

Kaiser Raman Analyzers

Embedded technology for reliable lab-to-process composition measurements

Kaiser Raman for reliable product quality parameters and composition measurements

- Kaiser's latest Raman analyzers incorporate embedded control technology to bring connectivity and reliability to your process 24/7
- Multichannel analyzer capable of measuring up to four concurrent reactors
- When combined with Kaiser's fiber-optic sampling probes, Kaiser Raman provides high performance for reliable measurements in any environment.
- Scalable process analytical technology (PAT) for cross-scale and cross-site method transfer
- Self-calibrating and monitoring systems



Connect your chemistry from lab-to-process

With Kaiser's Raman Rxn™ embedded spectroscopy



Maintaining consistent product quality is a challenge in a competitive global environment. Scientific, environmental, financial, and regulatory requirements create a challenging environment in which to ensure process and product quality.

Staying ahead of scientific, regulatory, and business demands on efficiency and quality enables you to rise to the top. Real-time in-process analysis has a significant impact on manufacturing success. Integration of quality measurements into the process ensures product and process consistency, saves time and resources, reduces contamination risk, and improves process efficiency. A trusted partner can help you.

Kaiser is a proven partner with over 30 years of experience in lab-to-process Raman spectroscopy solutions. The incorporation of PAT tools, such as Raman spectroscopy, into the process during the early stages of process development helps deliver consistent product and process quality, improve process efficiency, and quickly build process knowledge. Kaiser Raman equipment is proven from the analytical laboratory and process development to manufacturing. As a global company, Kaiser understands your challenges. Our products, solutions, and services help you to optimize your process and deliver application success.



Kaiser's innovations are supporting the needs of Industry 4.0. Raman RunTime™ integrates the spectrometer control and data handling functions into the Kaiser Raman analyzer without needing a separate computer that runs proprietary software. Raman RunTime™ embedded technology ensures reliability and provides an easy-to-follow touchscreen interface. Raman RunTime™ exports raw data and diagnostics using standard communication protocols to support data integrity assurance.

Raman RunTime™

Connect with your chemistry in any environment

Raman RunTime™ is the embedded control technology and human machine interface (HMI) for RamanRxn Systems™ analyzers. It is intended for easy integration with industry standard multivariate analysis and automation platforms to enable a real-time, in situ process monitoring and control solutions. RunTime uses an OPC interface which provides OPC clients with analyzer data as well as analyzer control functions. Modbus communication is also supported.

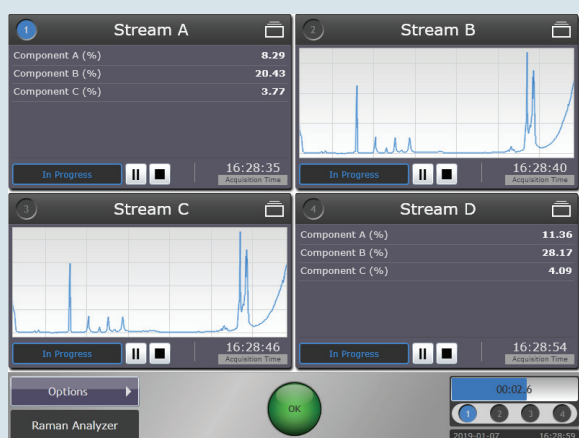
With Raman RunTime™ you can collect Raman spectra continuously for days, weeks or even months. These spectra, critical to real-time measurement of key process parameters, can be seamlessly collected and collated across multiple analyzers and probes. Raman RunTime™ offers a common interface from process development to cGMP.

Raman RunTime™ works with Kaiser Data Library enabling Kaiser Raman spectra to be organized and matched to 3rd party reference data at the convenience of your network connected desktop or laptop. This ensures seamless handling by multivariate analysis software and maintains 21 CFR part 11 compliance for implementing Kaiser Raman based models in cGMP. Additionally, there is an embedded methodology for automated matching, qualification, and search and retrieval of data in order to save time, reduce errors, and improve model performance.

Features:

- Intuitive Human Machine Interface
- OPC-UA and OPC-DA Protocol Support
- Easy Integration to OPC enabled platforms - synTQ, SIPAT, DeltaV and more
- Streamlined Calibration and Verification Procedures
- *In Situ* Verification (batch start sample)
- Three Collection Modes: Manual, Continuous & Periodic
- SIMCA, GRAMS IQ and PEAXACT Embedded Predictors

Touchscreen Interface



MVA Predictors

OPC Server

OPC UA



OPC DA

OPC-enabled device

- Two way OPC
- System control & diagnostics in addition to model outputs

PAT Suite, MVA, DSC, Historian, Reactor controller, etc.

- Control algorithms
- Alarm management
- Data and calibration report retention per cGMP

Speed up process development

Kaiser Raman has the widest selection of offerings trusted by industry leaders for its proven lab-to-process scalability



Speed up process development while ensuring quality Concurrent reactor runs under various conditions means that there is no time for offline analysis or developing an analytical model for each analyzer. Multichannel capability means that Kaiser Raman-based control methods can be achieved quickly with successful transfer to pilot and manufacturing environments.

The Raman Rxn2™ family is Kaiser's award-winning Raman analyzer and is ideal for bridging laboratory analysis to the process environment. When combined with Kaiser's phase-optimized sampling probes, the Raman Rxn2™ offers high-resolution performance for real-time, in-process measurement and control.

The Raman Rxn2™ has a unique analyzer self-monitoring system to ensure the validity of each measurement. The analyzer is capable of self-calibration and utilizes self-diagnostics and spectral correction methods when system calibration is unnecessary. Versatility, reliability, and scalability of the Raman Rxn2™ are distinguishing features. The four channels can be programmed individually or with the same method, allowing monitoring under various process conditions.

Modeling and Application Development Services

Application feasibility

- Initial consultation
- Calibration sample measurements

Calibration model development

- Experimental design consultation
- Data inspection
- Customizable model calibration and features

Automation implementation

- Calibration model transfer
- Model maintenance subscription
- Model integration

Contact Kaiser for technical references and other possible applications

"I need full application and development support"

Our response:

- We are your solution from technology to implementation
- Kaiser-built chemometric models are released under our ISO9001:2015 certified QMS so you can be assured of quality processes and controls.
- Benefit from our experience in process Raman and expert application support so that you can focus on your core business

Ensure process and product quality 24/7

With Raman Rxn4™ and Raman RunTime™

The Raman Rxn4™ is Kaiser's process Raman analyzer and is ideal for the manufacturing or process environment. When combined with Kaiser's phase-optimized sampling probes, the Kaiser Raman Rxn4™ offers high-resolution performance for *in situ*, real-time process measurement and control.

Available as a multi-channel analyzer at 532 nm or 785 nm, the Raman Rxn4™ has a unique analyzer self-monitoring system to ensure the validity of each measurement. The analyzer is capable of self-calibration and utilizes self-diagnostics and spectral correction methods when system calibration is unnecessary.

Ruggedness, versatility, and reliability of the Raman Rxn4™ are distinguishing features. Kaiser Raman performs whether you have a classified environment, washdown requirement, or control room installation. Kaiser released its first ATEX-certified Raman analyzer in 2005. We expanded that tradition of providing high quality Raman analyzers and probes for explosive or hazardous environments with ATEX or North America certifications and NEMA 4x enclosures for cGMP environments.



Installations

Bioprocessing

- Cell culture, fermentation

Chemical

- Reaction monitoring, blending, catalysis

Polymer

- Polymerization reaction monitoring, extrusion monitoring, polymer blending

Pharmaceutical

- API reaction monitoring, crystallization, polymorph, blending, coating, granulation

Contact Kaiser for technical references and other possible applications

Kaiser's complete compliance services

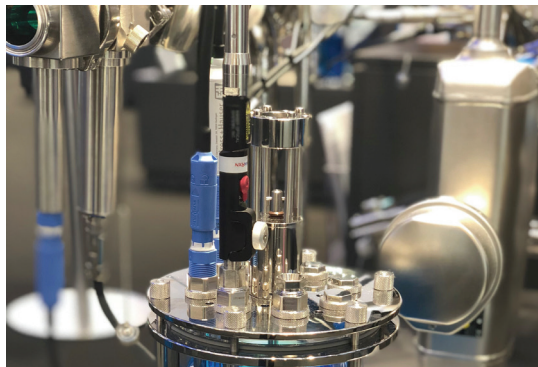
helps you to ensure a seamless transition to cGMP manufacturing while maintaining quality. We carry a ISO9001:2015 certification, ensuring quality to our customers, and have over 20 years experience in cGMP installations.

Kaiser provides:

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

Application successes in lab-to-process

Improve process efficiency and ensure product quality



Kaiser's robust, reliable and proven fiber optic probes brings the analytical laboratory to your process so that you can understand, monitor and control your process.

Advanced process control strategies are possible with real-time in-process Raman spectroscopy. Two examples demonstrate customer's ability to use Kaiser Raman for real-time process understanding in the laboratory and to use that information to increase process efficiency, enable feedback control strategies, and ensure product quality.

Example 1: Reaction Monitoring. In the first example, Kaiser Raman was used to monitor the endpoint of a heterogeneous etherification reaction.[1] The analyzer and fiber-optic probe had demonstrated compatibility with process chemistry and integration with process control software. A partial least-squares type 2 (PLS2) calibration model was developed in the laboratory (250 mL) by correlating Raman data to HPLC. The model was transferred to the pilot plant (1500 L) and used to predict the reaction endpoint. The PLS2 calibration model was then used to predict the concentration of ether 1 in the reaction mixture in real time. Raman results indicated that the endpoint was several hours earlier than the endpoint based on off-line sampling. On the basis of results from the 1st pilot plant batch, it was determined that in-line Raman spectroscopy with the PLS2 model could be used as the sole process-control technique for this reaction. Cost and plant efficiency savings from detecting the early endpoint were realized.

Example 2: Bioprocess feed control Industrial bioprocessing examples demonstrate successful lab-to-process model transfer, quick generation of models, and how Raman-based feedback improves product quality and titer. [2-5] Bioreactors at the 3 L process development scale, 200 L pilot scale, and the 2000 L manufacturing scale were examined in-process by Kaiser Raman, and the spectral data were correlated with off-line reference data using both spectral preprocessing and PLS1 regressions.[2] Later studies showed that a Kaiser Raman-driven feedback control system was rapidly implemented and shown to not only improve a biopharmaceutical protein product's quality and but also increase yield up to 85% over the historical process.[3,4] Kaiser Raman is easily integrated into bioreactor controllers, and is a robust Process Analytical Technology (PAT) solution able to provide real-time process control and ensure biopharmaceutical product quality. Incorporation of Quality by Design (QbD) principles into the bioprocess were possible by integrating Raman as a PAT. In upstream bioprocess development, Kaiser Raman helps improve understanding on the impact of process inputs on model performance, and enables multi-scale bioreactors to be simultaneously and quickly analyzed in process development.[5]

References:

- [1] Hart, R. J.; et.al. *Org. Process Res. Dev.* **2015**, 19 (1), 196–202.
- [2] Berry, B.; et.al. *Biotechnol Progress* **2015**, 31 (2), 566–577.
- [3] Berry, B. N.; et.al. *Biotechnol Progress* **2016**, 32 (1), 224–234.
- [4] Matthews, T. E.; et.al. *Biotechnol. Bioeng.* **2016**, 113 (11), 2416–2424
- [5] Santos, R. M et.al. *Talanta* **2019**, 199, 396–406.

Technical Data – Raman Rxn2™ and Raman Rxn4™

Technical Specifications

	Raman Rxn2™	Raman Rxn4™
Laser wavelength	785 nm, 1000 nm Contact Kaiser for 532 nm option	785 nm, 1000 nm Contact Kaiser for 532 nm option
Spectral coverage	150-4375 cm ⁻¹ (λ=532 nm) 150-3425 cm ⁻¹ (λ=785 nm) 200-2400 cm ⁻¹ (λ=1000 nm)	150-4375 cm ⁻¹ (λ=532 nm) 150-3425 cm ⁻¹ (λ=785 nm) 200-2400 cm ⁻¹ (λ=1000 nm)
Temperature % relative humidity	15°C-30°C 20-80% RH, noncondensing	Base model: 5°C-35°C (532 nm, 785 nm), 5°C-30°C (1000 nm), operating -15°C to 65°C, storage 20-80% RH, noncondensing NEMA 4x enclosure model: 5°C-50°C, operating -15°C to 65°C, storage 20-80% RH, noncondensing
Input voltage	110-240 VAC, 50-60Hz standard	Base model: 110-240 VAC, 50-60Hz standard NEMA 4x enclosure model: 100-110 VAC, 50 Hz, 103-127 VAC, 60 Hz, or 207-240 VAC, 50 or 60 Hz
Maximum power	<400 Watts max on startup; <150 Watts typical	Base model: <400 Watts on startup; <150 Watts typical NEMA 4x enclosure model: 1560 Watts
Warm up time	120 minutes	Base model: 120 minutes NEMA 4x enclosure model: 240 minutes
Unit dimensions (mm)	Benchtop model: 280 x 620 x 480 Cart model: 635 x 760 x 1420	Base model: 480 x 686 x 280 NEMA 4x enclosure model: 1100 x 826 x 1140
Weight (kg)	Benchtop model: 31 Cart model: 88	Base model: 31 NEMA 4x enclosure model: 185.5
Sampling probe compatibility	Solids: Kaiser non-contact optics, P ^h AT probe Liquids: RamanRxn™, bIO-LAB, bIO-PRO, SUB-Optic System, WetHead™, Pilot Gases: AirHead™ Extrusions: P ^h AT probe	Solids: Kaiser non-contact optics, P ^h AT probe Liquids: RamanRxn™, bIO-PRO, SUB-Optic System, WetHead™, Pilot Gases: AirHead™ Extrusions: WetHead™, P ^h AT probe
Certifications	Contact Kaiser for options	Contact Kaiser for options
Connection interface	OPC Modbus Contact Kaiser for options	OPC Modbus Contact Kaiser for options
Packaging options	Wheeled cart	Base model: 19 inch rack package NEMA 4x enclosure model: Trolley, stand

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