



Plasma Monitoring & Process Control System

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PlasCalc-2000-UV/VIS/NIR

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Real time and broad band fiberoptic spectrum acquisition

With its high resolution miniature fiberoptic spectrometer equipped with a 2048 pixel CCD and fast acquisition electronics, the PlasCalc acquires plasma light emission from 200 to 1100 nm in 3 ms. The well engineered PlasCalc process control system brings the benefits of sophisticated algorithms for data acquisition and signal treatment. The analog-digital OUTPUT and INPUT capabilities gives together with full PC connectivity all options to control the process.

Recipe editor

This tool allows the process engineer to easily and rapidly create an efficient process recipe by one click navigation to functions. It is easy to combine all these functions to build comprehensive recipes for the most difficult plasma processes.

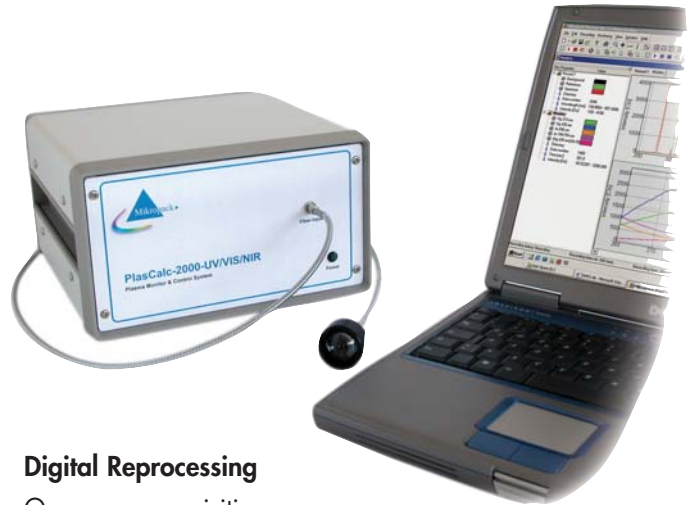


Tools for efficient Plasma Diagnosis

The Integrated formula editor gives easy access to a full range of mathematical functions. A library of emission wavelengths is as option available and gives direct access to species identification. The Wavelength editor allows their combination for signal to noise optimization. The double windows design gives easy access to the real actual spectrum and the monitoring screen with all process control information plus endpoints. Alarms monitor other events during the run to detect process drifts.

Multi applications easy to set up

The capability of using many significant wavelengths across the whole spectrum simultaneously make it possible to build recipes that can handle the most difficult process conditions such as very low open area; multi stack etches and trenches; film deposition; plasma etching; surface cleaning; plasma chamber health control; protection coating; pulsed magnetron sputtering of crystalline aluminum coatings; planarizing of blanket poly-silicon; recess depth while plugs are being recessed; and control of abnormal process phenomena (pollution, discharge etc). Efficient use of chamber capacity and reduction of monitor samples (wafers) by optimizing cleaning cycles.

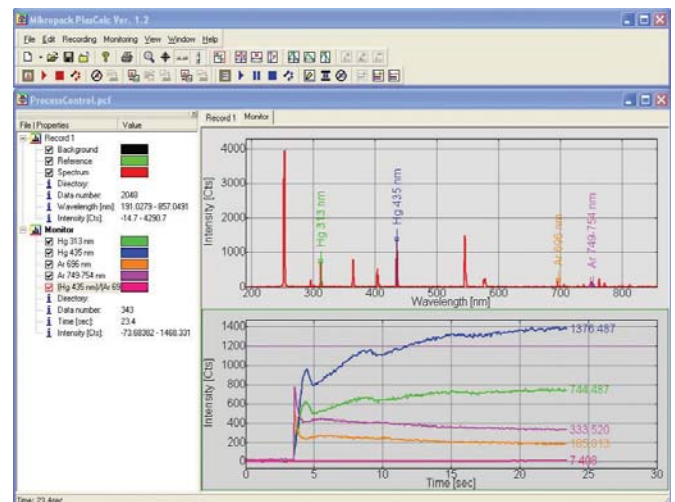


Digital Reprocessing

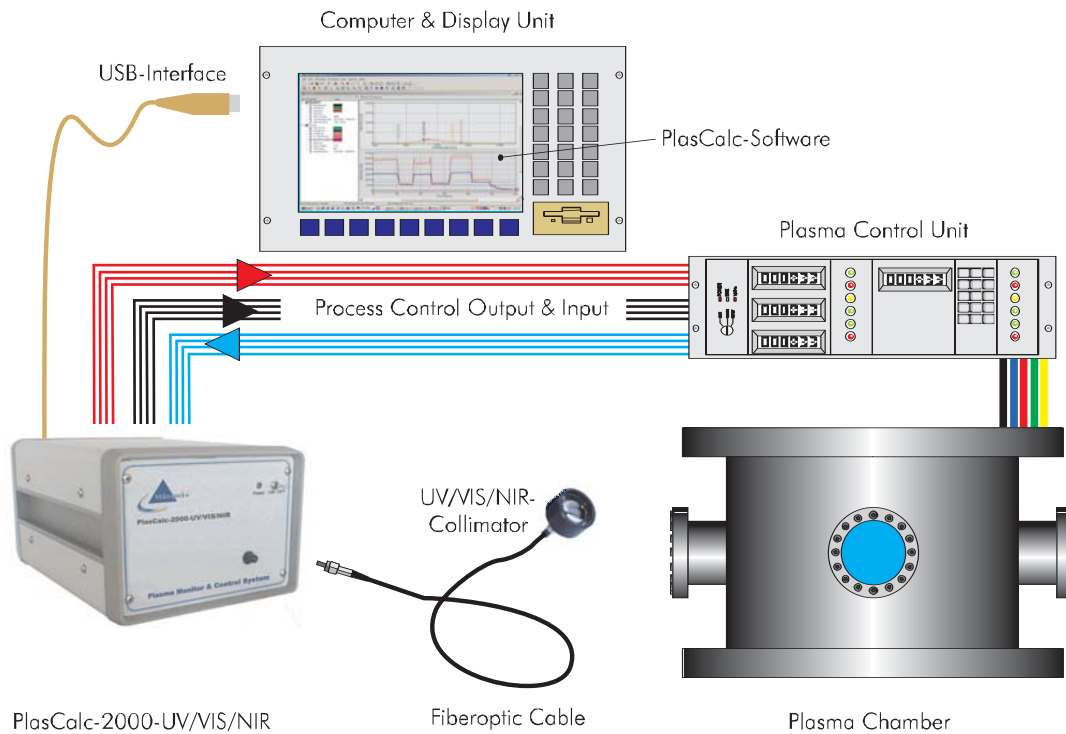
Once an acquisition run has been stored in the database, it can be reprocessed digitally, to build a robust step for accurate process monitoring and control. It minimizes the number of samples required for engineering. All runs can be saved as production runs for production simulation and analysis.

Full Connectivity

The USB interface concept allows it to be fully connected to external hardware with only one USB connection. The hardware remote control with digital In/Output and analog Signal Output of the PlasCalc enables it to be interfaced to the process equipment and the factory control system. The accessories are fibers, optics, collimators, vacuum feed through and customized solutions.

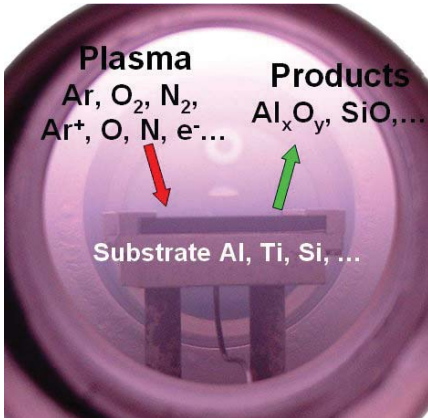


Plasma Monitoring & Process Control



Specifications:

Technical Data	PlasCalc-2000 - UV/ VIS/ NIR
Spectral range	200 - 1100nm
Optical resolution	1 nm FWHM (full width half maximum)
Fiber-Input-connector	SMA905
I/O-D/A-converter	14 bit
Digital Input/Output	8 x TTL / 8 x TTL
Analog Output /voltage sign.	4 x [0-10 V]
Interface	USB V 1.1
Power supply	12 V 1,25 A
Power requirements	90-240VAC 50/60 Hz
Markings	CE; VDI/VDE 0160 EN 61010
Operating temp./Humidity	5-35 °C / 5-95 % without condensation
Dimensions	257 x 152 x 263 mm
Weight	3,9 kg



The Plasma Parameters are:

- Gas mixture
- Plasma temperature
- Particle density
- Ionization, dissociation...

The Substrate Parameters are:

- Plasma interaction
- Sputtering, etching, cleaning, coating...
- Temperature
- Surface activity....

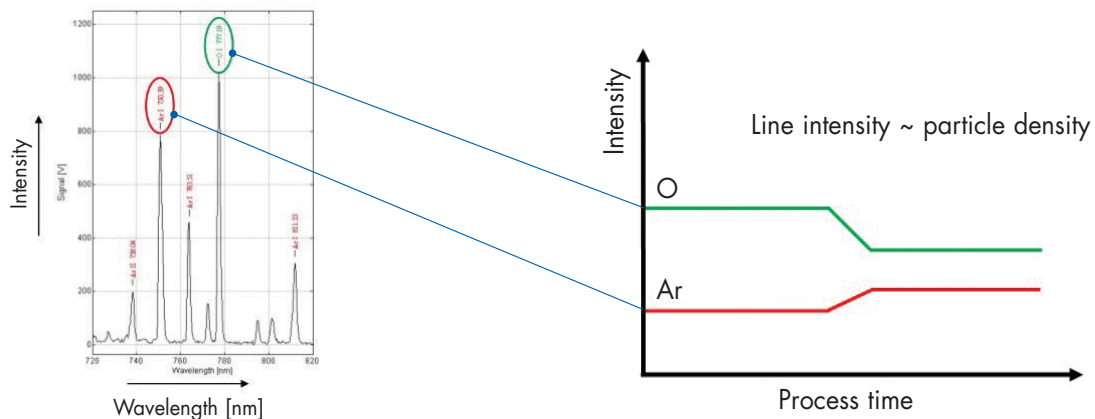
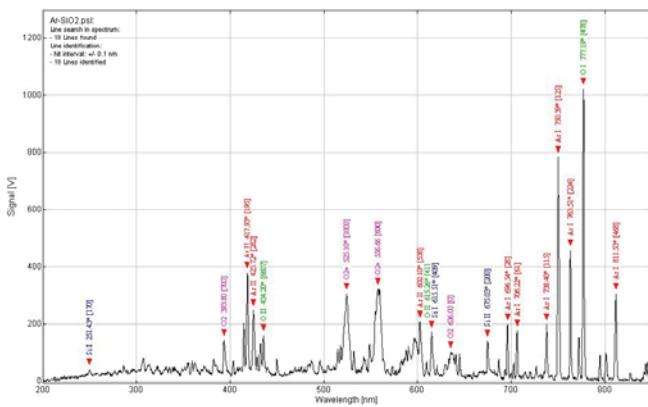
Optical Emission Spectroscopy is the only diagnostic method that can determine:

- Particle density
- Electron density
- Electron temperature

The Line intensity correlates with particle density and electron density.

The Intensity ratio yields particle density. Clever combination of lines of the same electron energy absorption compared to a third line gives back the correlation of the electron temperature.

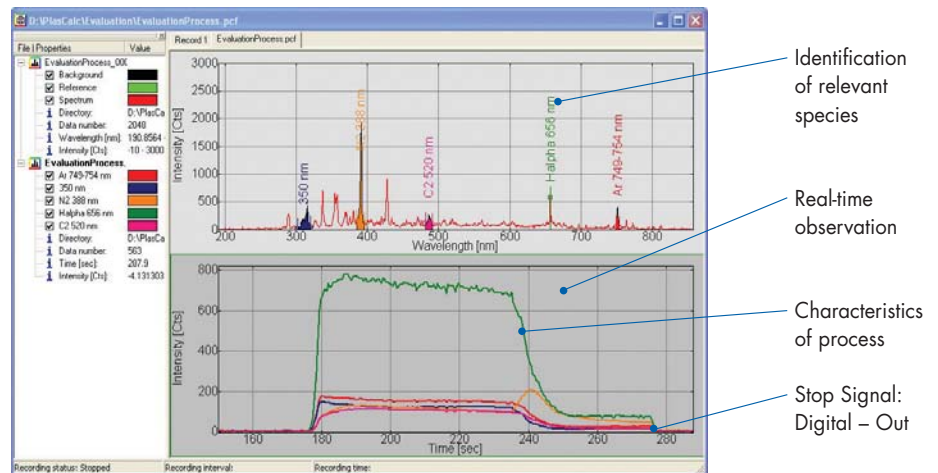
Now we have everything we need to fully control all of our relevant plasma process parameters.



Applications

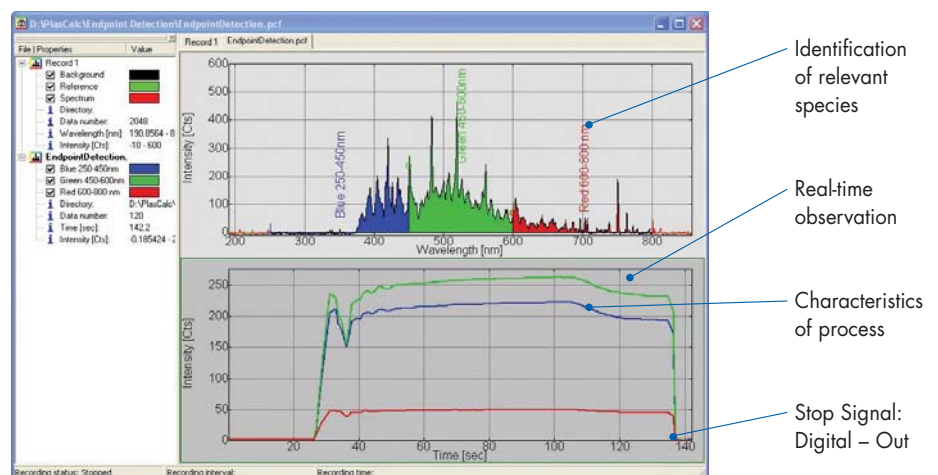
- Film deposition
- Plasma etching
- Surface cleaning
- Plasma chamber health control
- Protection coating

Example: Protection Coating



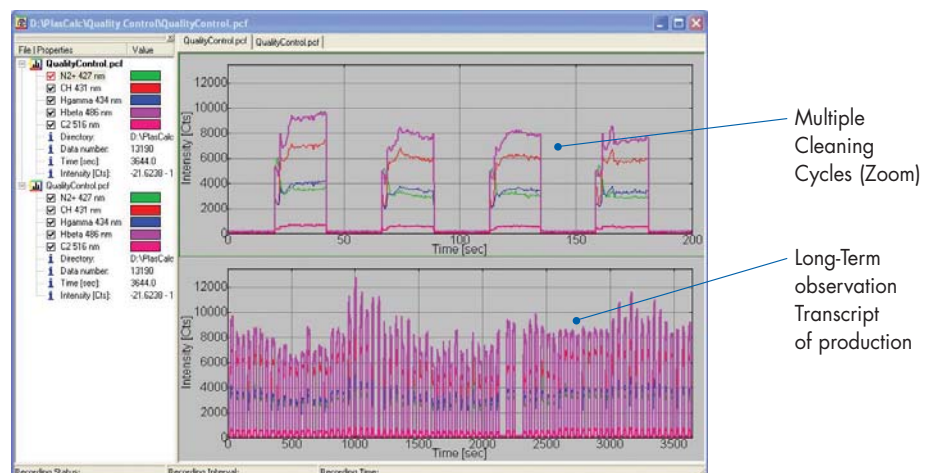
- Pulsed magnetron sputtering:
crystalline aluminum coatings
- Monitoring the endpoint when **blanket polysilicon** (100% Si loading) is being planarized
- Monitoring the **recess depth** while **plugs** are being recessed (<10% Si loading)

Example: Plasma Etching



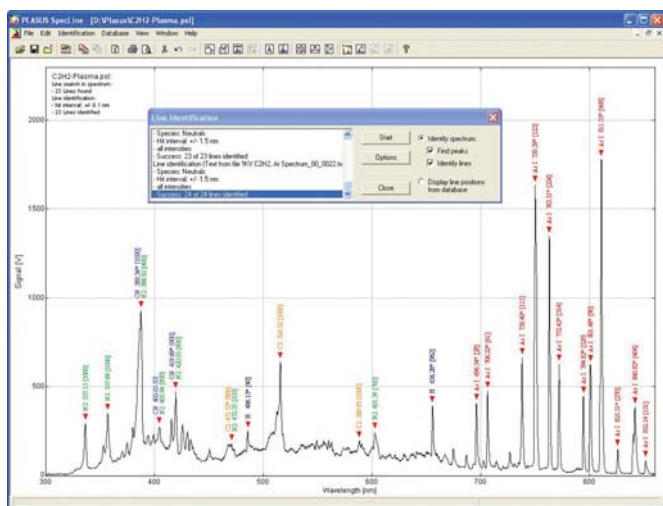
- Control of abnormal process phenomena, (pollution, discharge)
- Easy and complete optimization of new processes
- Maximises the capacity of chamber and decreases the number

Example: Surface Cleaning



SpecLine Software (OPTION) Peak finding and line identification

This high end software is for all scientists and engineers working in the field of spectroscopy, such as astrophysics, plasma science or plasma processing. This tool supports and makes it easy to evaluate spectral data, i.e. finding specific lines in spectra, identifying unknown peaks, identify atomic lines and molecular bands or comparing data from different measurements in spectral data. Almost instantly line peaks and bands will be found automatically using several powerful filter functions and the extensive data base for atoms and molecules.



Evaluation of Spectral Data

The spectral data may be evaluated using a variety of evaluation functions. You can change the display parameter of the spectrum, adjust the wavelength or you can smooth the data with a filter function.

Comparing of Spectral Data

Spectra comparison is easily possible in a single diagram. Up to twelve spectra – even with different file formats – can be opened in one single diagram. But still all the spectra may be evaluated by each other independently.

Peak Finding and Line Identification

In the special Line Identification dialog all the necessary parameters for peak finding and line identification can be easily defined and the line identification process can be started by a single click. In addition noise smoothing and specific filtering is possible to further improve automatic peak finding.



Database Search

The extensive database could be used for simulation too. After molecules and or atoms are selected, the line positions will be shown in the spectrum.

The figure shows the 'Database - 420 nm bis 435 nm' window. It displays a table of spectral lines found within the specified wavelength range. The table has columns for Line [nm], Element, I (rel.), Energy [eV] (lower - upper), Transition (lower - upper), Quantum number (lower - upper), and Comment.

Line [nm]	Element	I (rel.)	Energy [eV] lower - upper	Transition lower - upper	Quantum number lower - upper	Comment
420.0500	N2	600	7.39 - 11.05	B ² Pi(g) - C ² Pi(u)	6 - 2	2. Pos. System
422.5500	CH+	1000	0.00 - 2.99	X ² Sig+ - A ² Pi	0 - 0	Douglas-Hertzberg
422.6987	Ar II	502	21.35 - 24.28	4p ² P ^o - 5s ² D	1% - 2%	
423.6500	N2+	800	0.00 - 3.16	X ² Sig+u - B ² Sig+u	2 - 1	1. Neg. System
423.7600	CH+	1000	0.00 - 2.99	X ² Sig+ - A ² Pi	0 - 0	Douglas-Hertzberg
426.9700	N2	500	7.39 - 11.05	B ² Pi(g) - C ² Pi(u)	5 - 1	2. Pos. System
427.7528	Ar II	1048	18.45 - 21.35	4s ² D - 4p ² P ^o	2% - 1%	
427.8100	N2+	900	0.00 - 3.16	X ² Sig+u - B ² Sig+u	1 - 0	1. Neg. System
431.4200	CH	1000	0.00 - 2.87	X ² Pi - A ² Del	0 - 0	Q-Head
432.4000	CH	600	0.00 - 2.87	X ² Pi - A ² Del	2 - 2	Q-Head
432.9439	Ar II	759	23.90 - 26.66	4p ² P ^o - 5s ² S	1% - 1%	
434.3600	N2	400	7.39 - 11.05	B ² Pi(g) - C ² Pi(u)	4 - 0	2. Pos. System
434.8064	Ar II	453	16.64 - 19.49	4s 4P - 4p 4D ^o	2% - 3%	

Premium-grade Optical Fiber Assembly Specifications:



Operating wavelength:	UV-VIS (High-OH) 250 - 800 nm NIR (Ultra-low OH) 400 - 2100 nm UV (Solarization-resist.) 200 - 800 nm
Bare fiber:	Pure fused-silica core and fluorine-doped cladding, polyamide buffer
Fiber profile:	Step-index multimode
Numerical aperture:	0.22 +/- 0.02 (24.8°)
Core to cladding ratio:	1 to 1.10 (for core diameters > 200 µm)
Jacketing	Silicone-coated steel monocoil with Dacron braid
Terminations:	Precision SMA 905 Connectors
Operating Temp.:	up to 225°C
Bend radius:	Momentary = 200 x fiber core diam. Long-term = 600 x fiber core diam.

Specifications Collimating Optics COL-UV-6 COL-UV-30



Spectral range:	200 - 2000 nm
Material:	Fused silica Suprasil
Diameter:	6 mm / 30 mm
Focal length:	10 mm / 30 mm
Operating Temp.:	up to 225°C
Fiber connector:	SMA 905
Outside Dimension:	3/8 - 24 thread, D = 35 mm
Surface Finish:	Al black anodized

Vacuum Feed Through

The VFT Vacuum Feed Through channels light into and out of a vacuum chamber for optical monitoring in semiconductor processing and endpoint detection of thin film deposition.

- Performs well in NEMA enclosures and in high-pressure applications
- Vacuum rated to 10^{-10} Torr
- Operates up to 350 °C
- Glass-to-metalized optical fiber improves performance



The VFT contains a robust novel metal-to-glass seal that improves the VFT's performance in ultra-high vacuum applications. Each VFT is tested and certified to 10^{-10} Torr and operates to 350°C.

In addition to the VFT's use in semiconductor and thin films processing, the VFT is ideal for the optical coatings production. It can also be used in molecular beam epitaxy and chemical and physical vapor deposition, and is perfect as a general purpose feed through for NEMA enclosures, glove boxes and moderate-pressure installations.



The VFT's high- and low-pressure sides are terminated in a SMA 905 Connector which couples easily to optical fibers and the Mikropack PlasCalc-2000-UV/VIS/NIR system.

The VFT can be screwed into a 3/8-24 external threaded hole in the vacuum chamber, or can be bolted through a blank hole using the nut and washer provided. Optional aluminum-jacketed or armored-cable optical fiber assemblies are recommended for the low-pressure side of the chamber.

Vacuum Feed Throughs are available in optical fiber diameters of 200, 400, 600 and 1000 µm diameters. Each VFT includes two SMA Splice Bushings an inline adapter that mates SMA 905 Connectors.



System:

PlasCalc-2000-UV/VIS/NIR: Optical Emission Spectrometer, 200-1100nm, resolution 1nm FWHM, Input/Output-Unit with 14 bit D/A converter (4 x analog, 8 x digital input/output), Desktop housing, 1 x USB 1.1 Interface, 12 VDC power supply included, SMA Input, PlasCalc software included

Software:

PlasCalc Software: Real-time and in-situ access to the optical emission spectra of plasma processes. Monitoring- and control-window in dual-screen technique. Fully access to all functions via easy menu orientated software surface. Multiple plasma species can be picked by a mouse click, mathematically calculated, subtracted and monitored in real time and insitu. Capabilities; 8 digital inputs and outputs, 4 analog output channels, display messages with tone signal that can be set up for end point, start, stop and limit. (included in System)

SpecLine Software: For spectroscopy, astrophysics, plasma science or plasma processing. This tool supports and makes it easy to evaluate spectral data, i.e. finding specific lines in spectra, identifying unknown peaks, identifying atomic lines and molecular bands or comparing data from different measurements in spectral data. Almost instantly peaks of lines and bands will be found using several powerful filter functions. Extensive data base for atoms and molecules included.

Accessories:

COL-UV-6: Collimating Lens UV/VIS/NIR, fused silica Suprasil I®, 200-2000 nm, d = 6mm, f = 10 mm, 225 °C, SMA 905, 3/8-24 thread

COL-UV-30: Collimating Lens UV/VIS/NIR, fused silica Suprasil I®, 200-2000 nm, d = 30mm, f = 30mm, 225 °C, SMA 905, AD = 35mm

Fiber-Cable: Extra rugged with flexible stainless steel coil, quartz/quartz-core, silicone overcoat and Dacron braid and strain release. For temperatures up to 225 °C. UV/VIS/NIR Fiber assemblies solarization resistant and 1-25 m length available.
Ask us for your customized fiber setup.

Vacuum-Feed-Through: Stainless steel housing, be screwed into a 3/8-24 external threaded hole
Performs well in NEMA enclosures and in ultra high vacuum and high-pressure applications, vacuum rated to 10^{-10} Torr, Operates up to 350 °C, Glass-to-metalized optical fiber, each VFT is tested and certified.

PVFT-UVX-SR with single UV-Fiber, select Core Diameter: X = 200, 400, 600 µm
PVFT-UVX with single UV-Fiber, select Core Diameter: X = 800, 1000 µm
-SR = solarization resistant (if spectra is required below 250nm)
Standard flanges with vacuum feed through are available

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