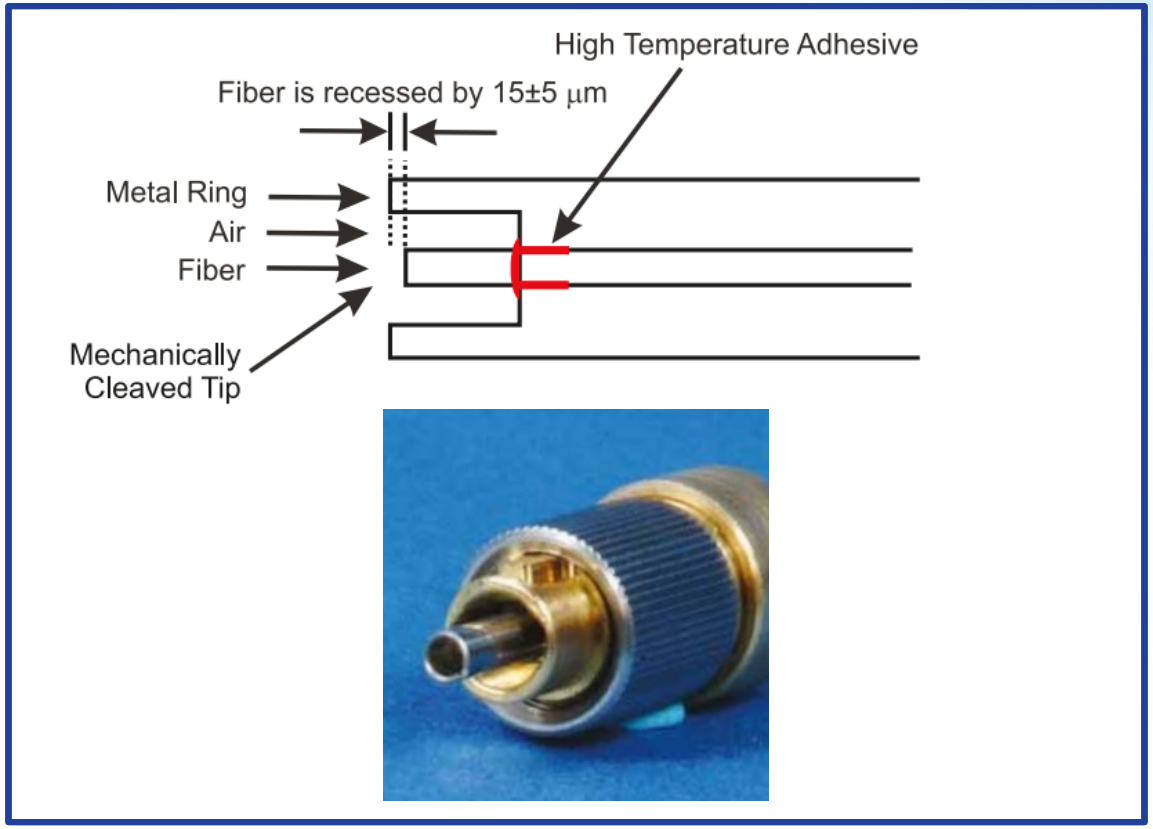
Air Gap Connector - Polished

- Eliminates the glue from the fiber tip
- Best for fibers >200 um in diameter (but can do 125 micron cladded fibers).
- Cleaning afterwards is essential.
- Embedded particles still an issue



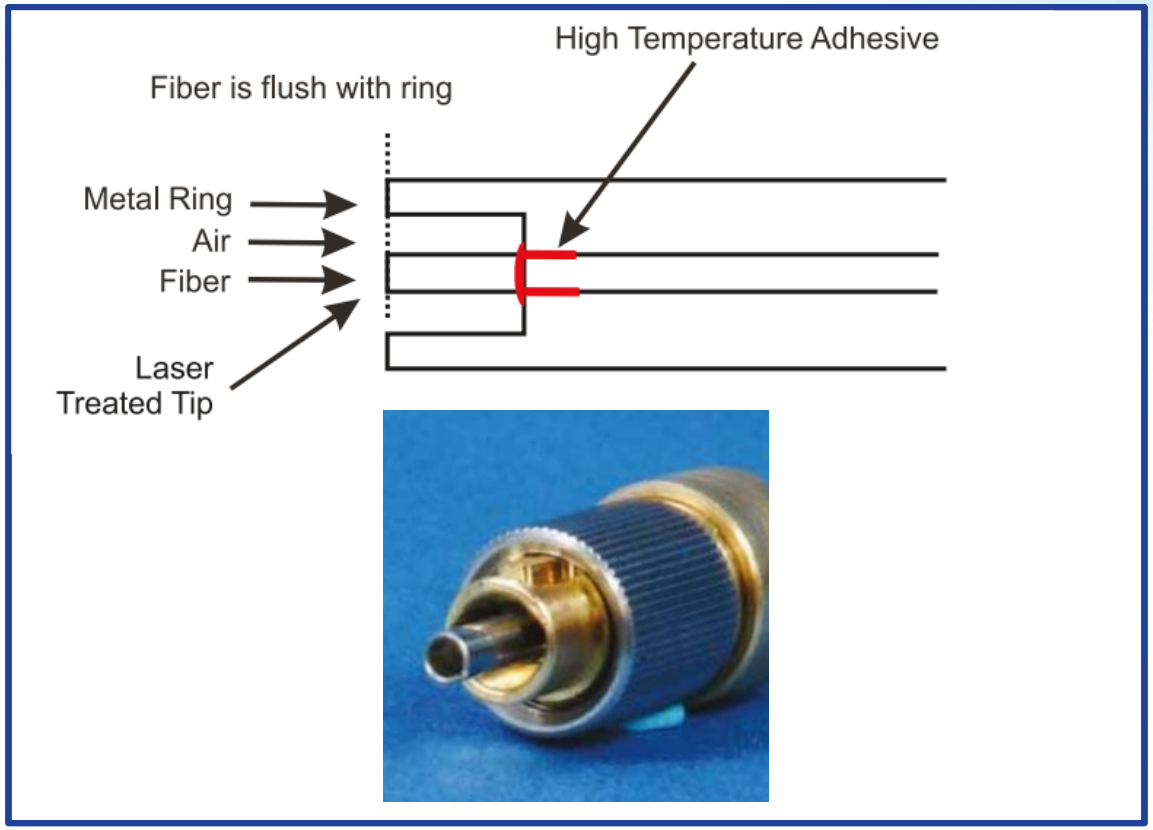
Air Gap – Cleaved fiber

- Eliminates the embedded particle problem.
- Need to watch out for small chips near the edge, especially for multimode fibers.

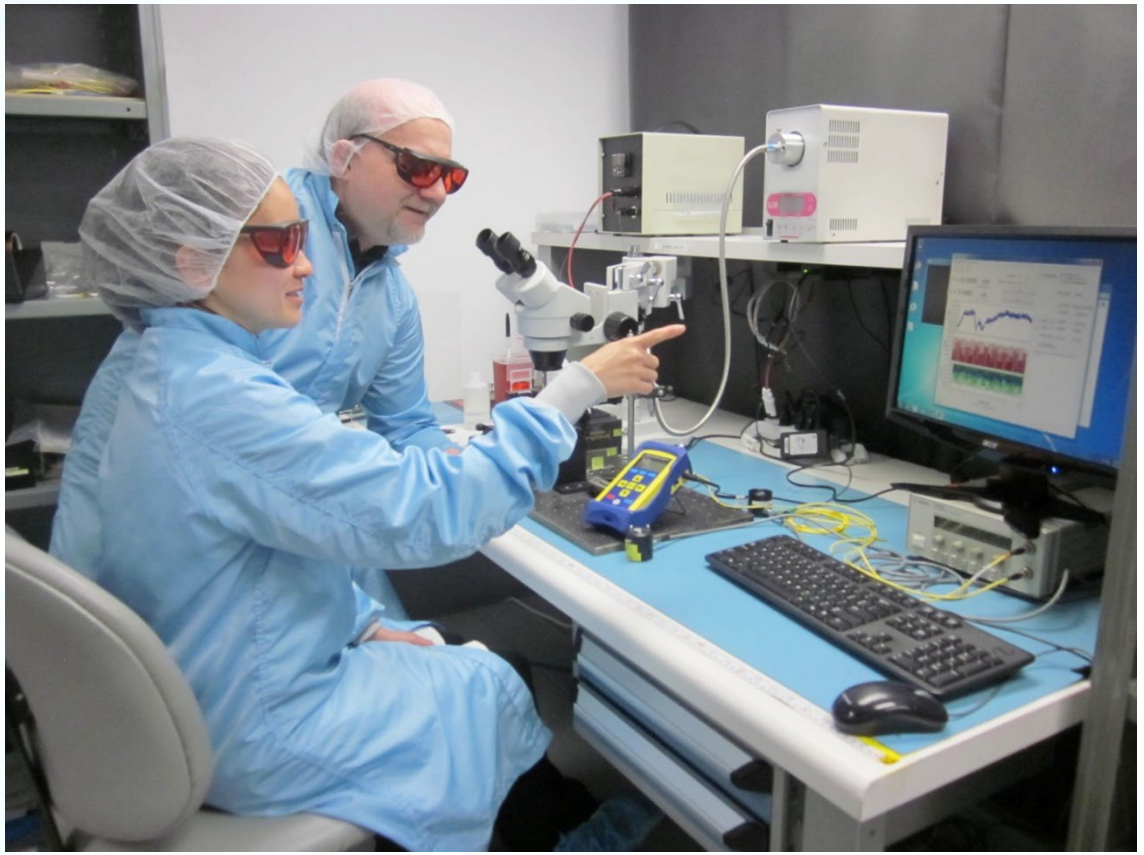


Air Gap – Laser Conditioned

- Anneals the fiber tip, making it stronger.
- Can cause rounding of the fiber tip near the edges, May be a concern for some multimode fibers.



Clean Room for High Power Manufacturing Components



Connectors with Heat Sinks

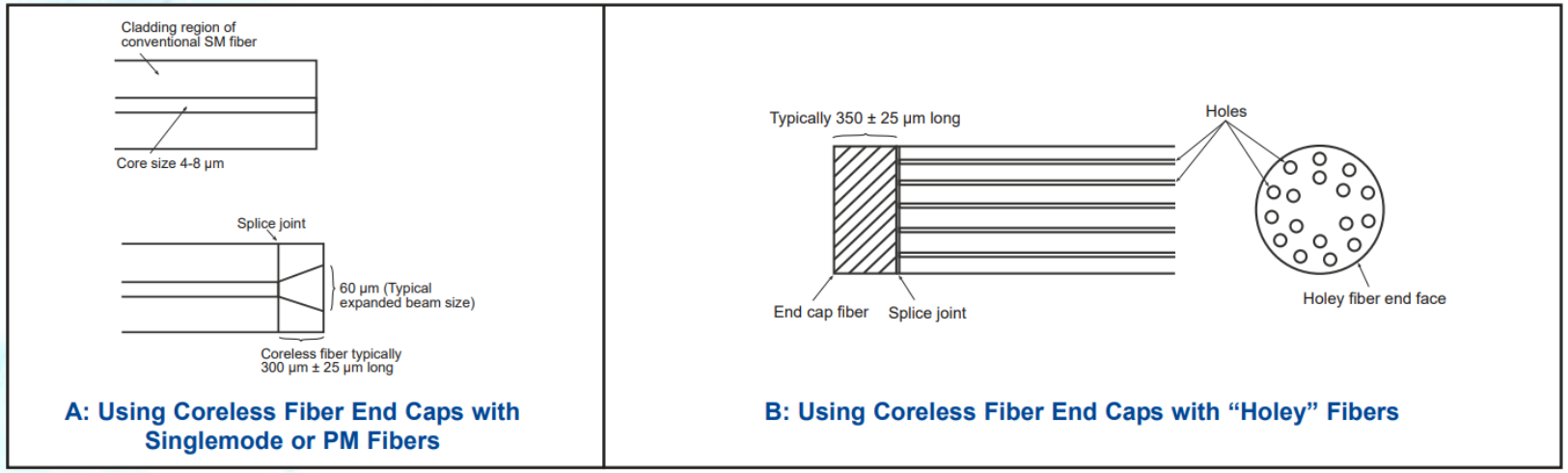
- Useful for applications exceeding 100 W.
- Any light not captured in the fiber core is diverted to the connector housing, absorbed, generating heat.
- Special epoxies enhance diverting light in the cladding (cladding mode stripping)
- Heat Sinks/Fins radiate this heat to the environment.

Very High Power Connector with Cooling Fins

Very High Power Connector
with Cladding Mode Stripping

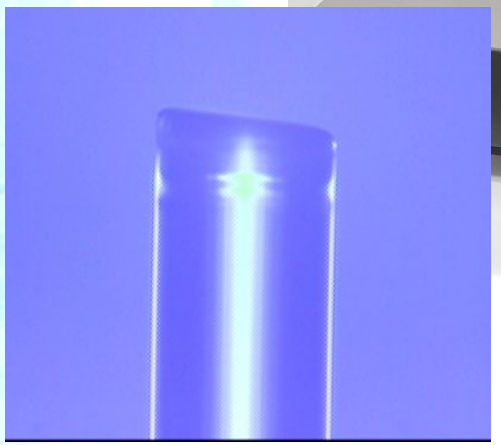
End-capping

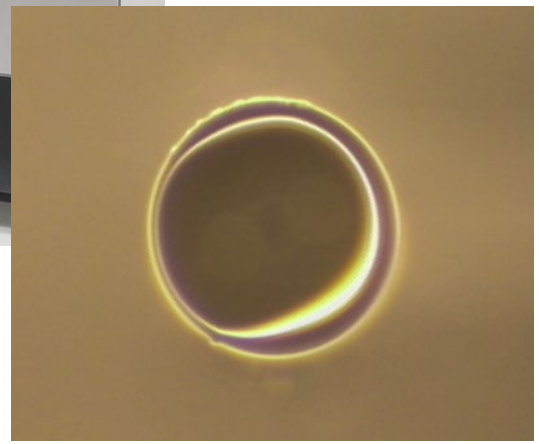
- Most failures occur at the glass-air interface at the end of a fiber.
- Intensity is very high in singlemode and PM fibers because of small fiber core size, so intensity (W/m2)is large.
- Endcap acts as a protective region allowing he beam to expand before encountering the air.



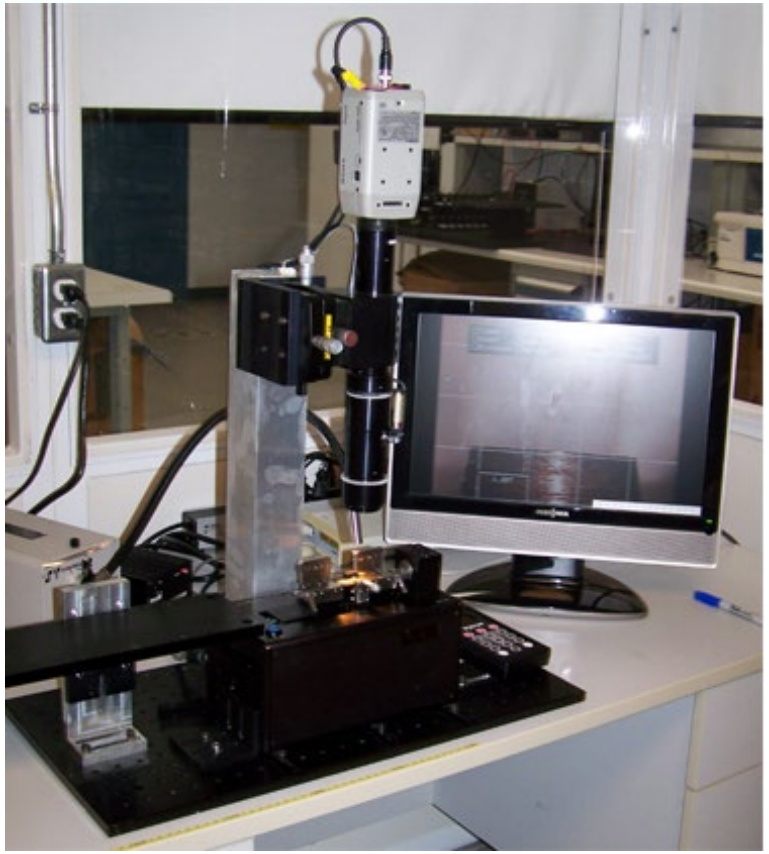
Fusion Splicer for End Capping

Laser Cleaving System

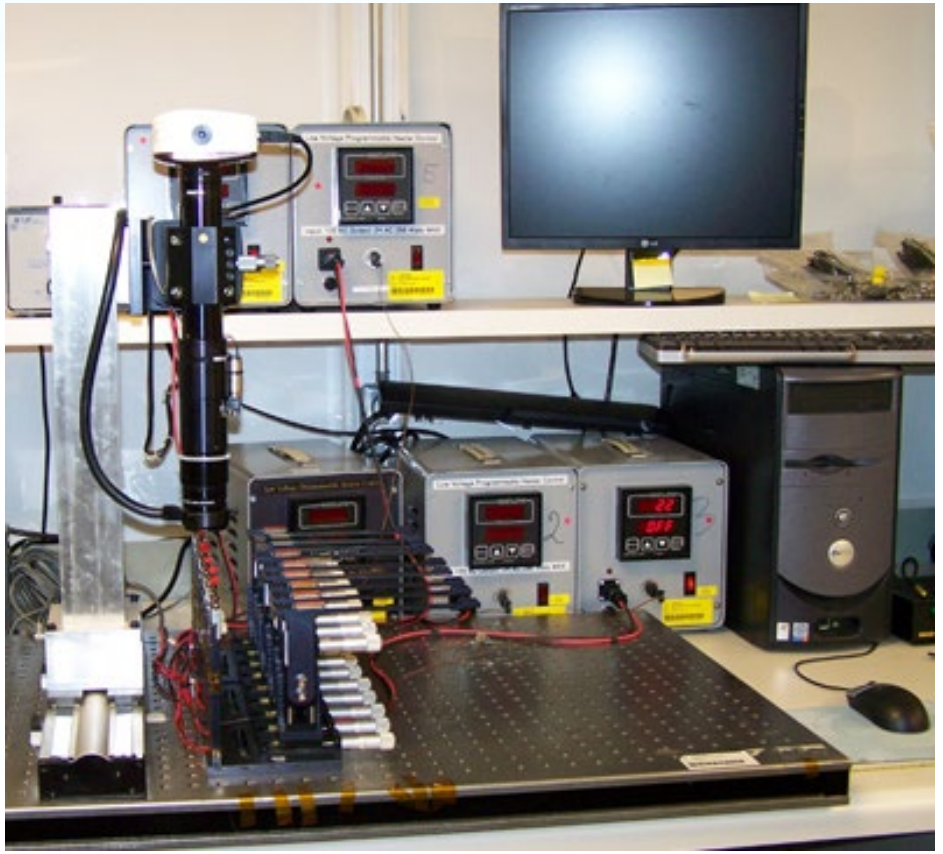




High Power Inspection Station

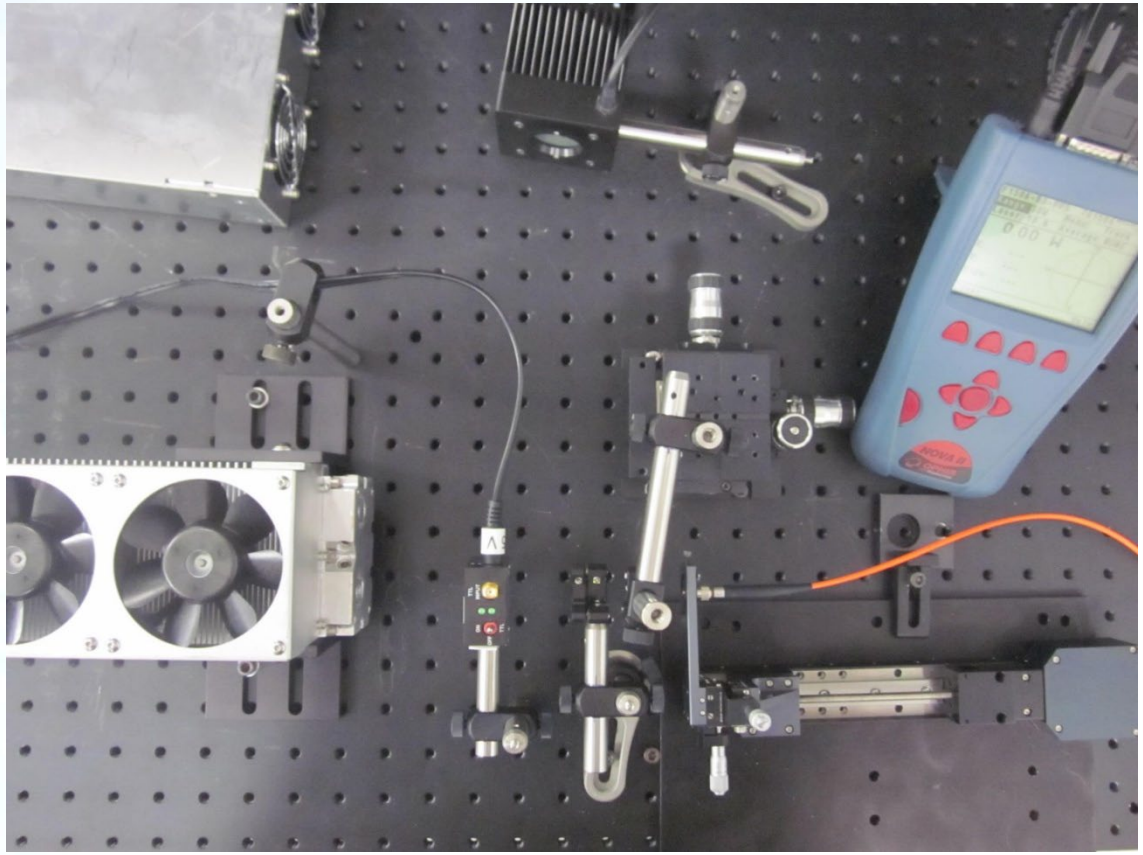


High Power Gluing Station for Patchcords



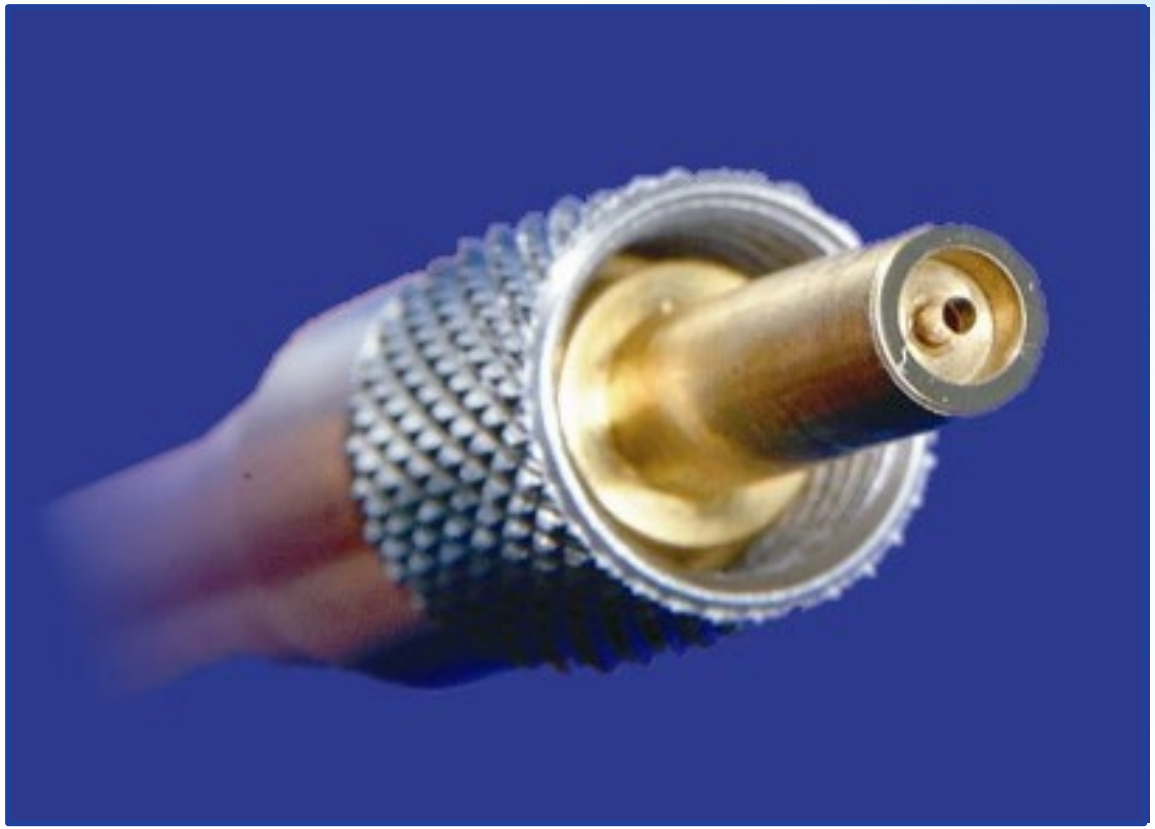
High Power AR Coating Machine

Laser Conditioning Station



High Power Patchcords And Connectors

- Able to Transmit Over 100 W of Optical Power
- Operating Wavelengths from 200 nm to 2000 nm
- PMF, SMF, and MMF High Power AR Coatings



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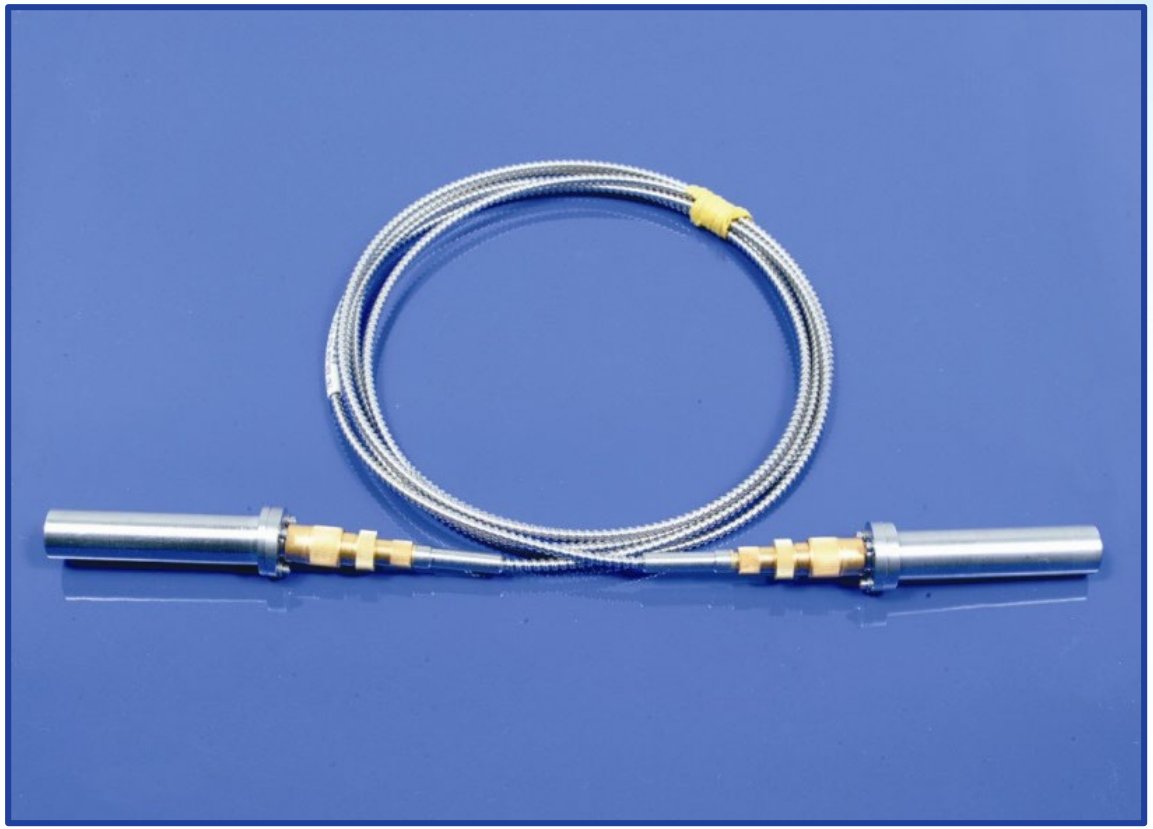
OZPEN™ CO_2 Fiber Optic Cleaning Unit

- Superior removal of contaminants on fiber optics and other components
- Quick and dry solvent free cleaning process
- Cleans variety of substrates
- Designed to clean small surface area
- Ideal for high power applications

High Power Collimators/Focusers

- Up to 100 Watts CW Power Handling
- Available for 180 nm to 2000 nm Wavelengths
- Receptacle and Pigtailed Versions

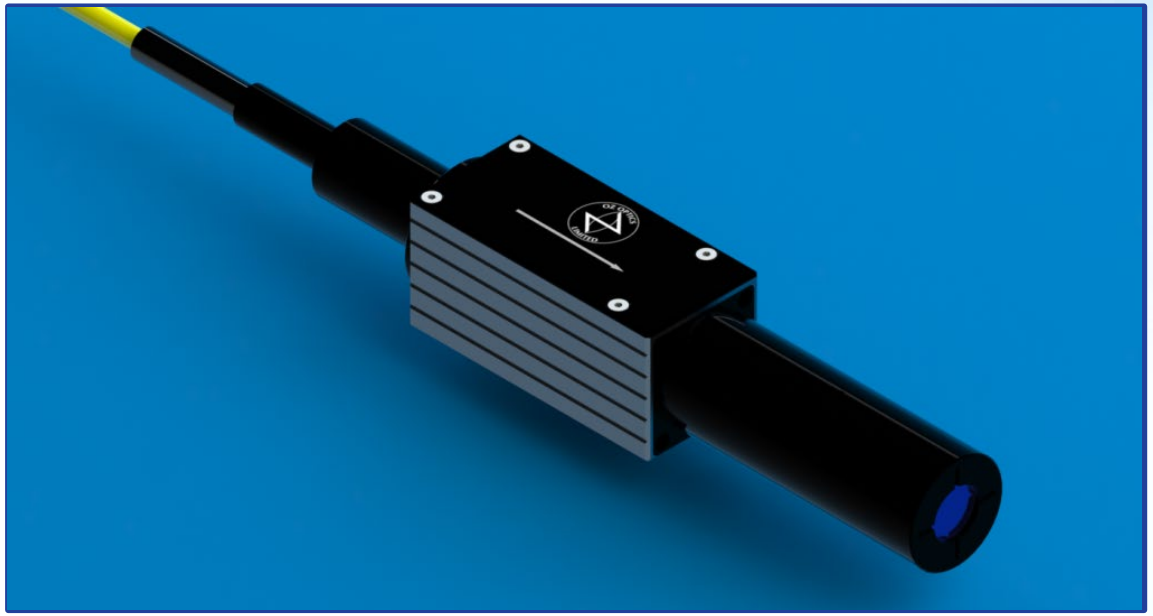


Fused High Power Fiber Collimators

- No air-glass interfaces for maximum power handling
- Over 1 kW power handling
- Singlemode, multimode, polarization maintaining and large mode area fiber versions available

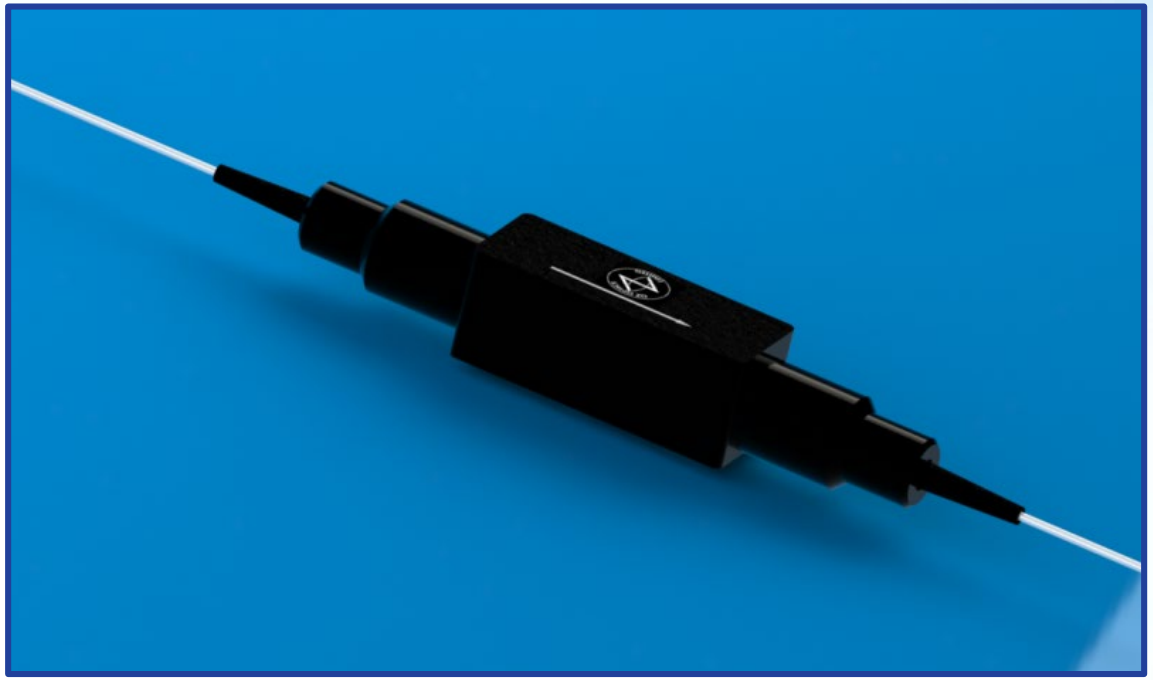
High Power Fiber Pigtailed Isolators

- Low Insertion Loss, Up to 100 Watts
- Available from 400 – 2000 nm
- Polarization Independent, High Isolation



High Power Fiber Pigtailed Isolators

- Multiple Watts CW Power Handling
- Shutter Speed of < 5 msec
- Temperature, Contact or Proximity Sensors for Safety Interlock
- SMA 905 or FC Receptacles



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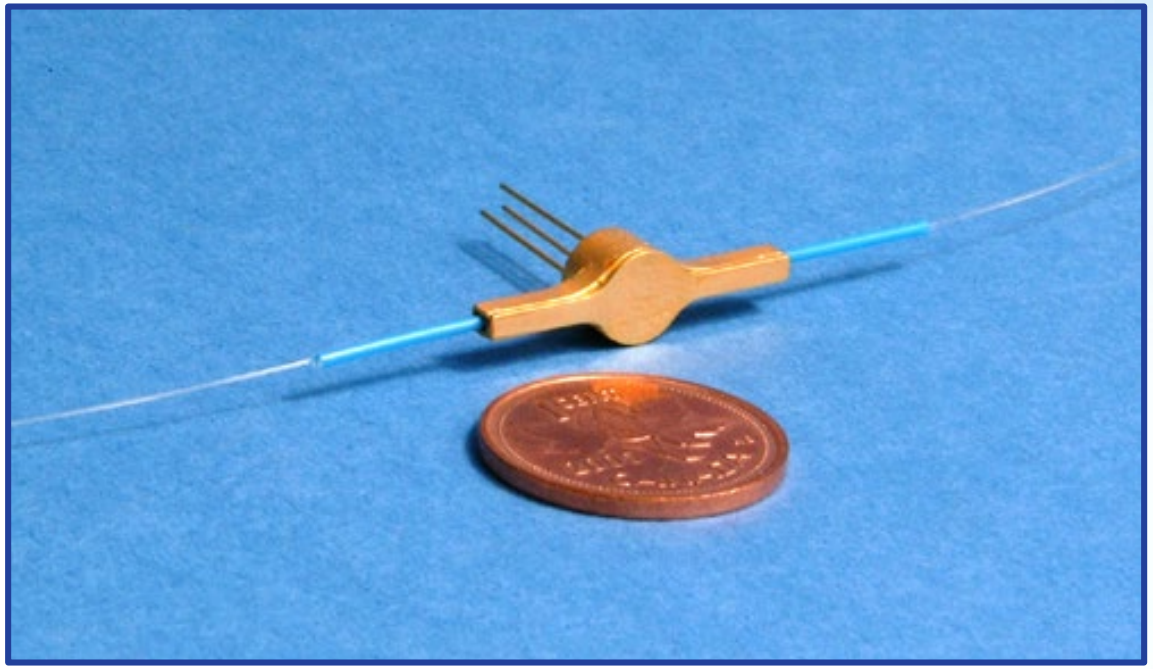
- Polarization Independent, High Isolation

Mode Field Adapter

- High Power Handling
- Adapts and Conserves Modal Content
- Singlemode and Polarization Maintaining Versions
- Custom Designs Available

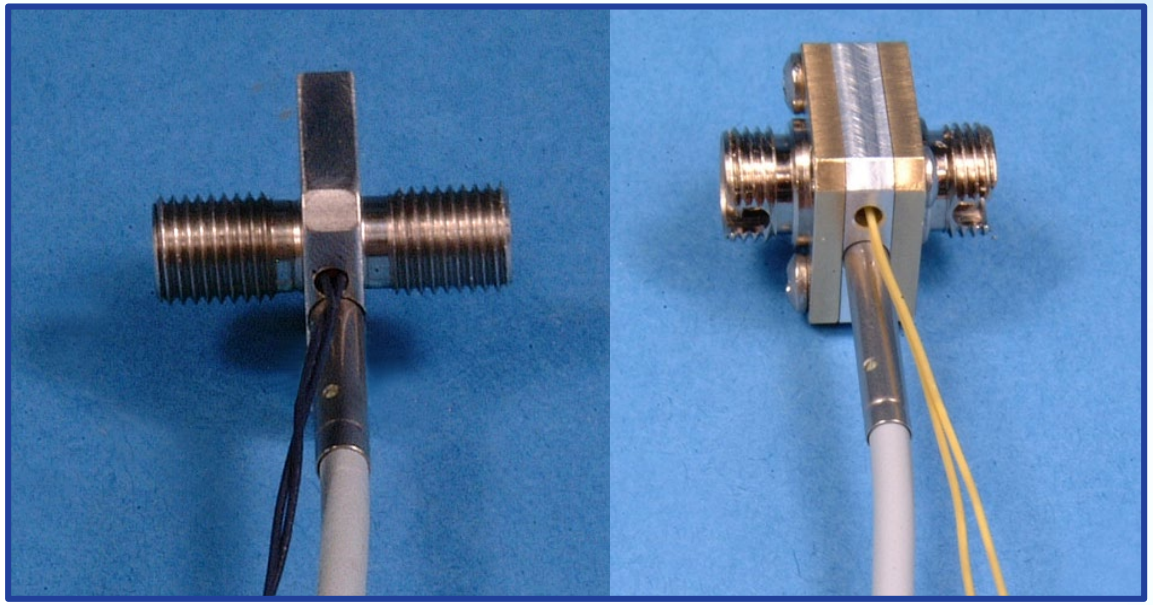
High Power Directional Taps/Power Monitors

- Up to 10 Watts Power Handling
- SM, PM and Specialty Fiber Versions, Including Photonic Crystal Fiber
- Available for 320nm to 2000nm Wavelengths



High Power Shutters/Bulkhead Receptacles With Safety Interlocks

- Multiple Watts CW Power Handling
- Shutter Speed of < 5 msec
- Temperature, Contact or Proximity Sensors for Safety Interlock
- SMA 905 or FC Receptacles



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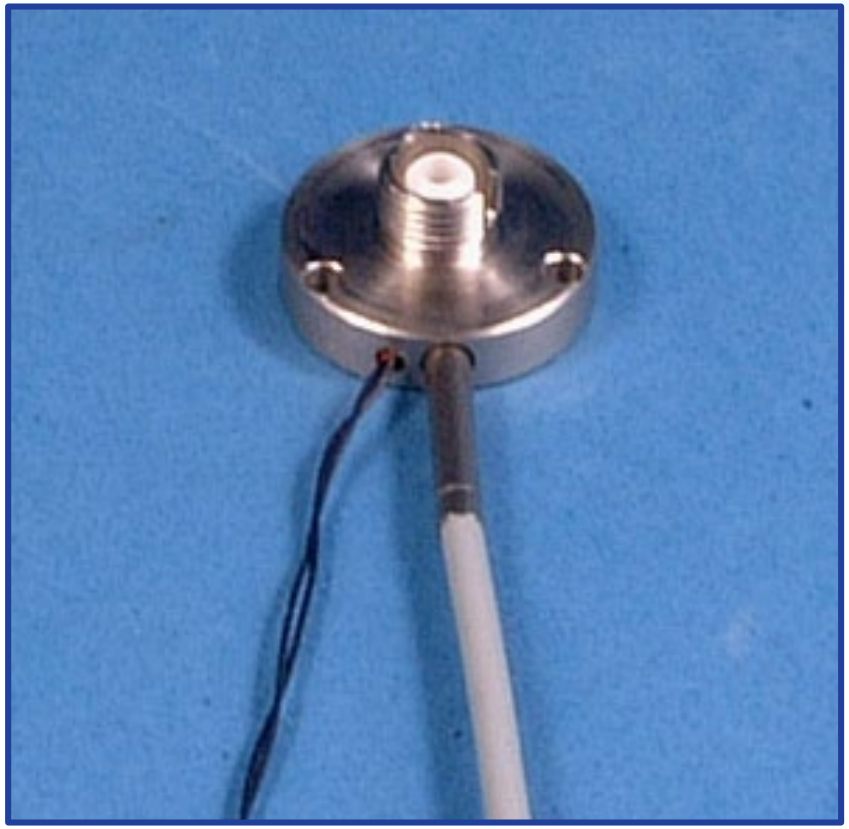

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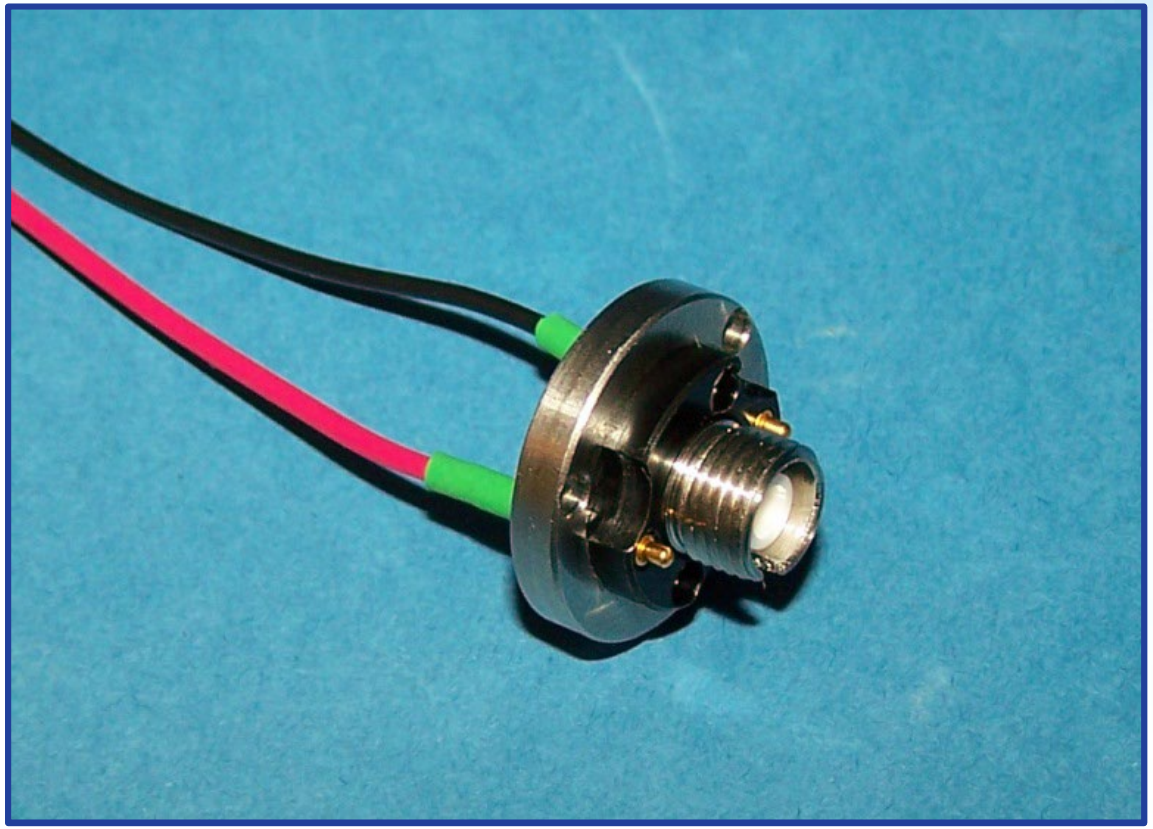

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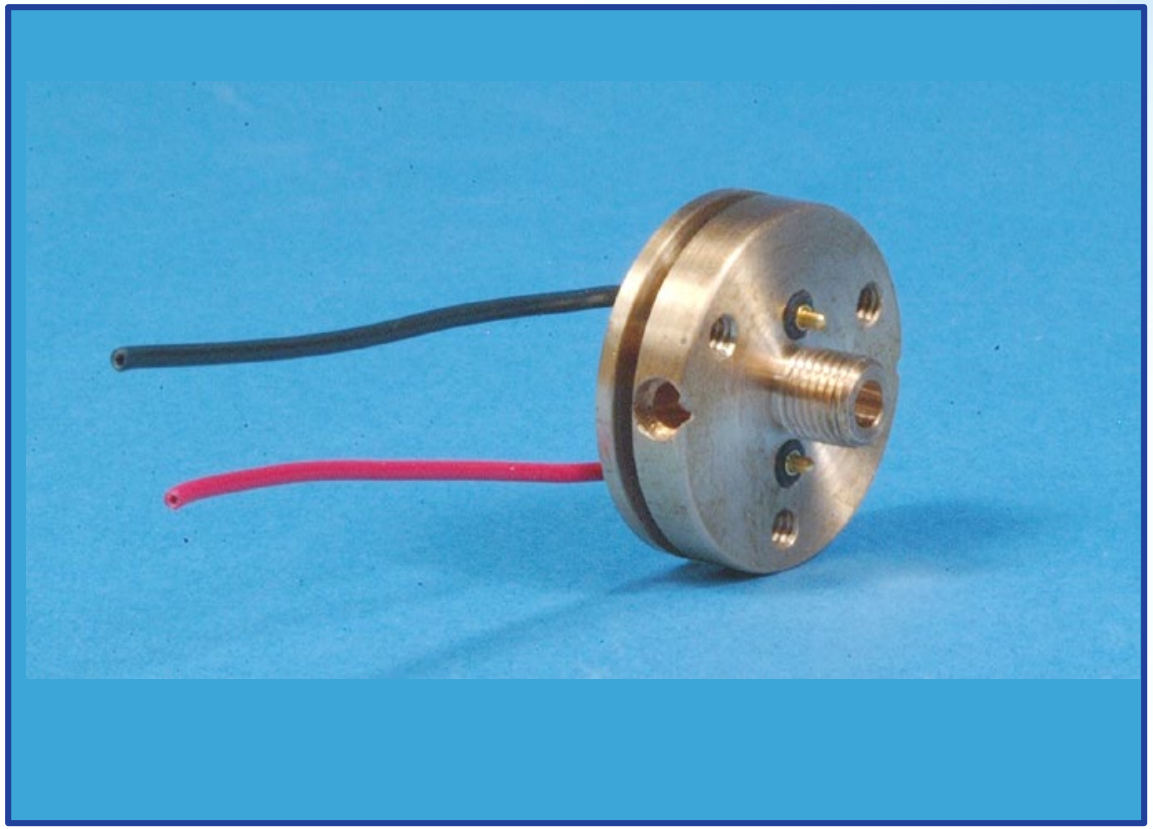

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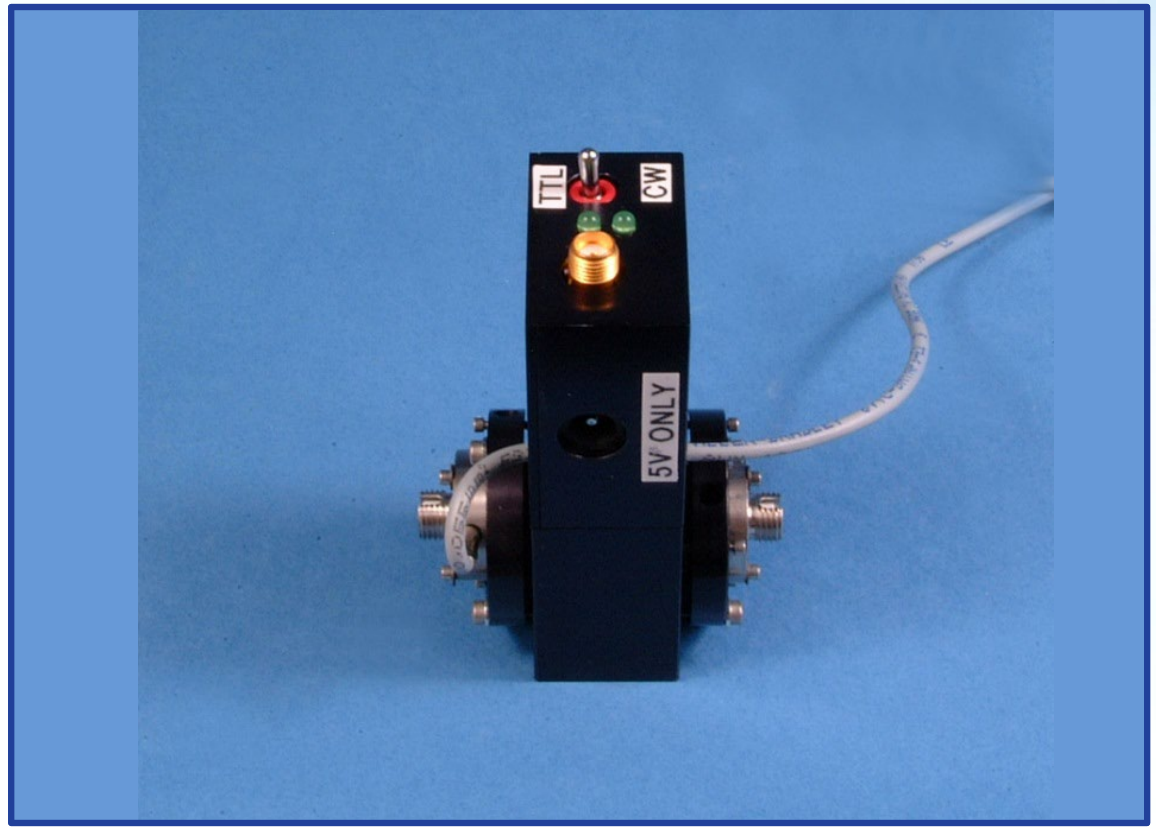

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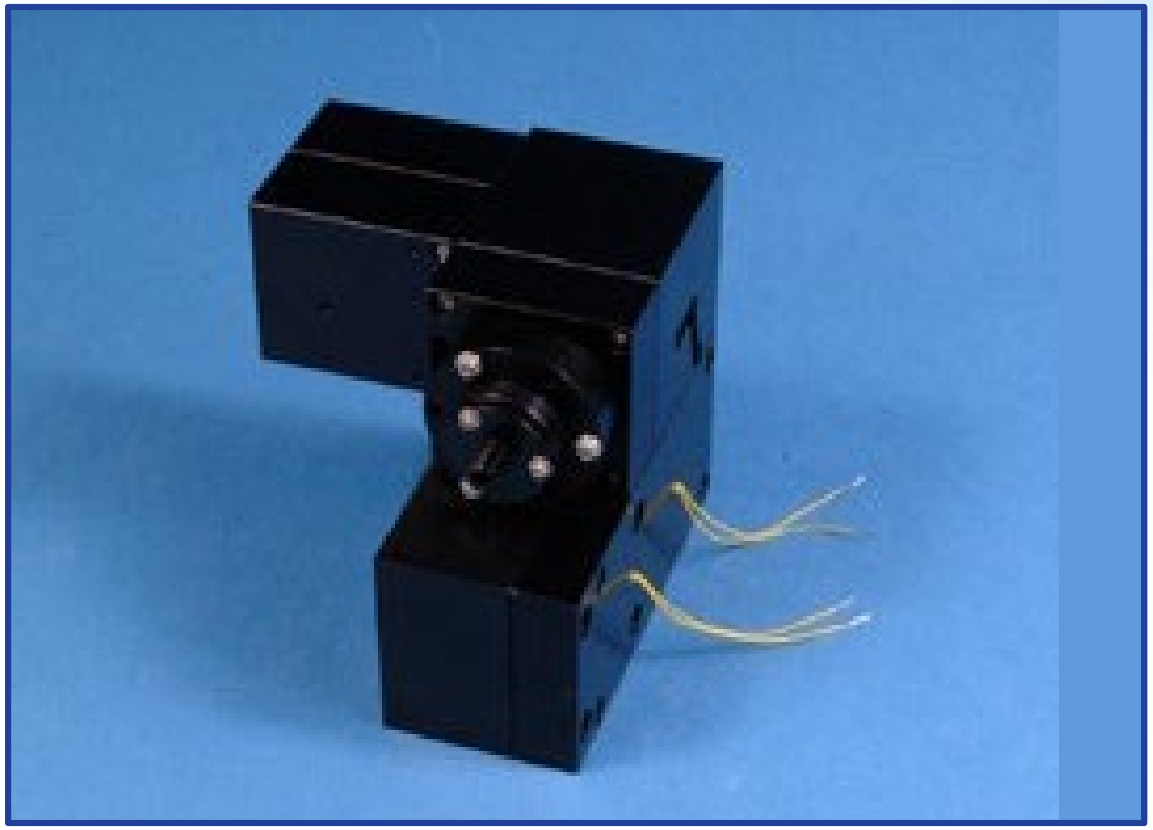
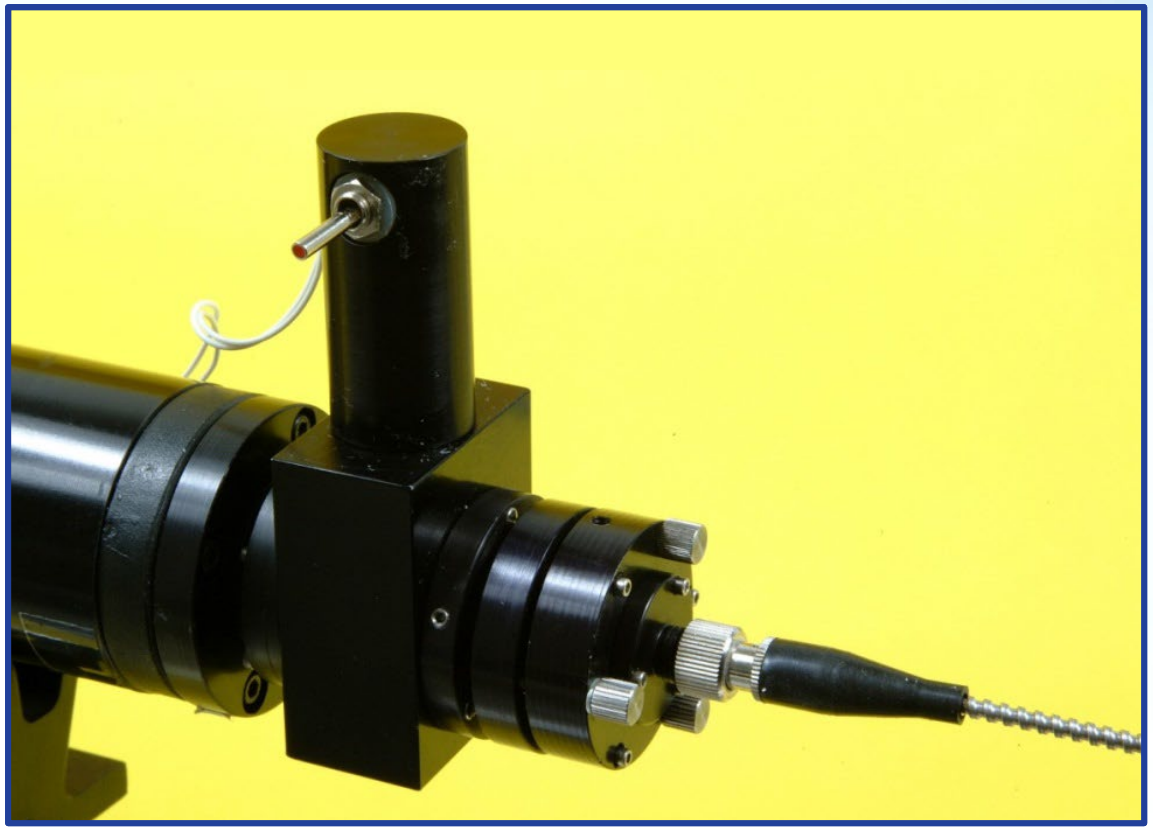


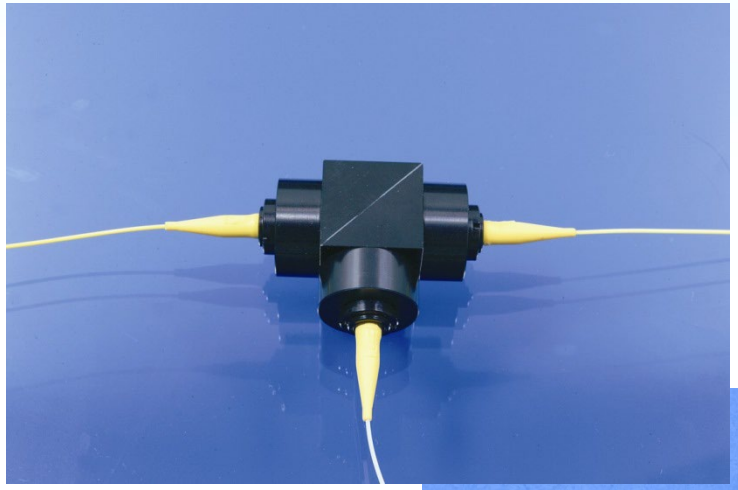
Laser To Fiber Coupler With Shutters

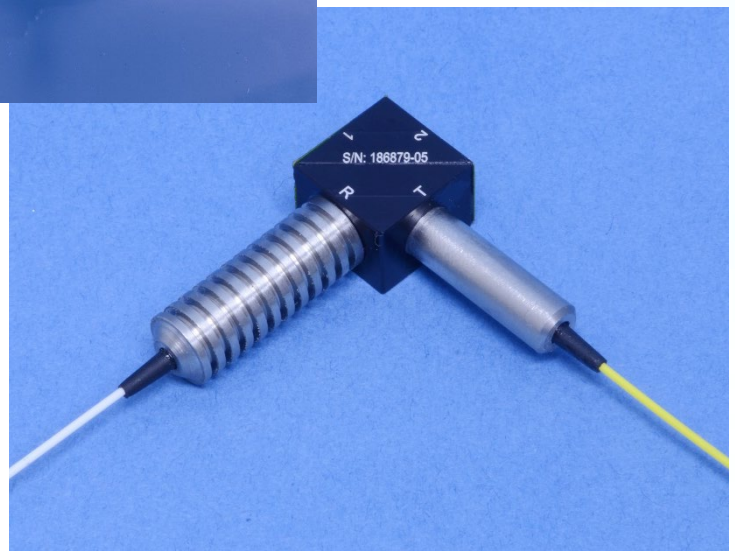
- Laser to Fiber Coupler with Shutters
- >60% Coupling Efficiency for SMF & PMF
- Up To 3 Watts Optical Power Handling
- Ideal for Safety Interlocks, Remote Control



High Power Wavelength Division Multiplexer

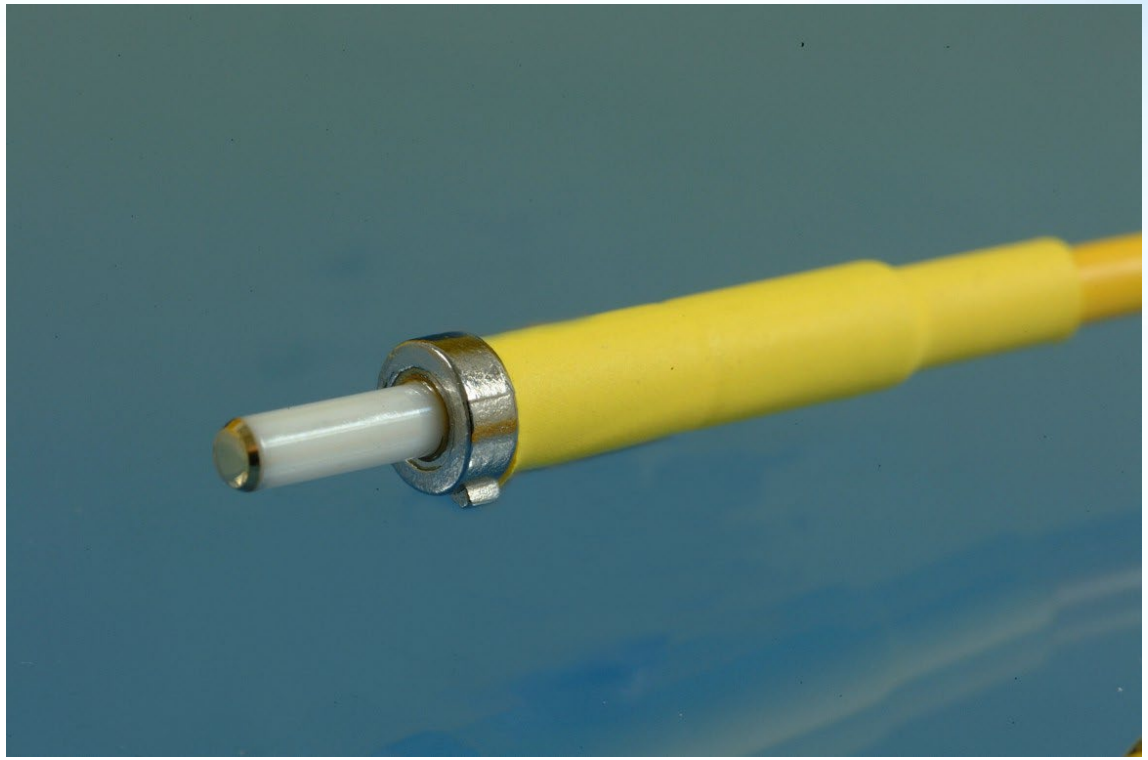
- 0.8 dB Insertion Losses, 65 dB Isolation
- Up To 200 Watt Power Handling
- -40 dB, -50 dB, -60 dB Backreflection





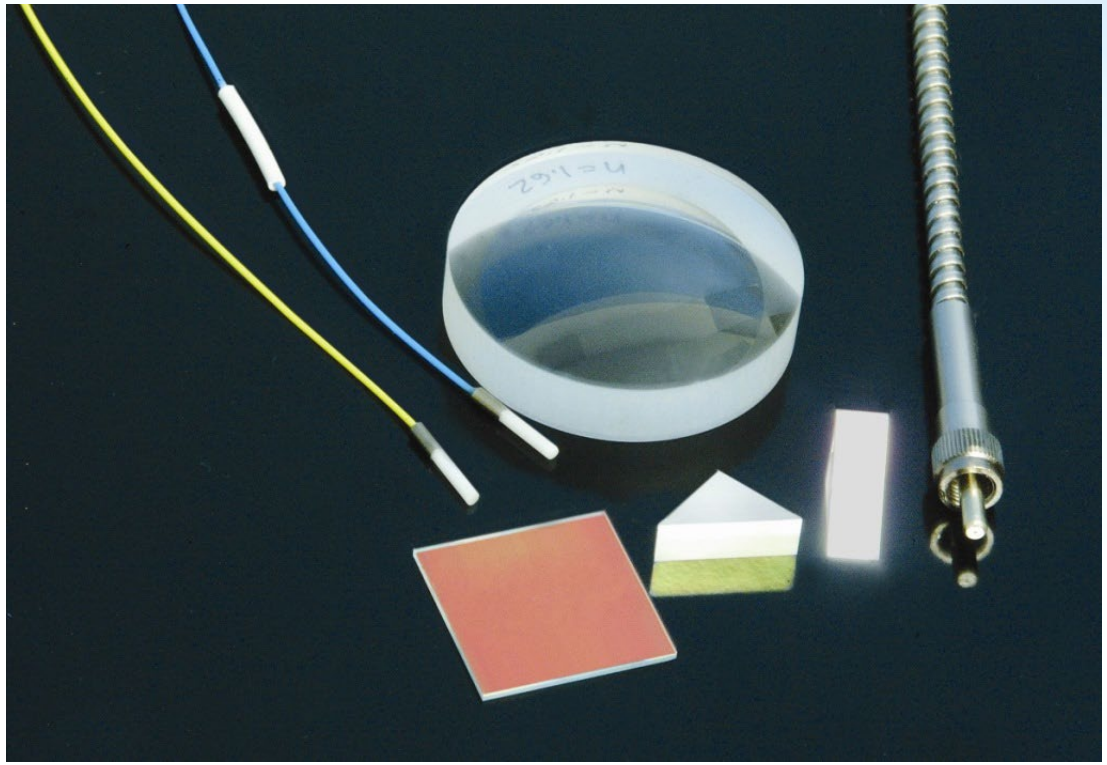
High Power Antireflection (AR) And Highly Reflective (HR) Coated Fiber Ends

- HR, R>98%, AR < 0.3%
- 350 nm to 2000 nm Wavelength Coatings
- SMF, MMF & PMF Versions



High Power Optical Coatings

- High Power AR, Beamsplitter, Dichroic Coatings
- Fibers, Micro Optics, Lenses, Plates, Prisms Etc.
- Low Temperature High Abrasion Resistant Coatings



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Email: sales@ozoptics.com

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