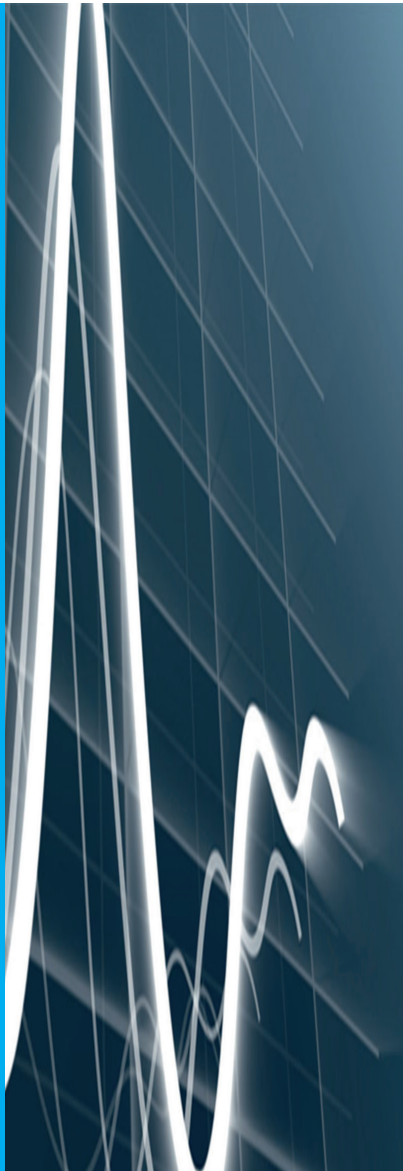
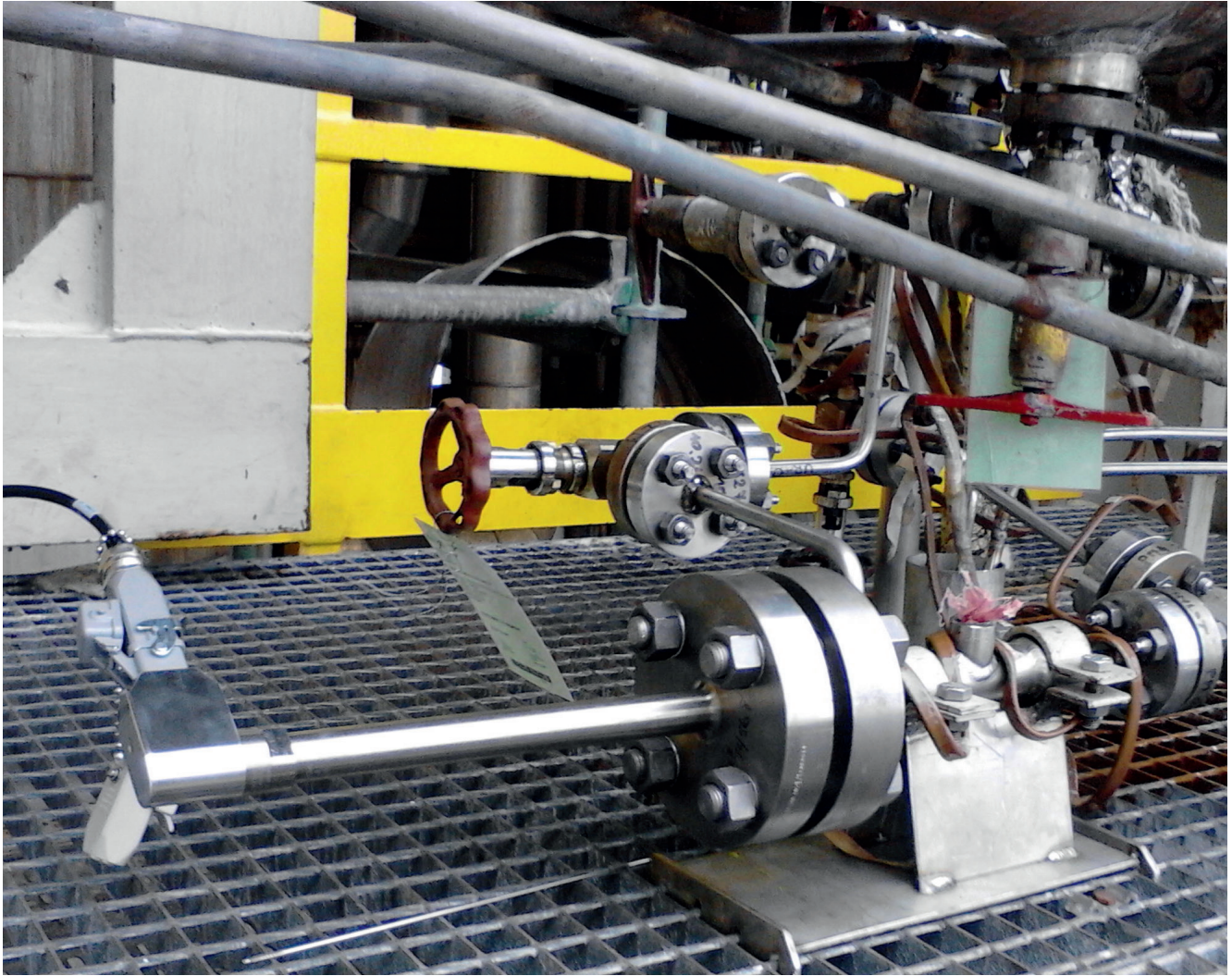


Sampling Probes for Raman Spectroscopy

Real-time inline chemical monitoring & control for lab or process





Contents

3	Challenges in lab-to-process analysis
4	Kaiser Optical Systems, Inc.: your partner in success
6	Sampling in bioprocessing
8	Sampling in solids
10	Sampling in liquids and gases
12	Technical specifications

Learn about Kaiser's competencies in sampling probes:



Challenges in lab-to-process analysis

Bringing chemical analysis from the laboratory to the process environment can help you realize process efficiency gains and ensure product quality



Deliver consistent product quality from the beginning Kaiser Raman provides *in situ*, real-time analysis of multiple components with a single probe. Through this information, you can gain process understanding, ensure the process is within control, and identify product quality markers for real-time release. Kaiser helps you efficiently and consistently deliver higher yield and improved product quality with reduced process risk.

Getting it right the first time We understand continuous improvement is key in an ever-changing business and regulatory environment. The trusted scalability and performance of Kaiser Raman simplifies your process equipment complexity and model transfer. We continue our history of excellence through our analysis products, compliance offerings, services, and support. These offerings allow you to focus on your core business while benefiting from our experience to ensure a rapid return on investment.



Complexity, simplified We put our experience in instrumentation, process analysis, and data analysis into the design and manufacturing of our products so you can easily integrate Kaiser Raman in laboratory or process environments with full confidence in our robust and reliable analytical solutions.

Successes from process innovation to process automation Kaiser has an established installation base throughout the world in manufacturing environments. Our proven reliability, scalability, automation integration, and compliance sets Kaiser above traditional off-line analyzers and other sensors. Our installation base worldwide speaks to how industry leaders trust their products to Kaiser Raman.

Kaiser Optical Systems, Inc.: a partner in success

Benefit from Kaiser's comprehensive product selection and application expertise to enable chemical analysis in any installation environment

From our 30+ years of experience in Process Raman, we understand the value of being a trusted partner. Kaiser has an established history, from its first feasibility studies in the 1990's to our first cGMP installation in 2000. Our comprehensive approach integrates high performance analyzer equipment, fiber optic sampling probes, and user-friendly software into a solution that is robust and reliable.

Our focus on quality, exceptional customer service, and people make The Kaiser Difference. These aspects distinguish Kaiser as a leader in process Raman spectroscopy. Kaiser is committed to providing our customers with quality products and services that represent the best value. To achieve this goal we have developed and maintain an ISO 9001:2015 based QMS that includes processes, process controls, and measurable quality objectives and targets. And, we provide a comprehensive offering in compliance services so that you can focus on your core responsibilities.

Kaiser's fiber-optic sampling probes ensures non-destructive, continuous, and real-time chemical analysis without needing to collect a sample or modify existing process hardware. Kaiser's probes are optimized for solids, liquids, gases, or turbid media to ensure high performance in the laboratory or in the process. Fiber optic probes enable chemical analysis in any installation environment including direct immersion, through a site glass, in a sleeve-type port, and in slip-stream. Modular designs are available for site installation or site acceptance.

Kaiser's comprehensive selection of probes and optics

	Solids	Liquids	Gases	BioProcessing	ATEX/NA certifiable
bIO-LAB		X		X	
bIO-PRO		X		X	
SUB-OPTIC				X	
Raman Rxn™	X	X		X	
P ^h AT	X				X
WetHead™		X			X
Pilot™		X			X
AirHead™			X		X
Immersion Optic		X			
Non-contact Optic	X	X			



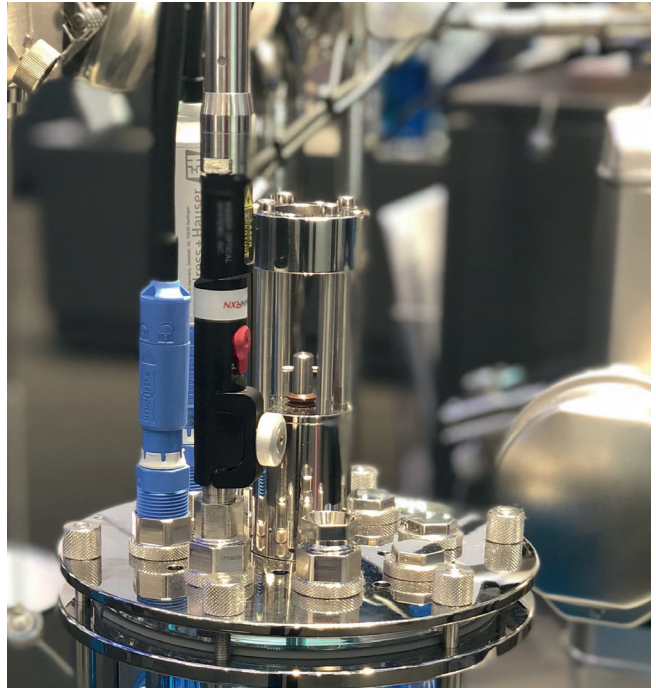
Sampling in bioprocessing

For successful lab-to-cGMP bioprocess monitoring and control

Kaiser has an established history in life sciences, from its first feasibility studies in the mid 1990's to our first GMP manufacturing installation in 2000. We bring this experience to bioprocessing, and our expertise in life sciences from R&D to GMP is one reason why Kaiser has been a leader of *in situ* monitoring and control in bioprocessing for over 10 years.

Kaiser has the right sampling solution from R&D to PD to cGMP whether you use stainless steel, glass or plastic single-use bioreactors. Our suite of bioprocessing probes feature a state-of-the-art, fixed-focus design which provides for long-term measurement stability so that you get the same results regardless of the bioreactor scale.

In process development applications, our probes are compatible with CIP/SIP, autoclave or gamma radiation sterilization protocols. In cGMP applications, our probes are compatible with CIP/SIP or gamma radiation sterilization. In single-use bioreactors, our SUB-Optic is compatible with gamma radiation sterilization.



Proven Kaiser Raman Applications in Bioprocessing

Cell Culture	Fermentation	Downstream
Glucose	Glycerol	Aggregation
Lactate	Methanol	Protein crystallization
Glutamate	Ethanol	Formula stability
Amino acids	Sorbitol	Product COA
Cell density	Biomass	Protein concentration
Titer		Buffer excipients

Additional product and process related COAs possible

 **"I need full application and development support"**

Our response:

- We are your solution from technology to implementation
- Kaiser's modeling, training, and advanced analytics services provide an opportunity for you to benefit from our experience in life sciences and expert application support so that you can focus on your core business



Learn about our focus on quality:





bIO-LAB Raman probe

- Bioprocess industry standard port design
- Pg 13.5 threaded connector
- 220, 320, or 420 mm length
- IP65 rated
- Autoclavable



SUB-Optic probe system

- Developed according to industry standards for single use sensors
- Materials of construction tested at an independent agency
- FDA-compatible window
- cGMP qualified
- Gamma sterilizable



bIO-PRO Raman probe

- Bioprocess industry standard port design
- Pg 13.5 threaded connector with 120 mm probe length
- Surface finish 15 Ra or better
- CIP, SIP compatible



Sampling in solids

Kaiser Raman has the widest selection of offerings to enable chemical analysis in any installation environment

The P^hAT approach to Raman sampling redefines solids and turbid media sampling by eliminating sample irreproducibility and focusing, by measuring a large area of sample simultaneously, and by offering the benefits of non-destructive sampling using laser powers below the ANSI exposure limit for skin.

A large excitation spot (6 mm) and multiple collection fibers in the P^hAT probe achieves sampling in both the axial and lateral dimensions. The large volume sampled by the P^hAT probe provides information on deeper layers in addition to the surface, which is useful for measuring a layered solid such as a tablet or capsule.

In-process Kaiser Raman measurements involving solids or turbid media, which are characterized by their high optical scattering properties, are established in pharmaceutical and polymer applications.




Proven Kaiser Raman Applications in Solids

Polymers	Pharmaceutical Solids	Chemicals
Extruded pellet quality	Crystallinity	Final product quality
Crystallinity	Polymorphism	Blend impurities
Density	Granulation	Crystallinity
Raw materials	Blend uniformity	Raw materials
	Biomass	
	Content uniformity	
	Coating	
	Tableting	

"How do I decide what probe is right for my application?"

Our response:

- Talk to our expert application scientists, who are knowledgeable in your application and Raman spectroscopy hardware
- Our application feasibility services can help you choose the right probe quickly

 Find Kaiser at your next conference:





Raman Rxn™ probe with non-contact optic

Laboratory solids or turbid media probe

- Range of working distances for remote measurements on solids or through sight glass
- Visible or near-infrared wavelengths



P^hAT probe

Laboratory or process solids

- Remote measurements on solids or through sight glass
- 3mm, 4.5 mm, or 6mm spot size
- Representative sampling without needing to align probe for surface roughness



Sampling in liquids and gases

Benefit from Kaiser's comprehensive product selection and process expertise to enable chemical analysis in any installation environment

Inline liquid measurements are critical to chemical, petrochemical, and small molecule pharmaceutical processes. Inline Kaiser Raman gives real-time chemical measurements without needing to send a technician to the field and collect a sample from the stream. Kaiser's line of probes for liquids analysis spans from laboratory measurements to process analysis. The probes feature Kaiser's design, including optimized signal collection and bubble-shedding characteristics, so that you can collect high performance measurements in any environment.

The Raman Rxn™ probe is designed for laboratory measurements. It is versatile enough to accept a range of immersion optics. The immersion optic line includes a standard ½" optic, ¼" optic for small reactors, and manufacturer specialized optics.

The WetHead™ probe is one of Kaiser's process probes for liquids that is compatible with installations in hazardous area/classified environments. The WetHead™ can be certified to meet both North American and European ATEX hazard area standards. Construction from Alloy C276, stainless steel 316L, or titanium grade 2 supports a range of chemical processes and corrosivity requirements.

The Pilot-E™ probe is another process probe for classified locations. The Pilot-E™ probe can be certified to North American or European ATEX hazard area safety standards.



Proven Kaiser Raman Applications in Liquids and Gases

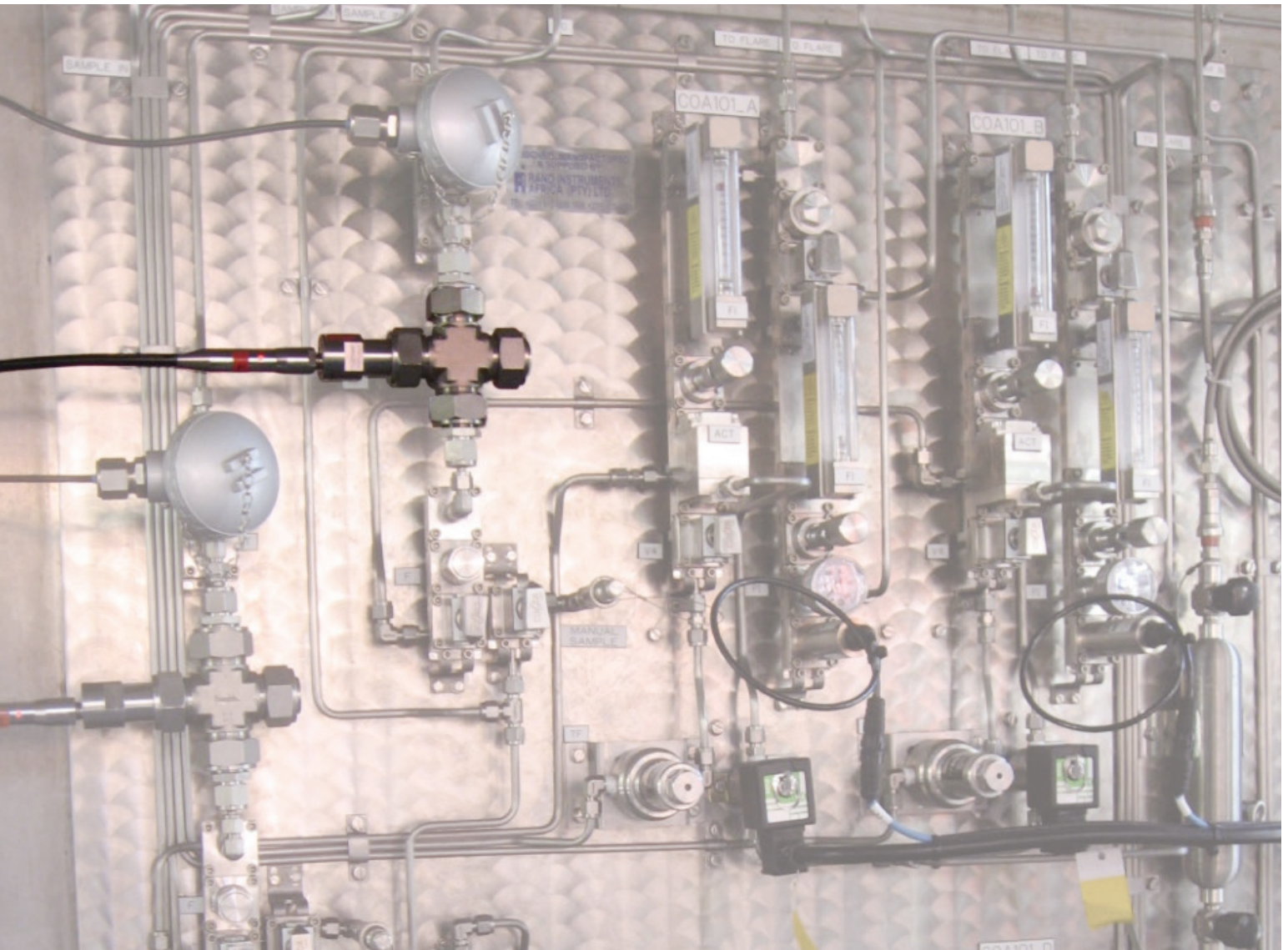
Bioprocessing	Chemical	Polymer	Pharmaceutical
Offgas	Reaction Monitoring	Polymerization reaction monitoring	API reaction monitoring
Volatiles	Blending	Extrusion monitoring	Crystallization
	Catalysis	Polymer blending	Polymorph
			Blending
			Coating
			Granulation

Contact Kaiser for technical references and other possible applications.

 **Kaiser's complete compliance services** helps you to ensure a seamless transition to cGMP manufacturing while maintaining quality. We carry an ISO9001:2015 certification, ensuring quality to our customers, and have over 20 years experience in cGMP installations.

Kaiser provides:

- Questionnaire and audit support
- Standard and customized IQ/OQ
- Factory acceptance testing
- In-house audits
- Supplier qualification
- cGMP trained service personnel



Raman Rxn™ probe with immersion optic
Laboratory liquid probe

- Compatibility with immersion optics, bioprocess optics, non-contact optics
- NeSSI compatible



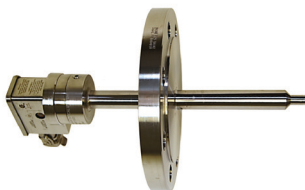
WetHead™ probe
Process liquid probe

- Compatible with direct insertion or slip-stream
- Alloy C276, Stainless steel 316L or Titanium construction
- ATEX or NA certifiable



Pilot-E™ probe
Process liquid probe

- Process probe compatible for direct insertion
- Meets Category I pressure equipment safety standards
- ATEX or NA certifiable



AirHead™ probe
Process gas probe

- Direct insertion, side insertion or sample loop
- NeSSI compatible
- Slip-stream compatible
- Sealed internal probe volume



Technical specifications: probes for bioprocessing

Technical Specifications			
	bIO-LAB	bIO-PRO	SUB-OPTIC System
Laser wavelength	785 nm, 1000 nm	785 nm, 1000 nm	785 nm, 1000 nm
Spectral coverage	150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)	150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)	150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)
Maximum laser power into probe head	500 mW	500 mW	500 mW
Sample interface	Temperature, bIO-Optic: -30°C to 150°C Temperature, Raman Rxn™ probe head: -10°C to 70°C Temperature ramp: withstands thermal shock Pressure: ≤200 psi	Temperature: -30°C to 150°C Temperature ramp: withstands thermal shock Pressure: ≤200 psi	Temperature, SUB-Optic: 0°C to 100°C Temperature, Raman Rxn™ probe head : -10°C to 70°C Pressure: ≤20 psi
Body and wetted materials	Body: 316L stainless steel Window: FDA-compatible window Process connection: Pg 13.5 Surface finish: Ra 15 or better Adhesive: USP Class VI biocompatible	Body: 316L stainless steel Window: FDA-compatible window Process connection: Pg 13.5 Surface finish: Ra 15 or better Adhesive: USP Class VI biocompatible	Body: 316L stainless steel Window: FDA-compatible window Process connection: Pg 13.5 Surface finish: Ra 15 or better Adhesive: USP Class VI biocompatible
Fiber optic cable	Design: PVC jacketed, proprietary construction Connections: proprietary electro-optic Temperature: -40°C to 80°C Length: 5000 mm (16.4 feet), contact Kaiser for custom lengths Minimum bend radius: 152.4 mm (6 inches)		
Length (mm)	bIO-Optic: 220, 320, 420 Raman Rxn™ probe head: 200	Insertion length: 120 Probe dimensions: 305 x 127 x 38	Insertion length: 5.1
Diameter (mm)	bIO-Optic: 12 Raman Rxn™ probe head: 19	12	
Sterilization protocol compatibility	Autoclave, CIP, SIP	SIP/CIP	Gamma irradiation

Technical specifications: probes for solid-phase

Technical Specifications

	Raman Rxn™ probe with non-contact optic	P ^h AT
Laser wavelength	532 nm, 785 nm, 1000 nm	785 nm
Spectral coverage	175-4323 cm ⁻¹ (532 nm) 150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)	175-1875 cm ⁻¹ (785 nm)
Maximum laser power into probe head	500 mW	500 mW
Sample interface	Temperature, non-contact optic: ambient Temperature, Raman Rxn™ probe head: -10°C to 70°C Pressure: ambient Relative Humidity: ambient	Temperature: 10°C to 40°C Pressure: ambient Relative Humidity: 20-80%, non-condensing
Body and window materials	Body: Aluminum Window: Optical-grade materials	Body: 316L stainless steel Window: Optical-grade materials
Fiber optic cable	Design: PVC jacketed, proprietary construction Connections: proprietary electro-optic Temperature: -40°C to 80°C Length: 5000 mm (16.4 feet), contact Kaiser for custom lengths Minimum bend radius: 152.4 mm (6 inches)	Design: PVC jacketed, proprietary construction Connections: proprietary electro-optic Temperature: -40°C to 80°C Length: 15000 mm. Contact Kaiser for custom lengths Minimum bend radius: 152.4 mm (6 inches)
Length (mm)	Non-contact optic: optic-dependent Raman Rxn™ probe head: 200	Probe: 305
Diameter (mm)	Non-contact optic: optic-dependent Raman Rxn™ probe head: 19	46
Working distance (mm)	10-432	120 (3mm lens) 175 (4.5 mm lens) 250 (6 mm lens)
Certifications	N/A	Contact Kaiser for hazardous area certifications

Technical specifications: probes for liquid-phase

Technical Specifications			
	Raman Rxn™ probe with immersion optic	WetHead™	Pilot-E™
Laser wavelength	532 nm, 785 nm, 1000 nm	785 nm, 1000 nm Contact Kaiser about 532 nm options	785 nm, 1000 nm Contact Kaiser about 532 nm options
Spectral coverage	175-4323 cm ⁻¹ (532 nm) 150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)	150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)	150-3425 cm ⁻¹ (785 nm) 200-2400 cm ⁻¹ (1000 nm)
Laser maximum	Maximum power into probe head: 500 mW		
Sample interface	SS 316L: -30° to 120°C Alloy C276: -30° to 280°C Titanium: -30° to 300°C Temperature ramp: ≤6°C/min	WetHead™ Mini SS 316L: -30° to 120°C Alloy C276: -30° to 150°C Titanium: -30° to 150°C Temperature ramp: ≤30°C/min WetHead™ Max SS 316L: -30° to 120°C Alloy C276: -30° to 280°C Titanium: -30° to 300°C Temperature ramp: ≤30°C/min	SS 316L: -30° to 120°C Alloy C276: -30° to 150°C Titanium: -30° to 150°C Temperature ramp: ≤6°C/min Flange: up to 305 diameter, ANSI B 16.5 or DIN
	Relative Humidity: up to 95%, non-condensing Pressure: SS 316L: up to 370 psi, Alloy C276: up to 650 psi. Titanium: up to 150 psi		
Body and wetted materials	Immersion Optic Body: Alloy C276 SS 316L, upon request Titanium, upon request Immersion Optic Window: High-purity sapphire	Body: Alloy C276 SS 316L, upon request Titanium, upon request Window: High-purity sapphire	Body: Alloy C276 SS 316L, upon request Titanium, upon request Window: High-purity sapphire
Fiber optic cable	Design: PVC jacketed, proprietary construction Connections: proprietary electro-optic Temperature: -40°C to 80°C Length: 5000 mm (16.4 feet) standard, custom lengths available Minimum bend radius: 152.4 mm (6 inches)		
Length (mm)	Immersion optic: 152, 305, 457 Raman Rxn™ probe head: 200	Immersion, WetHead™ Mini: up to 36 Immersion, WetHead™ Max: up to 457	Up to 4600
Diameter (mm)	Immersion optic: 12.7 Raman Rxn™ probe head: 19	12.7	From 25-51
Certifications	N/A	Contact Kaiser for hazardous area certifications	Contact Kaiser for hazardous area certifications

Technical specifications: probes for gas phase

Technical Specifications

	AirHead™
Laser wavelength	532nm
Spectral coverage	175-4325 cm ⁻¹ (532 nm)
Maximum laser power into probe head	500 mW
Sample interface	Temperature, probe head: -40°C to 150°C Temperature ramp: < 6°C/min Pressure at probe head: 1000 psi
Fiber optic cable	Design: PVC jacketed, proprietary construction Connections: proprietary electro-optic at analyzer Temperature: -40°C to 80°C Length: 5000 mm (16.4 feet) standard, custom lengths available Minimum bend radius: 152.4 mm (6 inches)
Gas stream filtration	1 µm or better Multistage filtration recommended
Certifications	Contact Kaiser for hazardous area certifications

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