PIKE TECHNOLOGIES

Attenuated Total Reflectance

ATR products successfully replace constant-path transmission cells and salt plates used for analysis of liquid and semi-liquid materials. Horizontal ATR accessories are used to analyze films, pastes, solids and fine powders. Thanks to the reproducible effective pathlength, ATR is well suited for both qualitative and quantitative applications. Several temperature control options are available.

MIRacle™
Single Reflection ATR
Ideal for sample identification

GladiATR™
Monolithic Diamond Single Reflection ATR
For intractable samples and temperature studies

GladiATR™ Vision
Monolithic Diamond ATR with Sample Viewing
Easy positioning and analysis of intractable samples

HATR
Multi-Reflection ATR
Highest sensitivity for minor components

ATRMax™ II
Variable Angle, Multi-Reflection ATR
Research-grade ATR

VeeMAX™ III ATR
Variable Angle, Single Reflection ATR
For depth profiling studies and monolayers

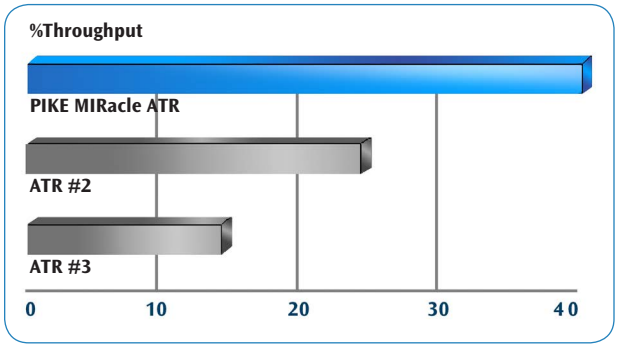
JetStream ATR
Cylindrical Crystal ATR
For measurement of liquids under varying conditions

VATR™
Classic Variable Angle ATR

Theory and Applications Included

PIKE Technologies, Inc., 6125 Cottonwood Drive, Madison, WI 53719
(608) 274-2721 · www.piketech.com · sales@piketech.com

MIRacle ATR – *Fast and Easy IR Sampling*

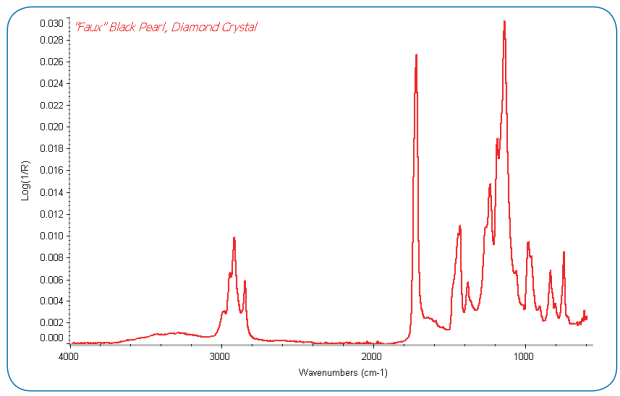


MIRacle – Highest IR Throughput ATR.

The PIKE MIRacle™ is a universal ATR sampling accessory for analysis of solids, liquids, pastes, gels, and intractable materials. In its most popular configuration it is a single reflection ATR accessory with high IR throughput which makes it ideal for sample identification and QA/QC applications. Easily changeable crystal plate design provides analysis of a broad spectrum of sample types while ensuring constant sampling pathlength. An assortment of crystal materials and single, three and nine reflection ATR crystals are available to optimize general qualitative or quantitative analysis.

Features

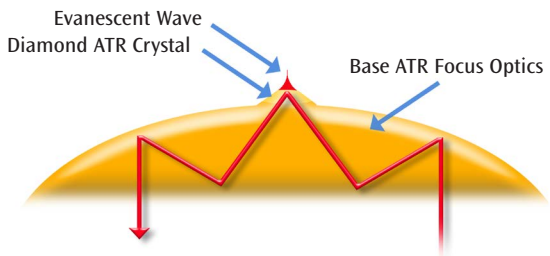
- Highest IR throughput – saving you time and improving your analysis quality
- Complete flexibility – add options to your MIRacle as your sampling needs change
- Highest value – for today's competitive analytical and research needs
- Fully configurable – diamond, ZnSe, Ge and Si MIRacle crystal plates; single or multiple reflections
- Pinned-in-place, changeable crystal plates – for fast and easy sampling optimization
- Highest purity, type IIa diamond crystal – will not scratch and is chemically inert to acidic or caustic materials
- Optional specular reflectance plate – for measurement of coatings on reflective surfaces
- Choice of pressure clamps – high-pressure, digital high-pressure and micrometric sample clamps
- Sampling options – temperature control, flow-through attachment and sealed clamp



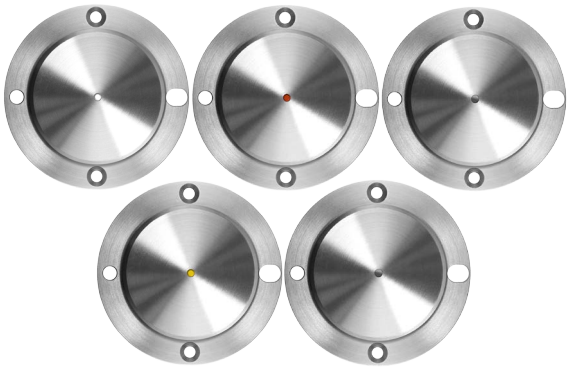
Faux black pearl, using MIRacle diamond ATR crystal.

MIRacle Optical Design

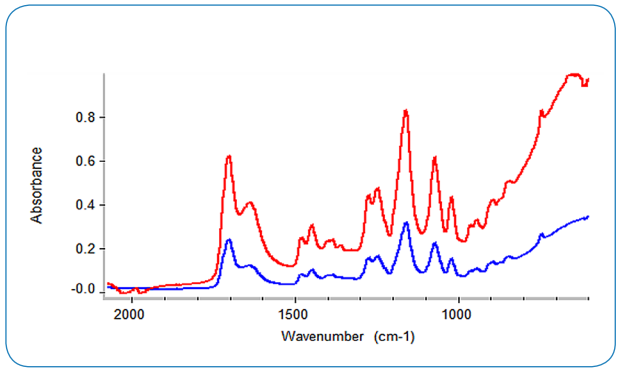
In the patented MIRacle optical design the ATR crystal focuses the IR beam and also provides the ATR sampling interface. This technology delivers greater energy throughput than competitive products, saves considerable time and produces higher quality spectra. For the single reflection, the small sampling surface results in increased force per unit area for improved contact between rigid samples and the ATR crystal.



Beam path through MIRacle crystal optic.



MIRacle crystal plates. Clockwise: diamond/ZnSe, diamond/KRS-5, ZnSe, Ge and Si.

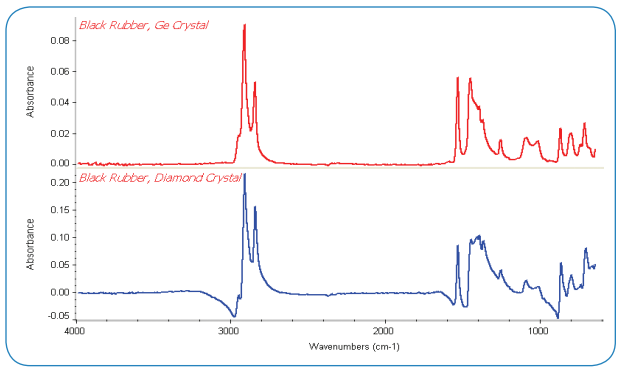


Hydrogel, using three reflection diamond/ZnSe crystal (red) and single reflection diamond/ZnSe (blue).

MIRacle Crystal Options

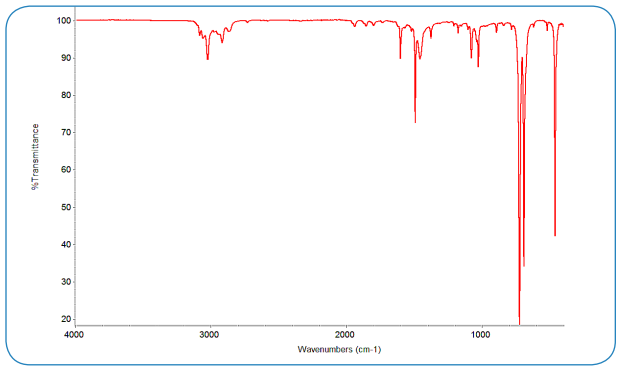
The MIRacle ATR accessory may be configured with five different crystal types: diamond/ZnSe, diamond/KRS-5, ZnSe, Ge and Si. 1-, 3- and 9-reflection styles are available. Trough and flat plate configurations are options for the multiple reflection plates.

Crystal plates are pinned in place and easily changeable within seconds with no alignment required. With this flexibility, you can change the crystal type to exactly match your sampling requirements. For example, diamond is ideal for brittle samples because it will not scratch, whereas Ge is ideal for carbon-filled samples because of its high refractive index and lower depth of penetration. Two single reflection diamond crystal plates are available, diamond/ZnSe and diamond/KRS-5. The latter offers a full spectral range to 250 cm^{-1}. 3- and 9-reflection crystal plates provide increased sensitivity for minor components in liquid samples. 3-reflection diamond/ZnSe crystal plates are available in flat and trough style, and 9-reflection diamond/ZnSe is offered in trough style only.



Black rubber samples are best run using Ge ATR crystal.

9-reflection trough plate, 3-reflection flat plate, specular reflectance plate



Toluene sample collected using diamond/KRS-5 crystal.

Table 1 shows MIRacle ATR crystal characteristics including refractive index, spectral range cutoff, pH range and hardness for single reflection ATR crystal plates. Still have questions? Please contact us as we are pleased to discuss your sampling requirements.

TABLE 1: MIRACLE CRYSTAL PLATE SPECIFICATIONS

MIRacle Crystal Plate	Application	Hardness kg/mm²	Cutoff cm^{-1}, Spectral Range	Refractive Index @ 1000 cm^{-1}	Depth of Penetration @ 45°, µ	pH Range of Sample
Diamond/ZnSe	Ideal for hard samples, acids or alkaline	5700	525	2.4	2.00	1–14
Diamond/KRS-5	When you need full mid-IR spectral range	5700	250	2.4	2.00	1–14
Ge	General purpose and carbon filled or rubber	550	575	4.0	0.66	1–14
Si	Excellent for far-IR spectral measurement	1150	8900–1500, 475–40	3.4	0.85	1–12
ZnSe	General purpose ATR crystal	120	520	2.4	2.00	5–9

MIRacle crystal plates are covered by PIKE Technologies patent numbers 5,965,889 and 6,128,075 or are manufactured under license of 5,200,609, 5,552,604 and 5,703,366.

MIRacle Digital Clamp – ideal for controlled pressure

MIRacle Confined Space Clamp – for instruments with limited area in sample compartment

MIRacle High-Pressure Clamp – ideal for routine sampling

MIRacle Micrometer Clamp – for low pressure applications

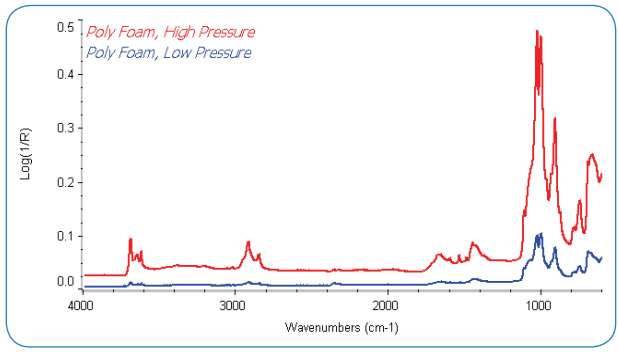
MIRacle Pressure Clamp Options

MIRacle pressure clamps are pinned in place and easily changeable within seconds. A high-pressure clamp is recommended for most applications and is available in basic and digital configurations. The digital version requires a high-pressure clamp and the Digital Force Adapter (DFA) that attaches directly to the clamping assembly. The DFA's embedded load cell exhibits high linearity, reproducibility, and exceptional accuracy. The magnitude of applied force is displayed on an external easy-to-read LCD readout. The digital clamp is ideal for applications that require controlled and reproducible pressure. All clamps include tips for hard, soft and pellet-shaped samples. High-pressure clamps are calibrated to deliver over 10,000 psi of pressure when used with the single reflection crystal plates, and utilize a slip-clutch mechanism to prevent excessive pressure from being applied to the crystal.

Ability to deliver high pressure is very important for achieving spectral quality. In the example to the right, we demonstrate spectral differences of a porous polymer sample measured with the micrometer clamp and the high-pressure clamp. Clearly the high-pressure clamp is required to obtain a high-quality spectrum.

MIRacle Clamp Pressures	Max Force, lbs	Crystal Diameter, mm	Pressure, psi
High-Pressure Clamps	40	1.8	10,141
		6.0	913
Micrometer Pressure Clamp	8	1.8	2,028
		6.0	183

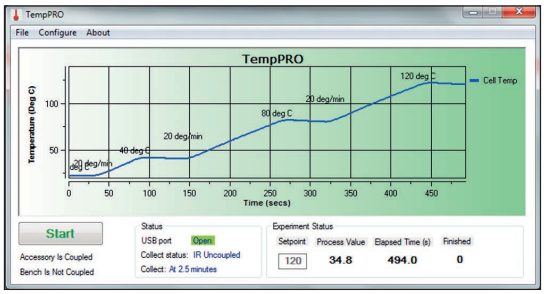
Note: All clamps except Micrometer are high-pressure.



Porous polymer sample measured using high- and low-pressure clamp.

Temperature Control

The MIRacle can be configured with liquid jacketed plates and resistively heated crystal plates with temperature control module. The PC module (resistively heated only) includes PIKE TempPRO software which provides a graphical user interface for temperature control and kinetics measurements. The liquid jacketed plates require user-provided liquid circulator.



TempPRO software for graphical setup and control of kinetic measurements.

MIRacle ATR Summary

The MIRacle ATR accessory is a high-performance FTIR sampling tool for solid, liquid, or polymer samples. Easily changeable crystal plates provide optimized spectral data for unique sample types. With options for single, three or nine reflection crystal plates, several pressure clamp styles and heating or cooling, the MIRacle is able to address a wide range of FTIR sampling applications.

Ordering Information

MIRacle Base Optics *(must select)*

Part Number	Description
025-18XX	MIRacle ATR Base Optics/Platform Assembly

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
MIRacle Base Optics includes purge tubes, purge kit and spectrometer base mount.

Crystal Plates for MIRacle *(must select 1 or more)*

Part Number	Description
025-2108	Diamond/ZnSe Performance Crystal Plate
025-2107	Diamond/ZnSe HS Performance Crystal Plate
025-2028	Diamond/KRS-5 Performance Crystal Plate
025-2027	Diamond/KRS-5 HS Performance Crystal Plate
025-2018	ZnSe Performance Crystal Plate
025-2058	Ge Performance Crystal Plate
025-2098	Si Performance Crystal Plate
025-2118	3-Reflection Diamond/ZnSe Performance Crystal Plate
025-2120	3-Reflection Diamond/ZnSe Performance Crystal Plate, Trough
025-2038	3-Reflection ZnSe Performance Crystal Plate
025-2218	9-Reflection Diamond/ZnSe Performance Crystal Plate, Trough
025-2208	Specular Reflection Performance Plate

Notes: MIRacle crystal plates are pre-aligned and pinned in place. Changing crystal plates is easy and fast to optimize sampling results. Crystal plate housings are manufactured using polished stainless steel for chemical resistance. The diamond/ZnSe and diamond/KRS-5 crystal plate is available with optional Hastelloy® (HS) metal for exceptionally caustic or acidic samples.

Specifications

ATR Crystal Choices	Diamond/ZnSe, Diamond/KRS-5, Ge, ZnSe, Si
Crystal Plate Mounting	User-changeable plates
Crystal Plate Mount	Stainless steel or Hastelloy
Angle of Incidence	45 degrees, nominal
Crystal Dimensions, surface	1.8 mm single reflection 6.0 mm three and nine reflection
Pressure Device	Rotating, continuously variable pressure; click-stop at maximum (High-Pressure Clamp)
Digital Force Adapter (option)	Load cell sensor for precise and reproducible pressure control. Attaches directly to High-Pressure MIRacle clamps. Digital readout. Not for use with heated plates.
Maximum Pressure	10,000 psi
Sample Access	55 mm, ATR crystal to pressure mount
Heating Options	Ambient to 60 or 130 °C maximum
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Digital or digital with PC control (up to 20 ramps, automated data collection, USB interface)
Input Voltage	100–240 VAC, auto setting, external power supply
Operating Voltage	1.3A/24 VDC 30 W
Specular Reflection Option	Optional, 45 degree nominal angle of incidence
Purge Sealing	Purge tubes and purge line connector included
Accessory Dimensions (W x D x H)	104 x 103 x 210 mm (excludes FTIR baseplate and mount)
FTIR Compatibility	Most, specify model and type

MIRacle Sampling Options

Part Number	Description
025-4018	Heated ZnSe Performance Crystal Plate
025-4058	Heated Ge Performance Crystal Plate
025-4108	Heated Diamond/ZnSe Performance Crystal Plate (60 °C max.)
025-2104	Liquid Jacketed Diamond/ZnSe Performance Crystal Plate, (60 °C max.)
025-2014	Liquid Jacketed ZnSe Performance Crystal Plate
025-2054	Liquid Jacketed Ge Performance Crystal Plate
025-2094	Liquid Jacketed Si Performance Crystal Plate
026-5012	Flow-Through Attachment, 100 µL
026-5013	Liquids Retainer and Volatiles Cover Set
026-3051	Volatiles Cover for Performance Plates
026-5010	Liquids Retainer for Performance Plates
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC Control

Notes: Flow-Through Attachment, Liquids Retainer and Volatiles Cover are compatible with non-trough crystal plate offerings and require High-Pressure Clamp, P/N 025-3020 or P/N 025-3035, sold separately. Temperature control module selection is required for heated crystal plates. Digital temperature control module with PC control includes TempPRO software. Liquid jacketed crystal plates require customer-provided circulator. Do not exceed 60 °C when using temperature controlled diamond plates and 130 °C for all others.

Pressure Clamps for MIRacle

(must select clamp for solids or polymer analysis)

Part Number	Description
025-3020	High-Pressure Clamp
076-6025	Digital Force Adapter for High-Pressure Clamp
025-3050	Micrometric, Low-Pressure Clamp
025-3035	High-Pressure Confined Space Clamp
076-6028	Digital Force Adapter for High-Pressure Confined Space Clamp

Notes: The High-Pressure Clamp is recommended for general applications. Pressure clamps include a flat tip, a swivel tip and a concave tip. The Digital Force Adapter requires High-Pressure Clamp, P/N 025-3020 (sold separately), and may not be used at temperatures above ambient.

Replacement Parts

Part Number	Description
025-3095	Flat Tip for High-Pressure Clamp
025-3093	Swivel Tip for High-Pressure Clamp
025-3092	Concave Tip for High-Pressure Clamp
025-3052	Flat Tip for Micrometric Clamp
025-3061	Swivel Tip for Micrometric Clamp
025-3054	Concave Tip for Micrometric Clamp
025-3053	MIRacle Micrometer Clamp Tip Assortment
025-3094	7.8 mm ATR Pressure Tip for High-Pressure Clamp
025-3096	7.8 mm ATR Pressure Tip for Micrometer Clamp
025-3099	Tip Assortment for High-Pressure Clamp

Notes: Please contact PIKE Technologies for items not described in this list.
Reconditioning service for used MIRacle crystal plates is available.

Dedicated MIRacle Sampling Tools and Options

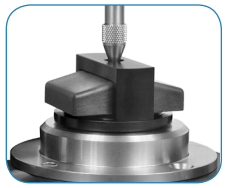
Sealed Clamp

The Sealed Sample Chamber for the MIRacle Single Reflection ATR accessory attaches to dedicated diamond, ZnSe or Ge crystal ATR plates allowing the complete assembly to be moved from the spectrometer to a protective environment for sample handling. Once the sample has been loaded onto the ATR crystal, the sealed clamp may be engaged shielding the sample from the external environment. Typical applications include studies of toxic or chemically aggressive solids and powders.

The chamber is made of stainless steel and is sealed against the crystal plate with a chemically resistant O-ring. The chamber contains an internal, spring-loaded anvil that compresses the sample against the ATR crystal at a preset, clutch-controlled setting.

Liquids Retainer and Volatiles Cover

The Liquids Retainer offers a trough configuration for the MIRacle. The Volatiles Cover reduces the amount of evaporation of a highly volatile liquid sample on the surface of the crystal. The High-Pressure Clamp is required, and serves to apply pressure to the u-bridge thus compressing a sealing PTFE O-ring located underneath the Liquids Retainer.



Temperature Control Options

The MIRacle can be configured with liquid jacketed plates and resistively heated crystal plates with temperature control module. The PC module (resistively heated only) includes PIKE TempPRO software which provides a graphical user interface for temperature control and kinetics measurements. The liquid jacketed plates require user-provided liquid circulator.

Digital Force Adapter for High-Pressure Clamp

The Digital Force Adapter attaches directly to the clamping assembly to precisely measure the applied force by using an embedded load cell that exhibits high linearity and exceptional accuracy. The magnitude of applied force is displayed on an external easy-to-read LCD readout. The digital clamp is ideal for applications that require controlled and reproducible pressure. This option may not be used with temperature controlled plates.

Flow-Through Attachment

The Flow-Through Attachment is used for continuous monitoring or handling samples that pose a hazard or are degraded from ambient exposure. Samples are introduced using the Luer-Lok™ fitting by connecting a syringe or a flow line. Swagelok® fittings are optional. The High-Pressure Clamp is required.

Specular Reflection Plate

The MIRacle may be converted from an ATR accessory to a specular reflection accessory by using the Specular Reflection Plate. The angle of incidence is 45 degrees, and the plate is easily interchangeable with ATR plates.

Ordering Information

Sealed High-Pressure Clamp for MIRacle *(must select the sealed clamp and at least one crystal ATR plate).*

Part Number	Description
025-6020	Sealed High-Pressure Clamp
025-6108	Diamond/ZnSe Sealed Clamp Performance Plate
025-6018	ZnSe Sealed Clamp Performance Plate
025-6058	Ge Sealed Clamp Performance Plate

Temperature Controlled MIRacle Options

Part Number	Description
025-4018	Heated ZnSe Performance Crystal Plate
025-4058	Heated Ge Performance Crystal Plate
025-4108	Heated Diamond/ZnSe Performance Crystal Plate, (60 °C max.)
025-2104	Liquid Jacketed Diamond/ZnSe Performance Crystal Plate, (60 °C max.)
025-2014	Liquid Jacketed ZnSe Performance Crystal Plate
025-2054	Liquid Jacketed Ge Performance Crystal Plate
025-2094	Liquid Jacketed Si Performance Crystal Plate
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC Control

Temperature controller is required for heated crystal plates. Digital temperature controller, PC control includes PIKE TempPRO software. Liquid jacketed crystal plates require customer-provided circulator.

More MIRacle Sampling Options

Part Number	Description
025-2208	Specular Reflection Performance Plate
025-2028	Diamond/KRS-5 Performance Crystal Plate
026-3051	Volatiles Cover for Performance Plates
026-5013	Liquids Retainer and Volatiles Cover Set
076-6025	Digital Force Adapter for High-Pressure Clamp
026-5012	Flow-Through Attachment, 100 ul

GladiATR –
Highest Performance Diamond ATR

Features

- **Diamond crystal design – cannot scratch or fracture**
- **Extreme pressure application – for hard and demanding solid samples**
- **Highest energy throughput design – for excellent-quality FTIR spectra and minimum scan time**
- **All reflective optics – full spectral range for analysis in the mid-IR and far-IR regions**
- **Optional extended spectral range Ge crystal plate – for high refractive index samples**
- **Heated crystal plate options – ATR temperature studies up to 300 °C**
- **Compatible with most FTIR spectrometers**

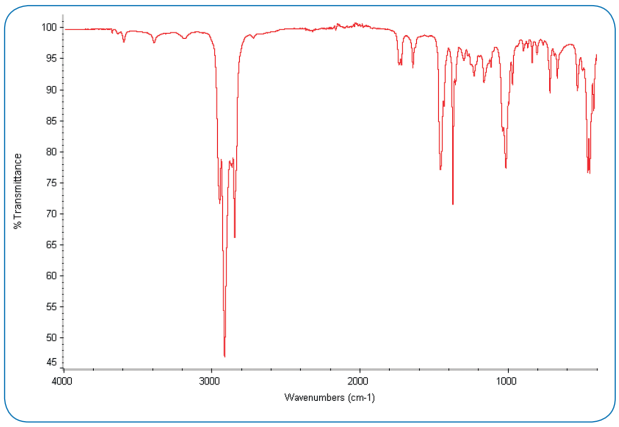
The GladiATR™ ATR from PIKE Technologies features an optical design providing the highest energy throughput, highest available pressure, widest spectral range and offering optional heated or cooled crystal plates. The GladiATR is a highly durable and rugged design to be used in environments where large numbers of samples are measured, where samples may be intractable solids, where you want the best quality spectrum every time and where you need flexibility for new sample types in the future.

The GladiATR diamond crystal is a monolithic design which will not scratch or fracture even at extreme pressures. This design permits analysis of hard, intractable objects such as coated metal wires, polymer pellets and geological samples without damage to the ATR crystal. The diamond crystal is brazed into the stainless steel or Hastelloy plate, which enables this ATR to be compatible with pressure up to 30,000 psi.

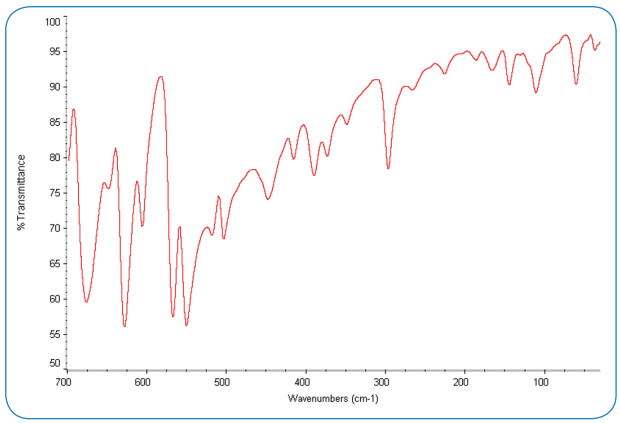
The energy throughput of the GladiATR is exceptional; twice that of other monolithic diamond ATR accessories. This significantly improves spectral quality and reduces sampling time.

The GladiATR is designed and manufactured using all reflecting optics providing full spectral range in the mid-IR and far-IR spectral regions. An optional Ge crystal plate is available for analysis of high refractive index samples, and offers a spectral range from 5000 – 450 cm^{-1}. The crystal plates are easily changeable.

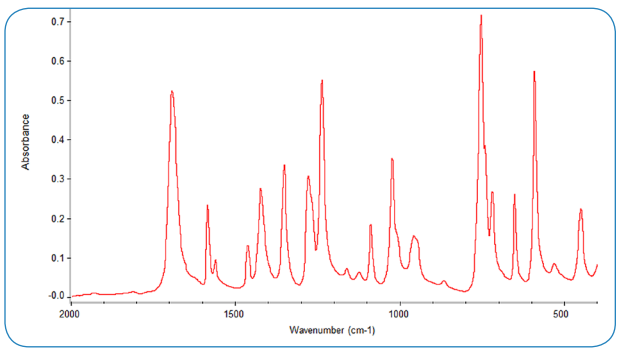
The GladiATR high performance diamond ATR is available in configurations to fit most FTIR spectrometers.



ATR/FTIR spectrum of polymer pellet run on GladiATR with diamond crystal. Spectral range in the mid-IR is 4000–400 cm^{-1}.



Spectrum of sulfathiazole using GladiATR with diamond crystal plate and far-IR optics in FTIR.

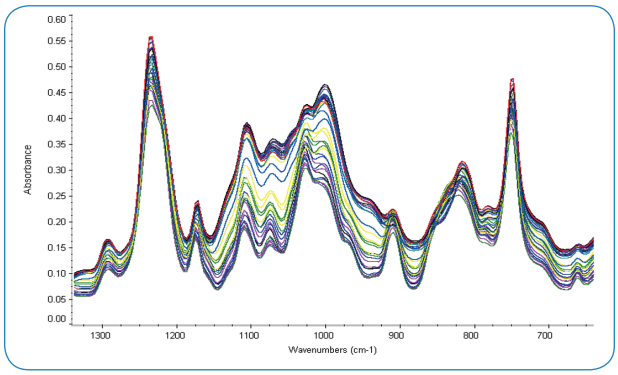


Spectrum of bromoacetophenone using GladiATR with expanded range Ge crystal plate.

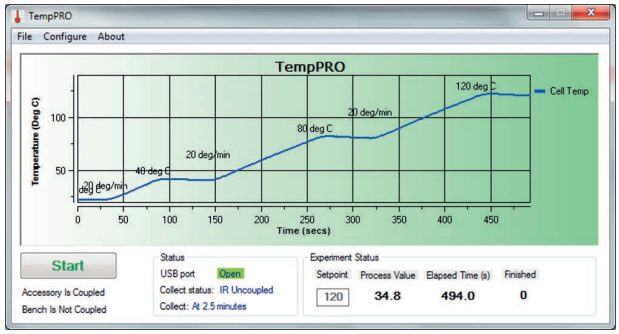
Pike Technologies
www.piketech.com
608-274-2721

GladiATR with 300 °C heated diamond crystal plate and temperature controller.

Temperature controlled crystal plates are available for thermal study of materials. The resistively heated diamond plate has a range from ambient to 210 or 300 °C. PIKE Technologies offers temperature controllers with digital and PC programmable set points with TempPRO software, which allows for easily programmed temperature profile and data collection by interfacing with most FTIR software platforms. For sub-ambient studies, liquid jacketed plates are an option. The new liquid jacketed/heated GladiATR diamond plate blends the benefits of both resistively heated and liquid jacketed.



ATR/FTIR spectra from cure of thermoset epoxy using the heated diamond crystal plate on the GladiATR.



Selection of the digital control module, PC control includes PIKE TempPRO™ software for graphical setup and automated data collection for thermal experiments.

SPECIFICATIONS

ATR Crystal Choices	Diamond, germanium
Crystal Plate Mounting	User changeable plates
Crystal Type	Monolithic
Diamond Mounting	Brazed
Crystal Plate Mounts	Stainless steel
Angle of Incidence	45 degrees, nominal
Crystal Dimensions (surface)	3.0 mm diameter
Optics	All reflective
Pressure Device	Rotating, continuously variable pressure; click stop at maximum
Digital Force Adapter (option)	Load cell sensor for precise and reproducible pressure control. Attaches directly to GladiATR clamp. Digital readout. For ambient temperature measurements only.
Maximum Pressure	30,000 psi
Sample Access	80 mm, ATR crystal to pressure mount
Spectral Range, Diamond	4000 to 30 cm^{-1} (IR optics dependent)
Spectral Range, Ge	4000 to 450 cm^{-1} (IR optics dependent)
Heating Options	Diamond, 210 or 300 °C maximum
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Digital or digital with PC control (up to 20 ramps, automated data collection, USB interface)
Input Voltage	
210 °C version	100–240 VAC, auto setting, external power supply
300 °C version	110/220 VAC switchable
Operating Voltage	4A/24 VDC, 100 W 6A/24 VAC, 150 W (300 °C version)
Cooling Options	Liquid jacketed crystal plates available
Specular Reflection Option	Optional, 45 degree nominal angle of incidence
Purge Sealing	Purge tubes and purge line connector included
Accessory Dimensions (W x D x H)	140 x 205 x 340 mm (excludes FTIR baseplate and mount)
FTIR Compatibility	Most, specify model and type

Ordering Information

GladiATR Base Optics *(must select)*

Part Number	Description
026-18XX	GladiATR Single Reflection ATR Base Optics, with heating capability up to 210 °C or 300 °C

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
All GladiATRs include purge tubes, purge kit, and selected spectrometer base mount. Crystal plates must be selected from the table below. High-Pressure Clamp, Digital Force Adapter and Liquids Retainer/Volatiles Cover are optional and need to be ordered separately, if required.

GladiATR Stainless Top *(must select one or more)*

Part Number	Description
026-2001	GladiATR Standard Stainless Top
026-2002	GladiATR Heated Stainless Top
026-2003	GladiATR Liquid Jacketed Stainless Top

Notes: Stainless top is not required for 300 °C version. For liquid jacketed/heated plate (P/N 026-4200) order 026-2002.

Crystal Plates for GladiATR *(must select one or more)*

Part Number	Description
026-2100	Diamond Crystal Plate
026-2050	Ge Crystal Plate
026-2200	Specular Reflection Plate

Notes: GladiATR crystal plates are pre-aligned and pinned-in-place. Changing crystal plates is easy and fast to optimize sampling results. Plate housing is stainless steel; contact us for Hastelloy options. Reconditioning service is available.

Pressure Clamp for GladiATR, all models *(must select for solid or powdered samples)*

Part Number	Description
026-3020	High-Pressure Clamp
076-6026	Digital Force Adapter for High-Pressure Clamp

Notes: The High-Pressure Clamp is required for analysis of solids, powders and use of Liquids Retainer, Flow-Through Attachment and/or Digital Force Adapter (Digital Force Adapter may be used when measuring samples at ambient temperature only). Pressure clamp includes a flat tip, a swivel tip and a concave tip.

GladiATR Temperature Controlled Crystal Plates

Part Number	Description
026-4102	Heated Diamond Crystal Plate, 300 °C
026-4100	Heated Diamond Crystal Plate, 210 °C
026-4200	Liquid Jacketed/Heated Diamond Crystal Plate
026-4110	Liquid Jacketed Diamond Crystal Plate
026-4050	Heated Ge Crystal Plate, 130 °C
026-4150	Liquid Jacketed Ge Crystal Plate, 130 °C
076-1220	Digital Temperature Control Module, 210 °C
076-1420	Digital Temperature Control Module, PC Control, 210 °C
076-1210	Digital Temperature Control Module, 300 °C
076-1410	Digital Temperature Control Module, PC Control, 300 °C

Notes: For heated diamond crystal plates, maximum crystal temperature is 300 or 210 °C. Ge becomes optically opaque at 150 °C; maximum recommended temperature for this crystal is 130 °C. Temperature controller is required for heated crystal plates. Digital temperature controller, PC control includes PIKE TempPRO software. Liquid jacketed crystal plates require customer-provided circulator.

GladiATR Sampling Options

Part Number	Description
025-3095	Flat Tip for High-Pressure Clamp
025-3093	Swivel Tip for High-Pressure Clamp
025-3092	Concave Tip for High-Pressure Clamp
025-3099	High-Pressure Tip Assortment
026-5012	Flow-Through Attachment, 210 °C, 100 µL
026-5014	Flow-Through Attachment, 300 °C, 100 µL
026-5013	Liquids Retainer and Volatiles Cover Set
026-3051	Volatiles Cover
026-5015	Liquids Retainer and Volatiles Cover Set, 300 °C
026-5010	Liquids Retainer, 260 °C

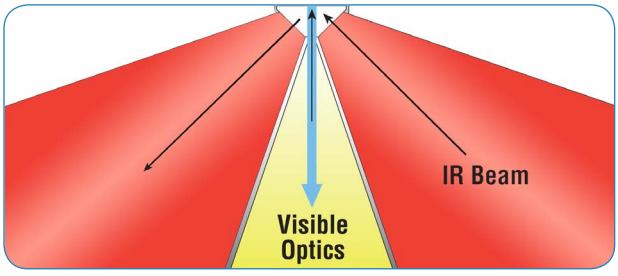
Note: Flow-Through Attachment and Liquids Retainer are compatible with all crystal offerings (require High-Pressure Clamp).

GladiATR Vision –
Diamond ATR with Sample View

Features

- View through diamond crystal – easily find sample point
- 110X magnification – find and position small sample areas
- USB image capture – document sample image
- Diamond crystal design – scratch and fracture resistant
- Highest energy throughput design – for excellent quality FTIR spectra and minimum scan time
- All reflective optics – full spectral range for mid-IR and far-IR analysis
- Optional heated, viewing crystal plate

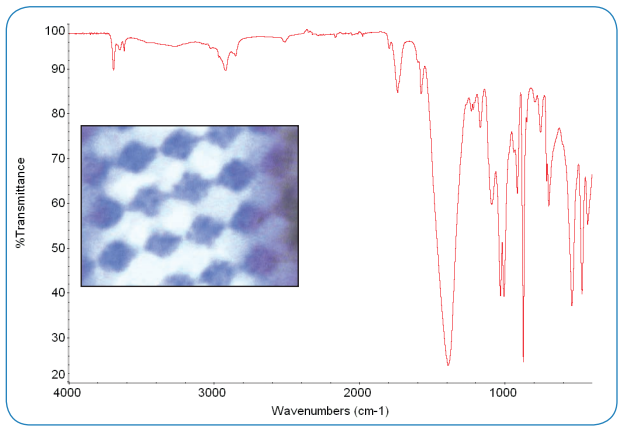
The GladiATR Vision™ is a novel sampling tool which couples small area infrared analysis with simultaneous viewing. Samples are placed face down and positioned on the diamond crystal while its image is projected in real-time on the LCD screen. Finding and optimizing the sample placement for specific analysis areas is easy and fast! Analysis of thick or non-transparent samples is no problem because viewing is through the diamond crystal.



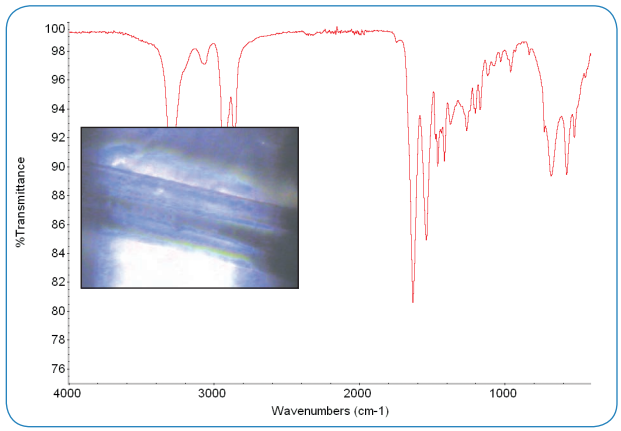
Diamond crystal plate of the GladiATR Vision accessory. IR beam and visible illumination meet at the sample position.

The GladiATR Vision accessory utilizes an innovative optical design with IR beam and visible optical image converging at the sample position – ensuring that "What you see is what you sample!" The 110X magnification of the sample image enables the positioning of even relatively small samples into the center of the diamond crystal for optimized analysis. Analysis of samples as small as 50 microns in size is doable with the GladiATR Vision accessory. Visible images from the GladiATR Vision are of highest quality color rendition because its refractive optics are fully transparent.

The GladiATR Vision optical design is all reflective, preserving the full spectral range inherent to diamond. For standard mid-IR FTIR spectrometers, the spectral range available with the GladiATR Vision will be 4000–400 cm^{-1}. For FTIR spectrometers equipped with far-IR optics, the spectral range is extended to less than 50 cm^{-1}.



ATR spectrum of print area on paper run on GladiATR Vision with diamond crystal. Image of the analysis area is shown in the inset. Spectral range is 4000–400 cm^{-1} with standard FTIR optics.



ATR spectrum of 200-micron fiber run on GladiATR Vision with diamond crystal. Compressed fiber image is shown with the spectrum.

Temperature controlled crystal plates are available for thermal study of materials. The resistively heated diamond Vision plate has a temperature range from ambient to 210 °C. PIKE Technologies offers temperature controllers with digital and PC programmable set points with TempPRO software, which allows for easily programmed temperature profiles and data collection by interfacing with most FTIR software platforms. For applications requiring temperatures from sub-ambient to 210 °C, liquid jacketed plates are available.

The viewing specular reflection plate transforms the GladiATR Vision into a 45 degree specular reflection accessory, uniquely allowing the sampling spot, such as a defect, to be easily located. With the small spot size of 3 mm, you can be confident of your sampling point.

The GladiATR Vision diamond ATR is available in configurations to fit most FTIR spectrometers.

Specifications

ATR Crystal Choices	Diamond, germanium (non-viewing)
Crystal Plate Mounting	User changeable plates
Crystal Type	Monolithic
Diamond Mounting	Brazed
Crystal Plate Mounts	Stainless steel
Angle of Incidence	45 degrees, nominal
Crystal Dimensions (surface)	3.0 mm diameter
Optics	All reflective
Pressure Device	Rotating, continuously variable pressure; click stop at maximum
Digital Force Adapter (option)	Load cell sensor for precise and reproducible pressure control. Attaches directly to GladiATR clamp. Digital readout. For ambient temperature measurements only.
Maximum Pressure	30,000 psi
Sample Access	80 mm, ATR crystal to pressure mount
Spectral Range, Diamond	4000 to 30 cm^{-1} (IR optics dependent)
Viewing Optics	Integrated 4" LCD
Magnification	110X magnification
View Area	770 x 590 microns
Optional Image Save	USB image capture
Viewing Mode	Through diamond crystal
Input Voltage	100–240 V, auto setting, external power supply
Operating Voltage, Wattage	12 VDC, 18 W maximum
Heating Options	Diamond, 210 °C maximum
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Digital or digital with PC control (up to 20 ramps, automated data collection, USB interface)
Input Voltage	100–240 VAC, auto setting, external power supply
Operating Voltage	4A/24 VDC 100 W
Specular Reflection Option	Viewing, 45 degree nominal angle of incidence
Purge Sealing	Purge tubes and purge line connector included
Accessory Dimensions (W x D x H)	140 x 225 x 340 mm (excludes FTIR baseplate and mount)
FTIR Compatibility	Most, specify model and type

Ordering Information

GladiATR Vision Base Optics *(must select one)*

Part Number	Description
026-19XX	GladiATR Vision Base Optics

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
GladiATR Vision Base Optics versions include purge tubes, illumination power supply, purge kit and spectrometer base mount. USB interface software included enables image capture on your PC.

GladiATR Stainless Top *(must select one or more)*

Part Number	Description
026-2004	GladiATR Vision Stainless Top
026-2005	GladiATR Vision Heated Stainless Top
026-2006	GladiATR Vision Liquid Jacketed Stainless Top

Crystal Plates for GladiATR Vision *(must select one or more)*

Part Number	Description
026-2102	GladiATR Vision Diamond Crystal Plate
026-2050	Ge Crystal Plate (non-viewing)
026-2202	Specular Reflection Plate (viewing)
026-2200	Specular Reflection Plate (non-viewing)

Notes: GladiATR Crystal Plates are pinned-in-place. Changing crystal plates is easy and fast to optimize sampling results. Only the GladiATR Vision Diamond Crystal Plate and viewing specular reflectance are compatible with sample viewing.

High-Pressure Clamp for GladiATR Vision

(must select for solid or powdered samples)

Part Number	Description
026-3020	High-Pressure Clamp
076-6026	Digital Force Adapter for High-Pressure Clamp

Notes: The High-Pressure Clamp is required for analysis of solids, powders and for use of liquids retainer and/or Digital Force Adapter (Digital Force Adapter may be used with samples at ambient temperature only). Pressure clamp includes a flat tip, a swivel tip and a concave tip.

GladiATR Vision Temperature Controlled Crystal Plate

Part Number	Description
026-4101	Heated Diamond Crystal Plate, 210 °C (viewing)
026-4050	Heated Ge Crystal Plate, 130 °C (non-viewing)
026-4112	Liquid Jacketed Diamond Crystal Plate, 210 °C max (viewing)
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC Control

Notes: For heated diamond crystal plates, maximum crystal temperature is 210 °C. Ge becomes optically opaque at 190 °C. Maximum recommended temperature for this crystal is 130 °C. Temperature controller is required for heated crystal plates. Digital temperature controller, PC control includes PIKE TempPRO software. Liquid jacketed crystal plates require customer-provided circulator.

GladiATR Vision Sampling Options

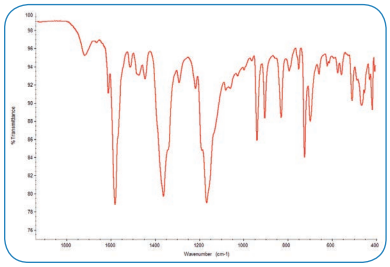
Part Number	Description
026-5012	Flow-Through Attachment, 100 µL
026-5013	Liquids Retainer and Volatiles Cover Set
026-3051	Volatiles Cover
026-5010	Liquids Retainer

Note: Flow-Through Attachment and Liquids Retainer are compatible with all crystal offerings (High-Pressure Clamp required).

Dedicated GladiATR and GladiATR Vision Sampling Tools – *More Options to Address Your Specific Application Requirements*

Extended Range Ge Crystal Plate

Due to the compact crystal size and the all reflective optics of the GladiATR platform, the Ge Crystal Plate offers an extended spectral range from 4000–450 cm^{-1}. A Ge ATR crystal is used to measure samples with a high refractive index. Types of high refractive materials that would benefit from sampling on the extended range Ge ATR crystal are carbon black filled samples and inorganic materials such as oxides, aluminas, titania, and minerals. The Ge crystal plate (non-viewing) may be fitted to the GladiATR or GladiATR Vision. Crystal plates are easily interchangeable. A heated version is available.



Spectrum of malachite green oxalate collected using the GladiATR with Ge crystal plate

Specular Reflection Plate

The GladiATR may be converted from an ATR accessory to a specular reflection accessory by using the Specular Reflection Plate. A viewing Specular Reflection Plate is available for the GladiATR Vision. The angle of incidence is 45 degrees, and plate is easily interchangeable with ATR plates.

GladiATR Specular Reflection Plate

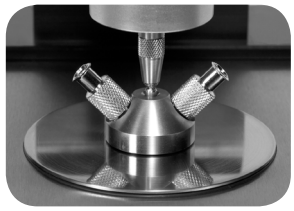
Temperature Control

The GladiATR and GladiATR Vision can be fitted for temperature control by configuring the accessory with a liquid jacketed or resistively heated diamond or Ge plate. When coupled with the PC temperature controller, up to 20 temperature ramps are easily programmed using PIKE TempPRO, which also interfaces with many FTIR software packages for data collection as a function of time or temperature.

Heated GladiATR with temperature control module

Flow-Through Attachment

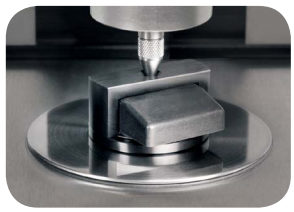
The Flow-Through Attachment is used for continuous monitoring or handling samples that pose a hazard from ambient exposure. Samples are introduced using the Luer-Lok fitting by connecting a syringe or a flow line. 1/16 inch compression fittings are optional. The High-Pressure Clamp is required.



Flow-Through Attachment

Liquids Retainer and Volatiles Cover

The Liquids Retainer offers a trough configuration for GladiATR and GladiATR Vision. The volatiles cover reduces the amount of evaporation of a highly volatile liquid sample placed on the surface of the crystal. The High-Pressure Clamp is required.



Liquids Retainer and Volatiles Cover Set

Ordering Information

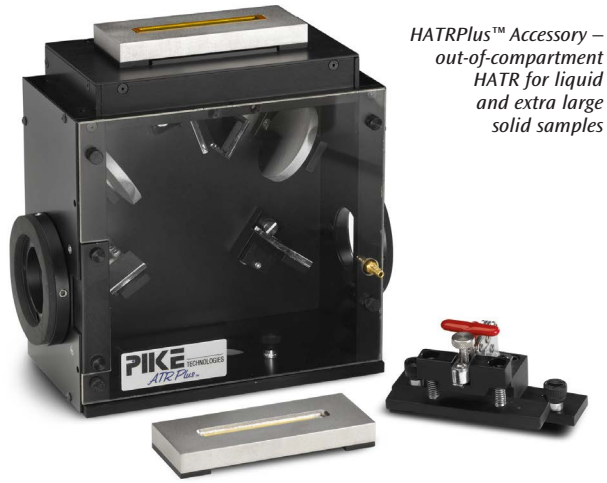
GladiATR Options

Part Number	Description
026-2050	Ge Crystal Plate (non-viewing)
026-4050	Heated Ge Crystal Plate, 130 °C (non-viewing)
026-4100	Heated Diamond Crystal Plate, 210 °C (non-viewing)
026-4101	Heated Diamond Crystal Plate, 210 °C (viewing)
026-4102	Heated Diamond Crystal Plate, 300 °C (non-viewing)
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC control
026-4110	Liquid Jacketed Diamond Crystal Plate (non-viewing)
026-4112	Liquid Jacketed Diamond Crystal Plate, 210 °C max (viewing)
026-2200	Specular Reflection Plate (non-viewing)
026-2202	Specular Reflection Plate (viewing)
026-5012	Flow-Through Attachment, 210 °C, 100 µL
026-5014	Flow-Through Attachment, 300 °C, 100 µL
026-5013	Liquids Retainer and Volatiles Cover Set
026-5010	Liquids Retainer
026-3051	Volatiles Cover
026-5015	Liquids Retainer and Volatiles Cover Set, 300 °C

Notes: The heated crystal plates require a temperature control module and appropriate stainless steel top. For more heated options, please review the GladiATR and GladiATR Vision accessory product data sheets.

Multiple Reflection HATR –
Maximum Sensitivity and Highly Versatile FTIR Sampling

HATR Accessory – in-compartment HATR for liquid and solid samples

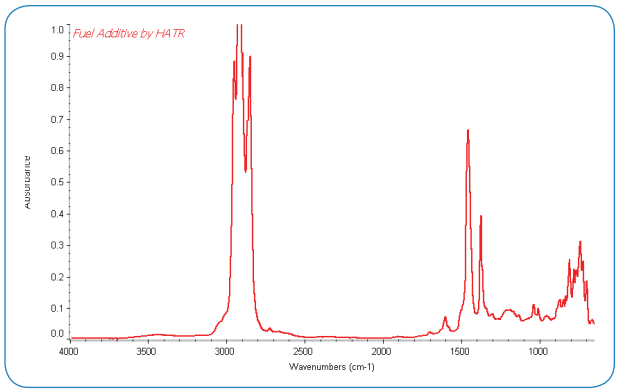


HATRPlus™ Accessory – out-of-compartment HATR for liquid and extra large solid samples

Horizontal Attenuated Total Reflectance (HATR) accessories successfully replace constant path transmission cells, salt plates and KBr pellets used in the analysis of liquid, semi-liquid materials and a number of solids. HATRs feature a constant and reproducible effective pathlength and are well suited for both qualitative and quantitative applications. In general, sampling is achieved by placing the sample onto the HATR crystal – generally eliminating sample preparation.

The PIKE Technologies HATR accessory provides high sensitivity for analysis of low concentration components in liquid, solid, and polymer samples. To optimize spectral measurements a selection of crystal materials, sample formats, and temperature and flow-through configurations are available.

PIKE Technologies HATR products are available in two base optic configurations. The HATR is an **in-compartment** design for samples which fit into the FTIR sample compartment. The HATRPlus is an **out-of-compartment** design for samples which are larger and do not fit into the FTIR sample compartment. The sampling surface of the HATRPlus extends above the FTIR cover, thereby permitting analysis of very large samples. Applications examples include coatings on large manufactured components, layered composition analysis on large objects, and skin analysis in the health care industry.



FTIR spectrum of fuel additive using HATR trough plate with ZnSe crystal.

Features

- Excellent energy throughput offering high signal-to-noise ratio and spectral quality
- Up to 20 internal reflections on the sample for maximum sensitivity for low concentration components
- Removable crystal plates with pinned positioning for high precision and quick cleanup
- HATR plates with ZnSe, KRS-5, Ge, AMTIR or Si crystals with selectable face angles to optimize sampling depth
- In-compartment (HATR) and out-of-compartment (HATRPlus) versions for small and extra large sample sizes
- Several temperature controlled and flow-through crystal options

The PIKE Technologies HATRs are high-performance accessories, carefully designed to provide excellent results with minimum effort. Accessories are easily installed in the sample compartment, locking into position on the sample compartment baseplate.

Stable alignment provides excellent analytical precision. Crystal plate changeover is rapid, allowing a wide range of samples to be analyzed with maximum convenience. PIKE Technologies HATRs have been optimized for maximum optical throughput and excellent quality spectra can be obtained from demanding samples. Several high-quality crystal materials covering a full spectrum of applications are available. Trough and sealed flat crystal plates are sealed using metallic gaskets, eliminating premature failure and the risk of cross-contamination associated with inferior, epoxy-bonded systems. Flat crystal plates are designed with positive surface relief to aid in improved sample contact.

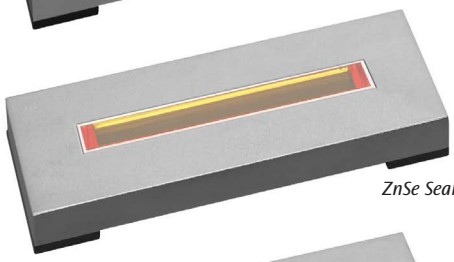
All PIKE HATRs include a purge tube interface for the FTIR spectrometer. This provides full integration of the accessory with the FTIR spectrometer's purging system (sealed and desiccated or purged) and removal of water and carbon dioxide artifacts from the FTIR spectra. Thanks to this, purging is very efficient and the spectrometer can be operated with the sample compartment door open.

PIKE TECHNOLOGIES
WWW.PIKETECH.COM
608-274-2721

HATR Crystal Plate Choices

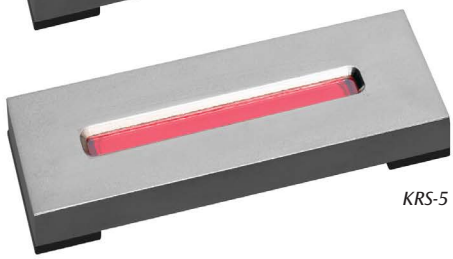
PIKE Technologies HATR crystal plates are available in trough, flat plate and flow cell configurations.

Ge Flat Plate



ZnSe Sealed Flat Plate

ZnSe Trough Plate



KRS-5 Trough Plate

The **flat plate** is used for the analysis of solid materials – including polymer and film samples. It is ideal for solid samples which are too large to fit within the trough plate configuration. The crystal is mounted slightly above the surface of the metal plate, which helps to achieve good crystal/sample contact when the flat plate press is used.

The ZnSe and Ge 45 degree flat plates are available in a sealed version, which is ideal for sampling of oils and other types of low surface tension liquids.

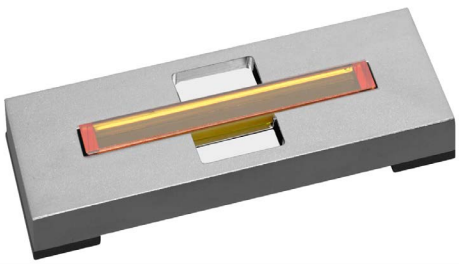
Flat plate HATR crystal plate – ideal for solids, polymer films and coatings.

The **trough plate** is designed for easy sampling, with a large, recessed crystal to accommodate the sample – generally a liquid, powder, or paste. The trough plate is ideal when samples must be cleaned from the crystal with some type of aqueous or organic solvent.

Typically, only a thin layer of the sample needs to be applied onto the crystal surface. For fast evaporating samples, a volatiles cover should be used to cover the sampling area.

Soft powders will often produce good spectra when analyzed by HATR, assuming that they can be put in intimate contact with the crystal. A powder press option is used to achieve this. This device is placed directly on top of the sample filled trough and pressed by hand until the desired result is obtained.

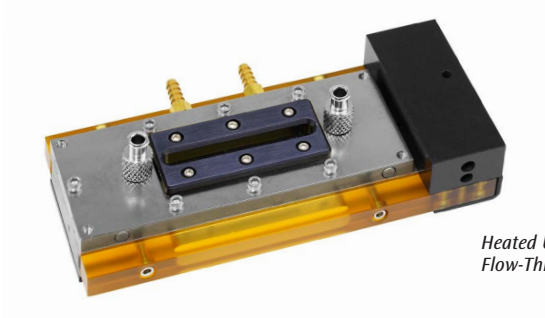
Trough plate HATR crystal plate – ideal for liquids, powders, pastes and gels.



RCPlate

RCPlate™

For special applications where you need to look at coatings on an HATR crystal, PIKE Technologies offers the RCPlate option. The RCPlate is designed to enable easy removal and reinsertion of the HATR crystal. Applications include analysis of coatings, mono-molecular layers, or bio-films deposited directly upon the HATR crystal. With these new RCPlates, it is easy to collect the background spectrum on the clean crystal, remove the HATR crystal from the RCPlate, coat the crystal and then reposition it into the RCPlate to collect the sample spectrum.

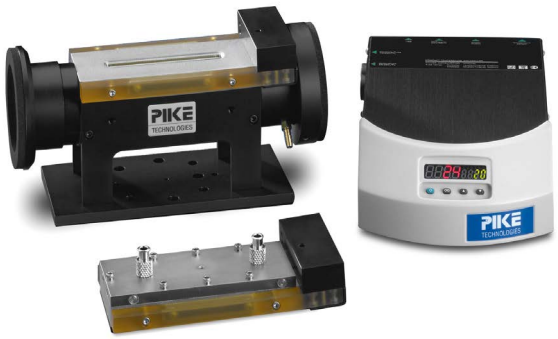


Heated UV HATR Flow-Through Cell

Flow-Through Cell

Flow-through cells are a versatile option for the dynamic laboratory. The ATR crystal is sealed in with O-rings, which allows for user-changeable crystals. The sample may be introduced by syringe or through tubing connected to a 1/16 inch compression fitting. Flow-through cells may be configured for temperature control with Teflon coating.

In addition to our standard flow-through cells, PIKE offers a flow-through cell with a quartz window for photocatalytic studies. Due to degradation of ZnSe in the presence of UV exposure, we recommend using an AMTIR crystal.



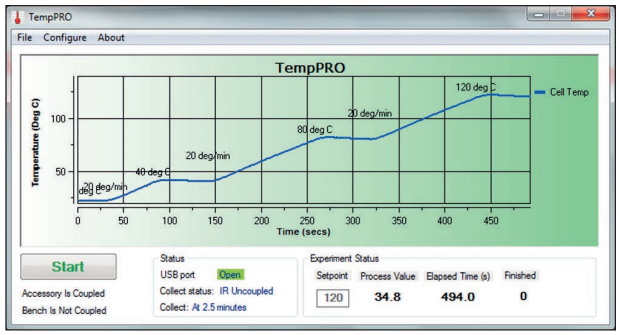
HATR with Heated Trough Plate and temperature control module – foreground shows Heated Flow-Through Cell.

All resistively heated HATR plates and flow-through cells are controlled by PIKE temperature controllers in digital or digital PC versions. The selection of the digital PC version includes PIKE TempPRO software, which provides a graphical user interface for temperature control and kinetic measurements.

A large number of flat, trough and flow-through sampling plates are available for PIKE Technologies HATRs – all are pin-mounted to the HATR with no alignment required. They are compatible and interchangeable with HATR and HATRPlus products which allows optimizing the accessory's configuration for best spectral results.

Do you need an HATR product or feature not shown here in our catalog? Please contact us to discuss your application.

HATR with Flow-Through Cell (background). Liquid Jacketed Trough Plate is shown in foreground.



PIKE TempPRO Software for kinetic experiments with our Resistively Heated Crystal Plates.

SPECIFICATIONS

Temperature Range	Ambient to 130 °C
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Controllers	
Digital	+/- 0.5% of set point
Digital PC	+/- 0.5% of set point, graphical setup, up to 20 ramps, USB interface
Input Voltage	100–240 VDC, auto setting, external power supply
Output Voltage	24 VDC/50 W maximum
HATR Crystals	ZnSe, Si, Ge, AMTIR and KRS-5
Crystal Dimensions	80 x 10 x 4 mm or 80 x 10 x 2 mm
Number of Reflections on the Sample	10 for 45 degree, 4-mm thick 20 for 45 degree, 2-mm thick 5 for 60 degree, 4-mm thick
Base Dimensions (W x D x H)	115 x 55 x 70-104 mm (excludes baseplate and purge collars; base height depends on the beam height of the spectrometer)

Ordering Information

Complete HATR Systems

Bundled HATR Systems (*insert spectrometer model for XX*)

Part Number	Description
022-10XX	HATR Trough Plate System with 45º ZnSe Crystal *Includes Trough Plate, Volatiles Cover and Powder Press*
022-11XX	HATR Flat Plate System with 45º ZnSe Crystal *Includes Flat Plate and HATR Pressure Clamp*
022-12XX	HATR Combined Trough and Flat Plate System with 45º ZnSe Crystals *Includes Trough Plate, Flat Plate, Volatiles Cover, Powder Press and Sample Clamp*
024-11XX	HATRPlus Flat Plate System with 45º ZnSe Crystal *Includes Flat Plate and HATR Pressure Clamp*

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
HATR and HATRPlus systems may be purchased with crystal plates other than ZnSe. Just add –Ge for germanium, –KR for KRS-5, –AM for AMTIR, or –Si for silicon to the part number. Additional plates can be added to an order for any system above. Other configurations may be selected from the options below.

Configurable HATR Systems

HATR Base Optics

Part Number	Description
022-19XX	HATR Platform Optics Assembly
024-19XX	HATRPlus Platform Optics Assembly

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
HATR and HATRPlus Platform Optics Assemblies include volatiles cover, powder press, purge tubes, purge kit and spectrometer base mount.

Pressure Clamp for HATR and HATRPlus

(*must select for solids, films or powder analysis*)

Part Number	Description
022-3050	HATR (pivoting) Pressure Clamp
022-3054	HATR High-Pressure Clamp
024-3050	HATRPlus (pivoting) Pressure Clamp
024-3053	HATRPlus High-Pressure Clamp

Notes: The pressure clamp is required for solids, films, coatings and powdered samples. Maximum force for (pivoting) Pressure Clamp and High-Pressure Clamp is 13 lbs and 30 lbs, respectively.

Crystal Plates for HATR and HATRPlus

(*must select 1 or more*)

Part Number	Description
022-2010-45	Trough Plate, ZnSe, 45°
022-2020-45	Flat Plate, ZnSe, 45°
022-2024-45	Sealed Flat Plate, ZnSe, 45°
022-2012-45	Trough Plate, ZnSe, 45°, 2 mm
022-2022-45	Flat Plate, ZnSe, 45°, 2 mm
022-2030-45	Trough Plate, KRS-5, 45°
022-2040-45	Flat Plate, KRS-5, 45°
022-2050-45	Trough Plate, Ge, 45°
022-2060-45	Flat Plate, Ge, 45°
022-2064-45	Sealed Flat Plate, Ge, 45°
022-2052-45	Trough Plate, Ge, 45°, 2 mm
022-2062-45	Flat Plate, Ge, 45°, 2 mm
022-2070-45	Trough Plate, AMTIR, 45°
022-2080-45	Flat Plate, AMTIR, 45°
022-2090-45	Trough Plate, Si, 45°
022-2100-45	Flat Plate, Si, 45°

Notes: HATR Crystal Plates are pre-aligned and pinned-in-place. Changing crystal plates is easy and fast to optimize sampling results. For most HATR crystal plates, 60 degree face angle is also available. Where not noted, crystals are 4-mm thick and generate 10 reflections on the sample (45° cut). 2-mm crystals result in 20 reflections (45° cut). If you need a crystal not listed here, please contact us. Reconditioning service is available.

Ordering Information

Heated Crystal Plates for HATR and HATRPlus

Part Number	Description
022-5110	HATR Heated Trough Plate, ZnSe, 45°
022-5120	HATR Heated Trough Plate, AMTIR, 45°
022-5130	HATR Heated Trough Plate, KRS-5, 45°
022-5140	HATR Heated Trough Plate, Si, 45°
022-5150	HATR Heated Trough Plate, Ge, 45°

Part Number	Description
022-5210	HATR Heated Flow-Through Cell, ZnSe, 45°
022-5212	HATR Heated Flow-Through Cell, ZnSe, 45°, 2 mm
022-5220	HATR Heated Flow-Through Cell, AMTIR, 45°
022-5230	HATR Heated Flow-Through Cell, KRS-5, 45°
022-5240	HATR Heated Flow-Through Cell, Si, 45°
022-5250	HATR Heated Flow-Through Cell, Ge, 45°
022-5252	HATR Heated Flow-Through Cell, Ge, 45°, 2 mm
022-5225	HATR Heated Flow-Through Cell with UV Port, AMTIR, 45°

Part Number	Description
076-1420	Digital Temperature Control Module, PC Control
076-1220	Digital Temperature Control Module

Notes: Temperature is adjustable to 130 °C for heated trough plates and flow-through cells. Ge becomes opaque near 100 °C. Resistance heated plates require selection of a PIKE Technologies Temperature Control Module. PC Control Module includes PIKE Technologies TempPRO software. PTFE-coated flow-through cells available – contact us for more information.

Flow-Through Cells for HATR and HATRPlus

Part Number	Description
022-4010	HATR Flow-Through Cell, ZnSe, 45°
022-4012	HATR Flow-Through Cell, ZnSe, 45°, 2 mm
022-4020	HATR Flow-Through Cell, AMTIR, 45°
022-4030	HATR Flow-Through Cell, KRS-5, 45°
022-4040	HATR Flow-Through Cell, Si, 45°
022-4050	HATR Flow-Through Cell, Ge, 45°
022-4052	HATR Flow-Through Cell, Ge, 45°, 2 mm
022-5228	HATR Flow-Through Cell with UV Port, AMTIR, 45°

Notes: HATR flow-through cells include Luer-Lok fittings for easy connection with a syringe. A set of 1/16" Swagelok fittings are also included with each flow-through cell for connection with 1/16" tubing. Flow-through cell volume is 500 µL. PTFE-coated flow-through cells available – contact us for more information.

Liquid Jacketed Crystal Plates for HATR and HATRPlus

Part Number	Description
022-5310	HATR Liquid Jacketed Trough Plate, ZnSe, 45°
022-5320	HATR Liquid Jacketed Trough Plate, AMTIR, 45°
022-5330	HATR Liquid Jacketed Trough Plate, KRS-5, 45°
022-5340	HATR Liquid Jacketed Trough Plate, Si, 45°
022-5350	HATR Liquid Jacketed Trough Plate, Ge, 45°

Notes: Liquid jacketed crystal plates require customer-provided liquid circulator. Liquid jacketed crystal plates enable heating to 130 °C and cooling. Ge becomes opaque near 100 °C.

Liquid Jacketed, Flow-Through Crystal Plates for HATR and HATRPlus

Part Number	Description
022-5410	HATR Liquid Jacketed Flow-Through Plate, ZnSe, 45°
022-5412	HATR Liquid Jacketed Flow-Through Plate, ZnSe, 45°, 2mm
022-5420	HATR Liquid Jacketed Flow-Through Plate, AMTIR, 45°
022-5430	HATR Liquid Jacketed Flow-Through Plate, KRS-5, 45°
022-5440	HATR Liquid Jacketed Flow-Through Plate, Si, 45°
022-5450	HATR Liquid Jacketed Flow-Through Plate, Ge, 45°
022-5452	HATR Liquid Jacketed Flow-Through Plate, Ge, 45°, 2 mm

Notes: Liquid jacketed flow-through crystal plates require customer-provided liquid circulator to enable heating to 130 °C and cooling. HATR flow cells include Luer-Lok fittings for easy connection with a syringe and 1/16" Swagelok® fittings for connection with 1/16" tubing. PTFE-coated flow-through cells available – contact us for more information.

HATR RCPlate

Part Number	Description
022-2300	RCPlate for HATR (for 45° crystals)

Note: Requires a selection of HATR Crystal – see below

HATR and HATRPlus Replacement Parts

Part Number	Description
022-3051	HATR Volatiles Cover
022-3052	HATR Powder Press
160-5554	Crystal, Trap, ZnSe, 45°, 80 x 10 x 4 mm
160-5559	Crystal, Trap, ZnSe, 45°, 80 x 10 x 2 mm
160-5555	Crystal, Trap, KRS-5, 45°, 80 x 10 x 4 mm
160-5556	Crystal, Trap, Ge, 45°, 80 x 10 x 4 mm
160-5560	Crystal, Trap, Ge, 45°, 80 x 10 x 2 mm
160-5557	Crystal, Trap, AMTIR, 45°, 80 x 10 x 4 mm
160-5558	Crystal, Trap, Si, 45°, 80 x 10 x 4 mm
160-5561	Crystal, Trap, ZnSe, 60°, 80 x 10 x 4 mm
160-5562	Crystal, Trap, Ge, 60°, 80 x 10 x 4 mm
022-3032	Spacer for HATR Flow Cell, 2 mm
022-3040	Viton O-Ring for HATR Flow-Through Cell, upper (6 ea.)
022-3045	Viton O-Ring for HATR Flow-Through Cell, lower (6 ea.)
022-3041	Perfluoroelastomer O-Ring for HATR Flow-Through Cell, upper (1 ea.)
022-3046	Perfluoroelastomer O-Ring for HATR Flow-Through Cell, lower (1 ea.)

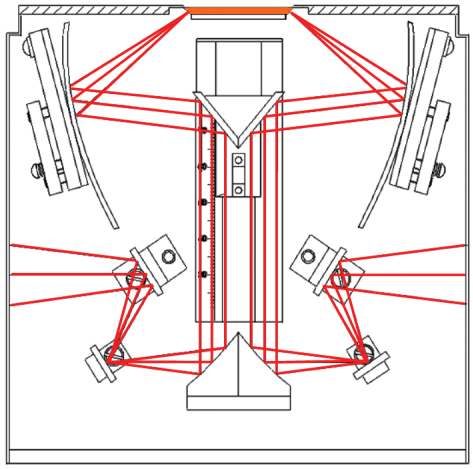
Notes: Reconditioning service for used HATR crystal plates is available. Contact PIKE Technologies for items not described in this list.

ATRMax II Variable Angle Horizontal ATR Accessory – *HATR for Inquisitive Minds*

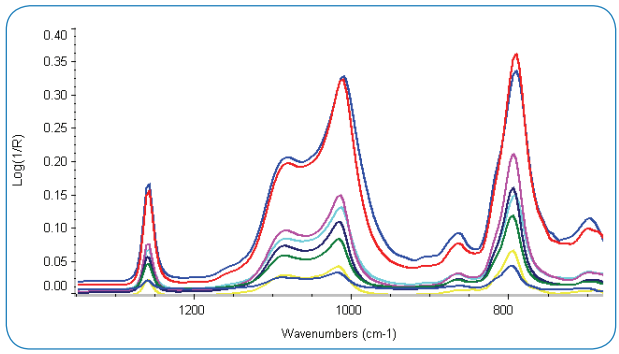
The ATRMax II is a high throughput, variable angle horizontal ATR accessory developed for use in FTIR spectrometers. The design employs a unique optical layout (U.S. patent 5,105,196) which enables samples to be analyzed over a range of incident angles from 25 to 65 degrees. Variable angle of incidence provides experimental control over the depth of penetration of an IR beam into the sample and the number of beam reflections in the ATR crystal, which in turn determines the effective IR beam pathlength for a given experiment. Adjustable angle of incidence allows immediate optimization of measurements for otherwise difficult to analyze samples. The ATRMax can be used for depth profiling studies where spectral composition may be analyzed relative to depth of penetration as the angle of incidence is changed.

Features

- Selectable angle of incidence – 25 to 65 degrees in one degree increments
- 0.5 to 10 micron depth of penetration – dependent on crystal material, angle of incidence, sample's refractive index and wavelength of IR beam – ideal for depth profiling studies
- 3 to 12 reflections of IR beam – dependent upon angle of incidence – ideal for optimizing ATR sampling methods
- Flat and trough crystal plates for solids, films, powders and liquid samples – optional temperature control for all plates
- Optional, high-pressure clamp for sampling of films, coatings or powdered samples
- Motorized option with electronic control module and AutoPRO™ software for automated, high-precision experiments
- Sealed and purgeable optical design to eliminate water vapor and carbon dioxide interferences



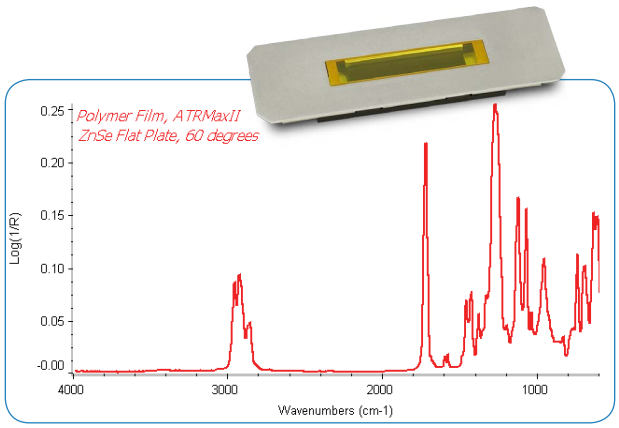
Proprietary beam path within the ATRMax II FTIR sampling accessory.



Depth profiling study of silicon release agent using ATRMax II accessory. FTIR spectra collected using Ge crystal flat plates at effective angles of incidence from 25 to 65 degrees.

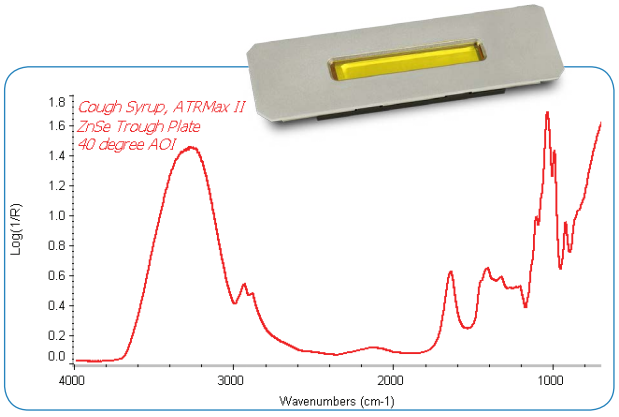
The ATR crystals for the ATRMax II are of trapezoidal shape and 56-mm long, 10-mm wide and 4-mm thick. Standard bevel angles at each end of the crystal are available in 30, 45, and 60 degree versions. Coupling the variable angle of incidence of the ATRMax II with the variable crystal face angles, one can select effective angle of incidence ranging from 25 to 65 degrees and the range in number of reflections from 3 to 12.

Two crystal plate configurations, flat and trough, are available for the ATRMax II. The **flat crystal plate** design is used for the analysis of coatings, films and non-particulate solids. Typical applications include depth profiling studies and optimization of ATR spectral data. A sample clamp is required to provide intimate contact between the sample and crystal surface.



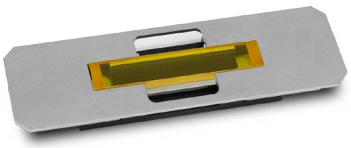
Optimized FTIR spectrum of polymer film run with the ATRMax II at 60 degree angle of incidence.

The **trough crystal plate** is recommended for use with liquids, pastes and powdered samples. Typical applications include the analysis of oils, detergents, and other liquid samples. A volatiles cover and powder press are included with the ATRMax II for use with this crystal mount.

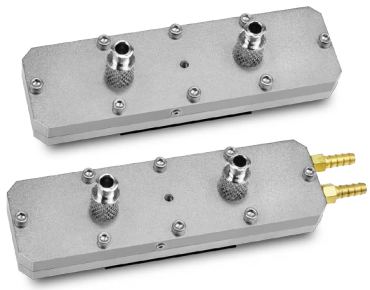


Liquid cough syrup sample spectrum collected with the ATRMax II accessory using the ZnSe trough plate and a 40 degree angle of incidence.

For special applications where you need to look at coatings on an ATR crystal, PIKE Technologies offers the RCPlate™ option. The RCPlate is designed to enable easy removal and reinsertion of the ATR crystal. Applications include analysis of coatings, mono-molecular layers, or bio-films deposited directly upon the ATR crystal. With these RCPlates, it is easy to collect the background spectrum on the clean crystal, remove the ATR crystal from the RCPlate, coat the crystal and then reposition it into the RCPlate to collect the sample spectrum.



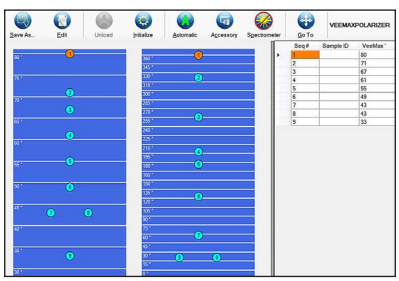
A variety of **flow-through cells** are available which feature removable crystals. This enables replacement of the crystals and facilitates cleaning of "sticky" samples. Flow cells may be configured for ambient measurements and heating and liquid jacketed temperature control. With the liquid-jacketed version one can measure samples at heated or cooled temperatures using a liquid circulator. PTFE coating of the cell is an option.



Optional **resistively heated crystal plate**s are available for the ATRMax II trough, flat and flow-through cell versions. These heated crystal plates are driven using PIKE Technologies temperature controllers available in digital and digital PC versions. The digital PC version offers PIKE TempPRO software for graphical setup and interfaces with most FTIR software packages for data collection.

The variable angle of incidence can be controlled manually or with an optional **motorized attachment** for the ATRMax II. Multiple ATR measurements at different angles of incidence can be fully automated with the motorized version and PIKE Technologies AutoPRO software. Automation streamlines the collection of spectra from multiple angles of incidence. With the automated ATRMax accessory, the entire experiment can be pre-programmed and executed by the computer. Advantages of the automated ATRMax II system include:

- Computer controlled precision, accuracy and repeatability
- Synchronization of mirror position changes with collection of sample spectra
- Full integration of the PIKE Technologies AutoPRO software with most FTIR spectrometer programs
- Tailor-made, predefined experiments
- "Hands-free" operation



AutoPRO Software control of ATRMax angle of incidence (automated polarizer available) for automated depth profiling studies and ATR experiment optimization.

Ordering Information

ATRMax II System Configurations

Part Number	Description
023-10XX	ATRMax II Trough Plate System with 45° ZnSe Crystal *Includes Trough Plate, Volatiles Cover and Powder Press*
023-11XX	ATRMax II Flat Plate System with 45° ZnSe Crystal *Includes Flat Plate and Pressure Clamp*
023-12XX	ATRMax II Combined Trough and Flat Plate System with 45° ZnSe Crystals *Includes Trough Plate, Flat Plate, Volatiles Cover, Powder Press and Pressure Clamp*

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
ATRMax II Systems may be purchased with crystal plates other than ZnSe. Just add -Ge for germanium, -KR for KRS-5, -AM for AMTIR, or -Si for Silicon. Additional plates can be added to an order for any system above. Other configurations may be selected from the options below.

ATRMax II Base Optics *(must select)*

Part Number	Description
023-19XX	ATRMax II Variable Angle HATR

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
ATRMax II Base Optics includes volatiles cover, powder press, purge tubes, purge kit and spectrometer base mount.

Crystal Plates for ATRMax II *(must select 1 or more)*

Part Number	Description
023-2001	Trough Plate, ZnSe, 45°
023-2011	Flat Plate, ZnSe, 45°
023-2021	Trough Plate, ZnSe, 30°
023-2031	Flat Plate, ZnSe, 30°
023-2041	Trough Plate, ZnSe, 60°
023-2051	Flat Plate, ZnSe, 60°
023-2003	Trough Plate, Ge, 45°
023-2013	Flat Plate, Ge, 45°
023-2023	Trough Plate, Ge, 30°
023-2033	Flat Plate, Ge, 30°
023-2043	Trough Plate, Ge, 60°
023-2053	Flat Plate, Ge, 60°
023-2046	Trough Plate, AMTIR, 45°
023-2047	Flat Plate, AMTIR, 45°
023-2002	Trough Plate, KRS-5, 45°
023-2012	Flat Plate, KRS-5, 45°
023-2022	Trough Plate, KRS-5, 30°
023-2032	Flat Plate, KRS-5, 30°
023-2042	Trough Plate, KRS-5, 60°
023-2052	Flat Plate, KRS-5, 60°
023-2044	Trough Plate, Si, 45°
023-2045	Flat Plate, Si, 45°

Notes: ATRMax crystal plates are pre-aligned and pinned-in-place. Changing crystal plates is easy and fast to optimize sampling results. If you need a crystal plate not listed here, please contact us.

Pressure Clamp for ATRMax II

Part Number	Description
023-3050	ATRMax Pressure Clamp

Note: The pressure clamp is required for solids, films, coatings and powdered samples.

ATRMax II Sampling Options

Part Number	Description
023-2800	Motorized Upgrade for ATRMax II
023-2850	Motorized Option for ATRMax II
090-1000	Manual Polarizer, ZnSe
090-5000	Precision Automated Polarizer, ZnSe, USB
023-2300	RCPlate for ATRMax II
023-4000	ATRMax Flow Cell Assembly (order crystal separately)
023-4100	ATRMax Liquid-Jacketed Flow-Through Cell Assembly (order crystal separately)
023-4200	ATRMax Heated Flow-Through Cell Assembly (order crystal separately)
023-4300	ATRMax Heated Trough Plate Assembly (order crystal separately)
023-4400	ATRMax Heated Flat Plate Assembly (order crystal separately)
013-4200	ATR Variable Angle Heating Conversion Plate
076-1420	Digital Temperature Control Module, PC Control
076-1220	Digital Temperature Control Module

Notes: Motorized Option includes PIKE Technologies AutoPRO software and controller. Other polarizer options are found in the polarization section of this catalog. The ATR Variable Angle Heating Conversion Plate must be selected with temperature controlled crystal plates. Resistively heated crystal plates require selection of the Temperature Control Module. Maximum crystal temperature is 120 °C.

Crystals for ATRMax II

Part Number	Description
160-5563	Crystal, 45°, Trap., 56 x 10 x 4, ZnSe
160-5571	Crystal, 60°, Trap., 56 x 10 x 4, ZnSe
160-5569	Crystal, 30°, Trap., 56 x 10 x 4, Ge
160-5565	Crystal, 45°, Trap., 56 x 10 x 4, Ge
160-5573	Crystal, 60°, Trap., 56 x 10 x 4, Ge
160-5570	Crystal, 30°, Trap., 56 x 10 x 4, Si
160-5567	Crystal, 45°, Trap., 56 x 10 x 4, Si
160-5575	Crystal, 60°, Trap., 56 x 10 x 4, Si
160-5566	Crystal, 45°, Trap., 56 x 10 x 4, AMTIR
160-5574	Crystal, 60°, Trap., 56 x 10 x 4, AMTIR

Note: Please contact PIKE Technologies for crystals not on this list.

ATRMax II Replacement Parts

Part Number	Description
023-3051	ATRMax II Volatiles Cover
023-3052	ATRMax II Powder Press

Notes: Please contact PIKE Technologies for items not described in this list. Reconditioning service for used ATRMax crystal plates is available.

Resistively Heated Plates Specifications

Temperature Range	Ambient to 120 °C
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Controller	
Digital	+/- 0.5% of set point
Digital PC	+/- 0.5% of set point, graphical setup, up to 20 ramps, USB interface
Input Voltage	100–240 VDC, auto setting, external power supply
Operating Voltage	24 VDC/36 W

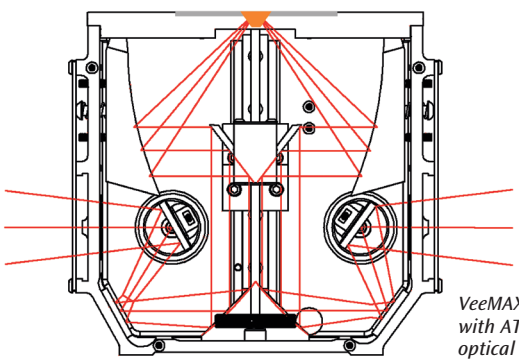
VeeMAX III with ATR –
Variable Angle, Single Reflection ATR for Depth Profiling Studies

The VeeMAX III with ATR offers continuous variable angle of incidence and a variety of crystal plates to selectively control the depth of penetration of the IR beam into the sample. ATR applications include the study of layered samples, coatings, release agents, monolayers on silicon and chemical migration studies.

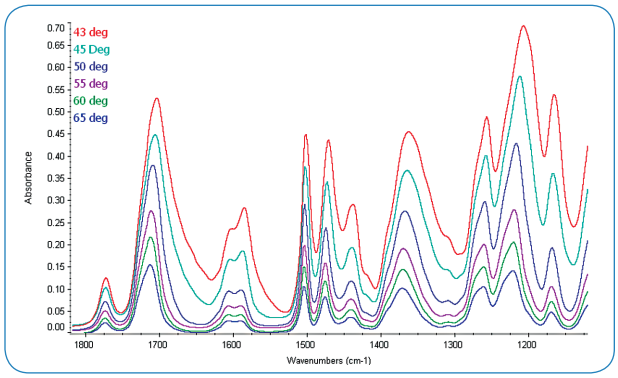
The VeeMAX III with ATR accessory provides exceptionally high throughput (over 50% with 45 degree ZnSe crystal) to minimize sampling time and enable detection of low concentration components in samples of complex composition. The crystal flat plates offered for the VeeMAX III are ideal for solid and layered samples and are designed for use with the optional pressure clamp. The combination of large crystal diameter (20 mm) and slip-clutch pressure clamp provides sample-to-crystal contact without altering layered sample composition. The optional liquids retainer may be added to the crystal plate for analysis of liquid samples.

Features

- Continuously variable set angle of incidence – 30 to 80 degrees
- 0.4 to 46 micron depth of penetration – ideal for depth profiling studies
- High throughput for excellent quality spectra
- Optional, high-pressure clamp for sampling of films, coatings or powdered samples
- Integrated position for manual or automated polarization
- Motorized option with electronic control module and AutoPRO software for automated, high-precision experiments
- VeeMAX III can be used as a variable angle of incidence specular reflection accessory
- Configurable for specialized applications – monolayer studies and spectroelectrochemistry
- Sealed and purgeable optical design to eliminate water vapor and carbon dioxide interferences

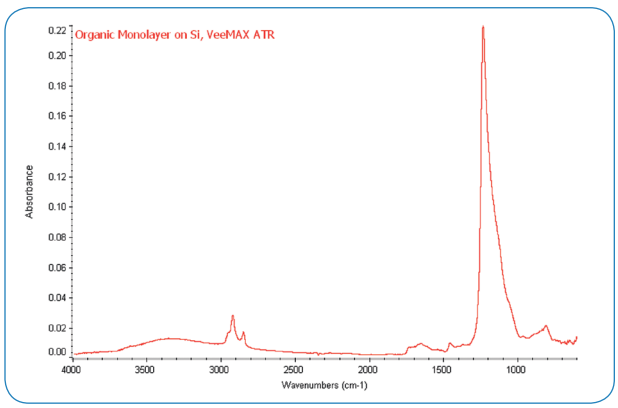


VeeMAX III with ATR optical layout



Depth profiling study of layered polymer film. FTIR spectra collected using ZnSe crystal at set angles of incidence from 43 to 65 degrees. IR absorbance band at 1591 cm^{-1} clearly increases relative to other bands as we probe deeper into the sample.

Monolayers and ultra-thin films absorbed on silicon or gold substrate are easily sampled using the VeeMAX III equipped with a high refractive index ATR crystal. Compared to specular reflectance sampling for monolayer analysis, an increase in sensitivity of up to 1–2 orders of magnitude may be realized via ATR sampling. For these applications, the VeeMAX III accessory is configured to include a high-angle Ge flat plate (60 or 65 degrees), the high-pressure clamp with a 7.8-mm pressure tip, and a polarizer.



Analysis of monomolecular layer on silicon – VeeMAX III with 60 degree Ge crystal, pressure clamp with 7.8-mm tip and p polarization.

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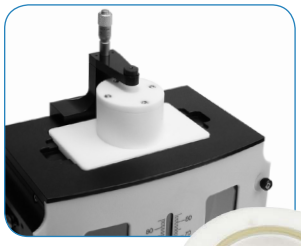
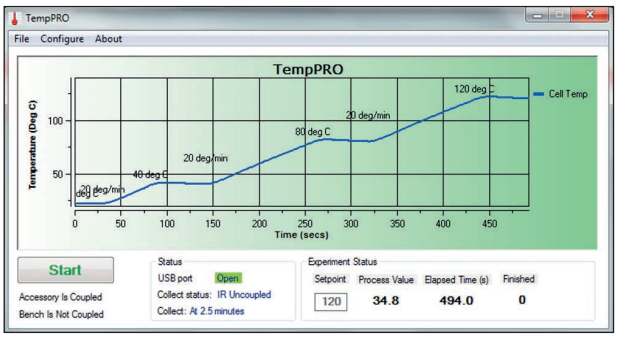
A spectroelectrochemical cell option for the VeeMAX III is also available. The innovative design offers a chemical-resistant vessel sealed to an ATR crystal, which is mounted on the VeeMAX III. The crystals are interchangeable for optimizing spectral results and are removable to allow electrode coating on the ATR surface. The high throughput of the VeeMAX III with ATR provides excellent sensitivity and reduced sampling time. Alternatively, a flat IR transparent window or 60 degree CaF_2 prism may be installed to permit specular reflectance sampling. The electrochemistry cell is equipped with a precision micrometer for electrode positioning, and is user-configurable.



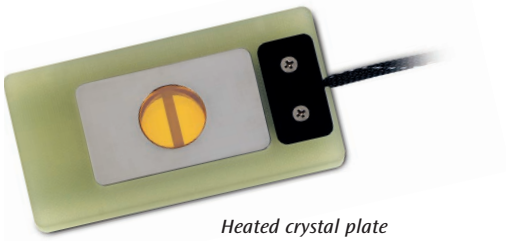
Spectroelectrochemical cell with removable and interchangeable crystals mounted on the VeeMAX III.

VeeMAX III spectroelectrochemical cell – maximum flexibility with its interchangeable and removable crystals.

Temperature controlled crystal flat plates are available for thermal studies. The maximum temperature is 130 °C for all crystal types. PIKE Technologies' PC version temperature controller allows up to 20 ramps to be easily programmed using PIKE TempPRO software, and data collection as a function of time or temperature may be prescribed for most FTIR spectrometers.

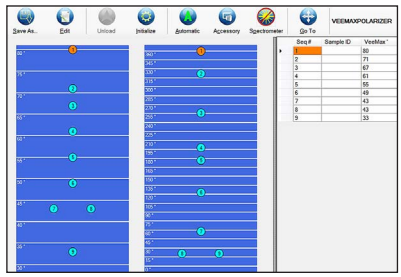


TempPRO software for graphical setup and control of kinetic measurements.



Heated crystal plate

Motorized control of angle of incidence via personal computer for automated data collection is available for the accessory. The motorized VeeMAX III is ideal for depth of profiling studies as it greatly speeds and improves the precision and reproducibility of the data collection process.



AutoPRO Software control of VeeMAX III angle of incidence (automated polarizer available) for automated depth profiling studies, angle of incidence and polarization angle can be set independently.

VeeMAX III with ATR Specifications

ATR Crystal Choice	ZnSe, Ge, Si, ZnS
Crystal Plate Mounting	User-changeable plates
Crystal Plate Mounts	Stainless Steel
Crystal Dimension (surface)	20-mm diameter
Optics	All reflective
Pressure Device	Rotating, continuous variable pressure; click stop at maximum
Heating Options	130 °C
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Digital or digital with PC control (up to 20 ramps, automated data collection, USB interface)
Input Voltage	100–240 VAC, auto setting, external power supply
Operating Voltage	24 VDC/50 W
Purge Sealing	Purge tubes and purge barb included
Accessory Dimensions (W x D x H)	177 x 92 x 162 mm (excludes clamp height and baseplate)
Spectroelectrochemical Vessel Dimensions	25 mm dia tapering to 19 mm, 25 mm tall
Spectroelectrochemical Vessel Volume	7.5 mL
Spectroelectrochemical Vessel Material	Polytetrafluoroethylene or PEEK
FTIR Compatibility	Most, specify model and type

Ordering Information

VeeMAX III Base Optics *(must select)*

Part Number	Description
013-11XX	VeeMAX III Variable Angle Specular Reflectance Accessory *Includes specular reflectance masks (2, 5/8 and 3/8"), purge tubes, purge kit and spectrometer base mount.*

Note: Replace XX with your spectrometer's Instrument Code. Click for List >

Crystal Plates for VeeMAX III ATR

(must select 1 or more for ATR)

Part Number	Description
013-4021	Flat Plate, ZnSe, 45°
013-4031	Flat Plate, ZnSe, 60°
013-4041	Flat Plate, Ge, 45°
013-4051	Flat Plate, Ge, 60°
013-4061	Flat Plate, Ge, 65°
013-4081	Flat Plate, Si, 45°
013-4071	Flat Plate, Si, 60°
013-4091	Flat Plate, ZnS, 45°
013-4096	Flat Plate, ZnS, 60°
013-3401	Liquids Retainer for VeeMAX III ATR crystals
013-3501	VeeMAX III ATR Flow Cell

Notes: VeeMAX III Crystal Plates are pre-aligned and pinned-in-place. Changing crystal plates is easy and fast to optimize sampling results. ZnS crystal plate is excellent for deepest penetration of IR beam. Si crystal plate is excellent for far-IR ATR. If you need a crystal not listed here, please contact us. Flow cell and Liquids Retainer require High-Pressure Clamp. Reconditioning service for used VeeMAX crystal plates is available.

Optional Crystal Plates for Heated VeeMAX III ATR

Part Number	Description
013-4121	Heated Flat Plate, ZnSe, 45°
013-4131	Heated Flat Plate, ZnSe, 60°
013-4141	Heated Flat Plate, Ge, 45°
013-4151	Heated Flat Plate, Ge, 60°
013-4161	Heated Flat Plate, Ge, 65°
013-4171	Heated Flat Plate, Si, 60°
013-4181	Heated Flat Plate, Si, 45°
013-4191	Heated Flat Plate, ZnS, 45°
013-4196	Heated Flat Plate, ZnS, 60°
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC Control

Notes: Heated VeeMAX III crystal plates may be heated to 130 °C. Temperature control module selection is required for heated crystal plates. Digital temperature control module with PC control includes TempPRO software.

Pressure Clamp for VeeMAX III *(must select for solids, films or powder analysis)*

Part Number	Description
013-3101	VeeMAX III ATR Pressure Clamp
025-3094	7.8-mm ATR Pressure Tip

Notes: The pressure clamp is required for solids, films, coatings and powdered samples. The pressure clamp is supplied with 20-mm tip for polymer films. The 7.8-mm pressure tip is required for monolayers on silicon or small samples.

VeeMAX III Sampling Options

Part Number	Description
013-2851	Motorized Option for VeeMAX III
090-1000	Manual Polarizer, ZnSe
090-1200	Manual Polarizer, KRS-5
090-3000	Precision Manual Polarizer, ZnSe
090-3200	Precision Manual Polarizer, KRS-5
090-5000	Precision Automated Polarizer, ZnSe, USB
090-5100	Precision Automated Polarizer, KRS-5, USB
007-0300	PIKECalc Software

Notes: PIKECalc software provides easy calculations of depth of penetration, effective angle of incidence and critical angle for ATR measurements. Motorized Option includes PIKE Technologies AutoPRO software and controller. Other polarizer options are found in the polarization section of this catalog. Motorized VeeMAX III and automated polarizer interface simultaneously.

Spectroelectrochemical Configuration

Part Number	Description
013-3300	Electrochemical Cell, PTFE
013-3370	Electrochemical Cell, PEEK
013-3402	Heated Electrochemical Cell, PTFE
160-5546	ZnSe Crystal, 45°
160-5550	ZnSe Crystal, 60°
160-5547	Ge Crystal, 45°
160-5551	Ge Crystal, 60°
160-5548	Si Crystal, 45°
160-5552	Si Crystal, 60°
160-5549	ZnS Crystal, 45°
160-5553	ZnS Crystal, 60°
160-5527	CaF_2 Crystal, 60°
160-1144	CaF_2 Flat Window, 20-mm diameter
160-1304	ZnSe Flat Window, 20-mm diameter
013-3320	Flat Window Holder, Delrin™
013-3345	45° Crystal Holder, Delrin
013-3360	60° Crystal Holder, Delrin
013-3374	45° Crystal Holder, PEEK
013-3376	60° Crystal Holder, PEEK
013-3445	Heated 45° Crystal Holder
013-3460	Heated 60° Crystal Holder

Notes: The electrochemical configuration requires electrochemical cell, crystal or window holder and VeeMAX III accessory. Must select one or more crystal or flat window. Choose a crystal holder to match the crystal angle. A flat window or CaF_2 crystal are used for specular reflectance sampling. Other window types for specular reflectance measurements may be found in our listing of transmission windows, 20 mm x 2 mm. The heated electrochemical cell requires the choice of a digital temperature controller. Electrodes supplied by the end-user.

Replacement Parts

Part Number	Description
013-4010	Mask Set for VeeMAX
300-0002	Gold Substrate Alignment Mirror, 1.25 x 3.0"

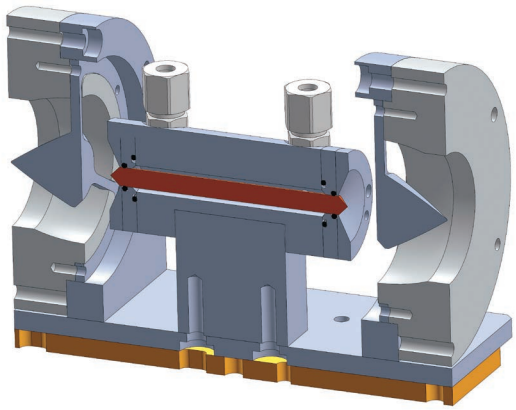
JetStream ATR Accessory – *Measurements of Liquids under Varying Conditions*

Features

- Efficient ATR design for static and flowing liquid measurements
- Small sample chamber provides efficient sampling
- ZnSe and Germanium crystal options to match sample requirements
- Qualitative and quantitative applications
- Temperature control option up to 200 °C
- Pressures up to 1500 psi

The PIKE Technologies JetStream is a unique ATR accessory optimized for analysis of liquids in static or flow modes at varying pressure. The accessory design revolves around a cylindrical ATR crystal that is encased in a heavy-duty stainless steel body. The sample is introduced via a compression filling from 1/16" up to 1/4" tube OD and completely surrounds the ATR crystal providing efficient sampling for excellent reproducibly and sufficient throughput for high sensitivity measurements. The maximum pressure rating is 1500 psi.

The compact cell design employs a pair of transfer optics to direct the infrared beam to one end of an IR transmitting ATR crystal. A similar pair of optics directs the beam emitted from the other end of the ATR crystal to the spectrometer detector.

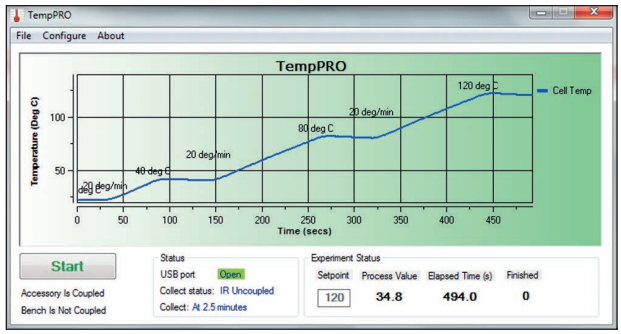


Optical diagram of the JetStream ATR

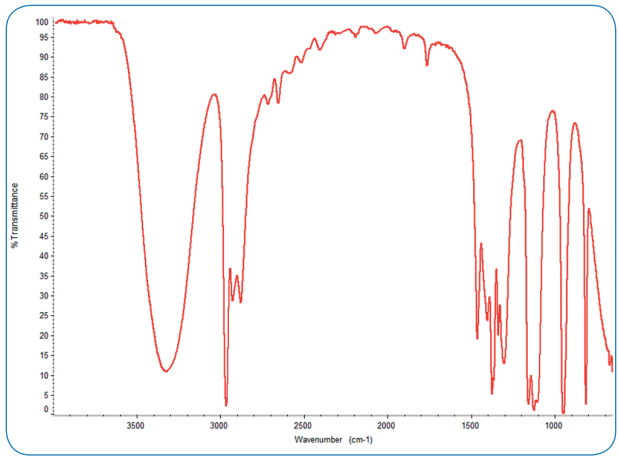
The ATR crystal for the JetStream ATR accessory is of a cylindrical shape and is 82-mm long and 6.4-mm in diameter. To optimize accessory performance, crystal geometry has been carefully chosen. The design of the JetStream ATR accessory provides 12 reflections of the IR beam along the crystal surface. The volume of the sample chamber is 1.3 mL.

Heating up to 200 °C may be realized with the heated JetStream base. PIKE Technologies offers digital and PC programmable temperature controllers. Ramps and hold times are easily programmed through TempPRO software when using the PC module. Data collection may be initiated as a function of time or temperature with many FTIR spectrometers.

Heated JetStream accessory



Selection of the digital control module, PC control includes PIKE TempPRO™ software for graphical setup and automated data collection for thermal experiments.



Isopropanol spectrum collected using the JetStream with ZnSe crystal.

Ordering Information

Part Number	Description
020-19XX	JetStream ATR Base Optics Assembly
020-18XX	Heated JetStream ATR Base Optics Assembly

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
Choose a temperature controller below for the Heated JetStream. Ge becomes opaque near 100 °C.

ATR Crystals for JetStream *(must select one)*

Part Number	Description
020-2010	ZnSe Rod
020-2050	Ge Rod

Temperature Controller for JetStream

Part Number	Description
076-1220	Digital Temperature Control Module
076-1420	Digital Temperature Control Module, PC Control

Replacement Parts

Part Number	Description
020-3040	EPDM Crystal O-Rings, 120 °C max (2 ea.)
020-3041	EPDM Housing O-Rings, 120 °C max (2 ea.)
020-3045	Perfluoroelastomer Crystal O-Rings (2 ea.)
020-3046	Perfluoroelastomer Housing O-Rings (2 ea.)

Specifications

Cell Body	316 Stainless Steel
ATR Crystals	ZnSe or Germanium
Crystal Size	82 mm x 6.4 mm
Crystal Face Angle	45°
Number of Reflections	12
Cell Volume	1.3 mL
Liquid Connectors	316 Stainless Steel Swagelok®
Maximum Pressure	1500 psi
Heating Options	Ambient to 200 °C maximum
Accuracy	+/- 0.5%
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Digital or digital with PC control (up to 20 ramps, automated data collection, USB interface)
Input Voltage	100–240 VAC, auto setting, external power supply
Operating Voltage	3 A/24 VDC/75 W
Accessory Dimensions (W x D x H)	153 x 100 x 108 mm (excludes FTIR baseplate and mount)
FTIR Compatibility	Most, specify model and type

Classic VATR –
Variable Angle ATR for Analysis of Solids, Films and Coatings

The Variable Angle ATR is a traditional in-compartment accessory with the ATR crystal mounted vertically with respect to the spectrometer baseplate. Its optical layout is based on an optimized Gilby configuration and allows continuous adjustment of the incident beam angle between 30 to 60 degrees. This accessory is suitable for the analysis of solids, films and coatings, but for obvious reasons, it cannot be used for working with liquids. For enhanced sensitivity the sample may be mounted on both sides of the crystal. A unique mirror adjustment mechanism which utilizes mirror placement and proportional pivoting allows precise and repeatable alignment. PIKE Technologies' Variable Angle ATR offers flexibility when the frequent replacement of ATR crystals is required. VATR is an excellent, low-cost tool for teaching the principles of internal reflection spectroscopy, and for basic research.

Features

- 30 to 60 degree – continuously variable angle of incidence
- Full control over the number of reflections and depth of penetration
- Unique mechanism for fine-tuning mirror positions and precise and repeatable alignment
- High energy throughput
- Stainless steel, easy to remove crystal mounts and anvils
- Economical introduction to ATR techniques – excellent R&D and teaching tool

Ordering Information

VATR Base Optics *(must select)*

Part Number	Description
021-19XX	VATR Variable Angle, Vertical ATR

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
VATR Base Optics includes plate for mounting in FTIR spectrometer slide mount.

Crystal Options for VATR *(must select 1 or more)*

Part Numbers P/N 50 mm	Part Numbers P/N 25 mm	Description
160-5528	160-5530	KRS-5, 45° Parallelogram
160-5529	160-5531	KRS-5, 60° Parallelogram
160-5532	160-5533	ZnSe, 45° Parallelogram
160-5543	160-5540	ZnSe, 60° Parallelogram
160-5541	160-5538	Ge, 30° Parallelogram
160-5534	160-5536	Ge, 45° Parallelogram
160-5535	160-5537	Ge, 60° Parallelogram
160-5544	160-5539	Si, 45° Parallelogram

Notes: VATR crystals are available in lengths of 25 and 50 mm. All are 3-mm thick and 10-mm wide. Select crystal length and type based upon desired sample absorbance and spectral range.

Crystal Holder and Clamp for VATR
(must select 1 or more to hold ATR crystals)

Part Number	Description
021-5050	50-mm VATR Crystal Holder and Clamp
021-5020	25-mm VATR Crystal Holder, Clamp and Mirror

Note: The pressure clamp is selected for the ATR crystal length.

VATR Replacement Parts

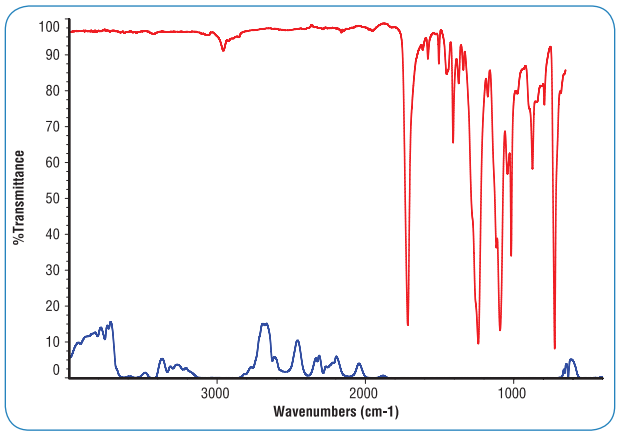
Part Number	Description
021-5040	25-mm VATR Crystal Holder and Clamp
021-5030	Set of 25-mm and 50-mm Pads

Note: Please contact PIKE Technologies for items not described in this list.

ATR – *Theory and Applications*

Attenuated Total Reflectance (ATR) is today the most widely used FTIR sampling tool. ATR generally allows qualitative or quantitative analysis of samples with little or no sample preparation, which greatly speeds sample analysis. The main benefit of ATR sampling comes from the very thin sampling pathlength and depth of penetration of the IR beam into the sample. This is in contrast to traditional FTIR sampling by transmission where the sample must be diluted with IR transparent salt, pressed into a pellet or pressed to a thin film, prior to analysis to prevent totally absorbing bands in the infrared spectrum.

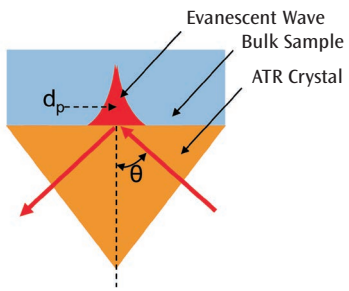
A comparison of transmission versus ATR sampling results for a thick polymer sample is shown below where the sample is too thick for high-quality transmission analysis (shown in the lower blue spectrum). In transmission spectroscopy, the IR beam passes through the sample and the effective pathlength is determined by the thickness of the sample and its orientation to the directional plane of the IR beam. Clearly in the example below the sample is too thick for transmission analysis because most of the IR bands are totally absorbing. However, simply placing the thick sample on the ATR crystal (Diamond MIRacle) and applying pressure generates a nearly perfect result (upper red spectrum) – identified by a library search as a polybutylene terephthalate. The total analysis time for the thick polymer by ATR was less than 1 minute.



ATR and transmission spectra of a thick polymer sample.

How ATR Works

With ATR sampling we direct the IR beam into a crystal of relatively higher refractive index. The IR beam reflects from the internal surface of the crystal and creates an evanescent wave, which projects orthogonally into the sample in intimate contact with the ATR crystal. Some of the energy of the evanescent wave is absorbed by the sample and the reflected radiation is returned to the detector. This ATR phenomenon is shown graphically in the following representation of a single reflection ATR.



Graphical representation of a single reflection ATR.

While the analysis of samples by ATR is easy, it is interesting and useful to be aware of each of the following experimental factors and how they affect the final spectrum:

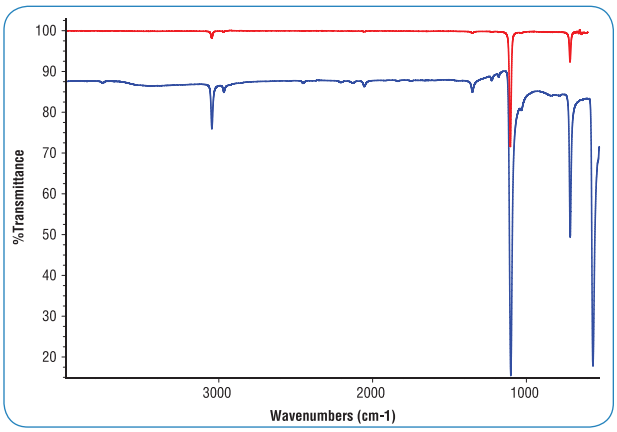
- Refractive indices of the ATR crystal and the sample
- Angle of incidence of the IR beam
- Critical angle
- Depth of penetration
- Wavelength of the IR beam
- Effective pathlength
- Number of reflections
- Quality of the sample contact with ATR crystal
- ATR crystal characteristics

The **refractive indices of the crystal and sample** are important considerations in the ATR sampling technique by virtue of the following equation:

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

where θ_c is the **critical angle**, n_2 is the refractive index of the sample and n_1 is the refractive index of the crystal.

When the angle of incidence exceeds the critical angle, we will observe a purely ATR spectral result. If the critical angle is not met, we will observe a combined ATR and external reflectance result. This occurs if the angle of incidence of the IR beam is too low, if the refractive index of the crystal is too low, if the refractive index of the sample is too high or a combination of these three factors. In most cases this problem is not observed; however, an example of this is shown in the following spectral data. The sample is a high refractive index liquid (n_1=1.8) run on a 45 degree accessory using diamond and Ge crystal plates. The spectrum run on the Ge crystal plate exhibits a normal baseline and symmetric absorbance bands – critical angle is met. The spectrum run on the diamond crystal plate has a baseline shifted and asymmetric absorbance bands due to non-adherence to the critical angle requirements for this set of analysis parameters.



Spectra of high refractive index liquid using Ge (red) and diamond (blue) ATR crystals.

Another way to correct the spectral artifacts observed (above) in the high refractive index sample spectrum would be to increase the angle of incidence in the ATR accessory to a value above the critical angle. Adjustment or selection of the angle of incidence is available in several of the PIKE Technologies ATR accessories.

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Table 1: Pathlengths and penetration depth (in microns), and ATR crystals at various angles of incidence (in degrees) and numbers of reflections.

ATR Sampling for $n_2 = 1.5$ $\lambda = 1000\ cm^{-1}$		ZnSe, Diamond $n_1 = 2.4$ $\theta_c = 38.7°$			AMTIR $n_1 = 2.5$ $\theta_c = 36.9°$			Ge $n_1 = 4.0$ $\theta_c = 22.0°$		
θ	N	d_p	d_e	EPL	d_p	d_e	EPL	d_p	d_e	EPL
45	1	2.0	4.36	4.36	1.7	3.38	3.38	0.66	0.61	0.61
45	3	2.0	4.36	13.08	1.7	3.38	10.15	0.66	0.61	1.84
45	10	2.0	4.36	43.60	1.7	3.38	33.84	0.66	0.61	6.14
30	1	N/A	N/A	N/A	N/A	N/A	N/A	1.2	1.59	1.59
30	3	N/A	N/A	N/A	N/A	N/A	N/A	1.2	1.59	4.76
30	10	N/A	N/A	N/A	N/A	N/A	N/A	1.2	1.59	15.85
60	1	1.11	1.53	1.53	1.02	1.30	1.30	0.51	0.32	0.32
60	3	1.11	1.53	4.59	1.02	1.30	3.91	0.51	0.32	0.97
60	10	1.11	1.53	15.32	1.02	1.30	13.03	0.51	0.32	3.23

Note: N/A indicates critical angle is violated.

Further useful consideration for ATR analysis is the **depth of penetration** (d_p) of the IR beam into the sample. Technically, this is defined as the distance required for the electric field amplitude to fall to e^{-1} of its value at the surface and is further defined by

$$d_p = \frac{\lambda}{2\pi(n_1^2 \sin^2\theta - n_2^2)^{1/2}}$$

where λ is the wavelength of light and θ is the angle of incidence of the IR beam relative to a perpendicular from the surface of the crystal. Typical depth of penetration in ATR ranges from about 0.5 microns up to about 5 microns depending upon these experimental conditions. Shown in the graphical representation of the ATR phenomenon, the strength of the evanescent wave decays rapidly as we progress from the surface of the ATR crystal. If we wish to compare the sample absorbance of the ATR measurement with that of a transmission measurement, we need to calculate the volume of the evanescent wave, known as the effective penetration of the IR beam. The effective penetration (d_e), is unique for parallel polarization ($d_{e\parallel}$) and perpendicular polarization ($d_\perp$) and these are defined by:

$$d_{e\perp} = \frac{n_1^2 n_2 \cos\theta}{(n_1^2 - n_2^2)} \times \frac{\lambda_1}{\pi\sqrt{n_1^2 \sin^2\theta - n_2^2}}$$

$$d_{e\parallel} = \frac{n_1^2 n_2 \cos\theta}{(n_1^2 - n_2^2)} \times \frac{2n_1^2 \sin^2\theta - n_2^2}{(n_1^2 - n_2^2)\sin^2\theta - n_2^2} \times \frac{\lambda_1}{\pi\sqrt{n_1^2 \sin^2\theta - n_2^2}}$$

Where $\lambda_1 = \lambda / n_1$

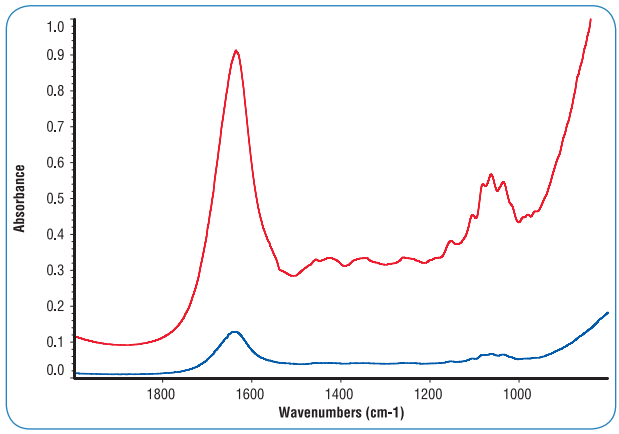
The effective penetration for an unpolarized IR beam is the average of the parallel and perpendicular penetration.

$$d_e = \frac{(d_{e\perp} + d_{e\parallel})}{2}$$

Generally, a single reflection ATR is ideal for qualitative analysis, "what is my sample?" When we need to look at minor components of a sample for qualitative or quantitative analysis, then we need to increase the **effective pathlength** (*EPL*) by increasing the number of reflections (*N*) within the ATR crystal. The effective pathlength in ATR is derived by the following equation, where N = number of reflections on the sample.

$$EPL = N \times d_e$$

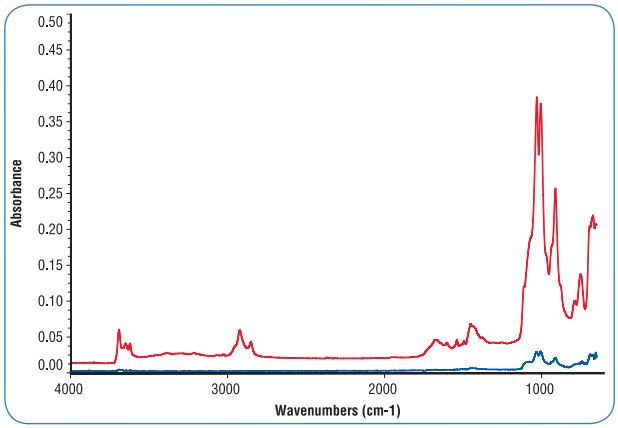
An example of the benefit of increased number of reflections is shown in the following spectral data for the analysis of carbohydrate content in a soft drink sample. The red spectrum is run using a 10-reflection HATR accessory. The blue spectrum is run using a single-reflection ATR using an identical scaling factor. Clearly the minor carbohydrate bands are more readily apparent in the multi-reflection ATR accessory.



Soft drink sample using 10-reflection and 1-reflection ATR.

For your convenience we have calculated theoretical values of depth of penetration, effective penetration, and effective pathlength for typical combinations of crystal materials, angles of incidence, and number of reflections (Table 1).

With the thin penetration of the evanescent wave into the sample, it is obvious that intimate contact of the sample be made onto the surface of the ATR crystal. For liquid or pliable samples, **quality of sample contact with the ATR crystal** is generally not a problem. For rigid, irregular shaped or porous samples, high pressure sufficient to deform the sample will increase the extent of sample contact and thereby increase sample absorbance. This is shown in the following spectral data collected for a porous foam polymer using a MIRacle ATR with ZnSe crystal.



Porous foam sample with high pressure (red) and low pressure (blue).

The blue spectrum was collected with low pressure applied to the foam sample, whereas the red spectrum is produced with high pressure. The ATR absorbance using high pressure is about 10 times greater than with low pressure – all other sampling factors are identical. For rigid, crystalline, or hard, irregular surface samples we recommend a single reflection Diamond MIRacle ATR because it is easy to apply high pressure onto the small crystal (1.8 mm diameter) with the high-pressure clamp, producing over 10,000 psi.

The selection of the **ATR crystal characteristics** should be matched to the type of samples we run. Selection can be made to control depth of penetration of the IR beam, for hardness to prevent crystal damage, for desired spectral range and for acceptable pH range for acid or caustic samples. No individual crystal type will solve all problems, so PIKE Technologies offers a broad range of choices for ATR. Table 2 will give you some guidelines for selection of your ATR crystal.

Table 2: ATR crystal characteristics for FTIR sampling.

Crystal	n_1	d_p, for $n_2 = 1.5$ $\lambda = 1000\ cm^{-1}$, 45 deg, microns	Water Solubility g/100 g	pH Range	Hardness kg/mm
AMTIR	2.5	1.70	Insoluble	1–9	170
Diamond	2.4	2.01	Insoluble	1–14	5,700
Germanium	4.0	0.66	Insoluble	1–14	550
KRS-5	2.37	2.13	0.05	5–8	40
Silicon	3.4	0.85	Insoluble	1–12	1,150
ZnS	2.2	3.86	Insoluble	5–9	240
ZnSe	2.4	2.01	Insoluble	5–9	120

Ordering Terms, Contact Information and Guarantee

Part Numbers and Price

The PIKE price list includes accessories that may be used with a variety of makes and models of spectrometers. Please specify the part number and description when ordering, including your instrument type and model number. Click here for a list of spectrometer and spectrophotometer instrument codes. When placing an order, substitute these codes for the final two digits (XX) in the accessory part number.

PIKE Technologies is continually extending the accessory product range. If you are unable to find a required item, please contact us to discuss your needs. We will be glad to assist.

Payment Terms

Purchase Order Number, cash in advance, MasterCard and Visa are acceptable. Payment is net 30 days, and shipments are FOB Madison, WI USA. Freight charges are prepaid and added to your invoice. If you wish to pay freight charges, please specify this on your order. Prepayment is required for international customers.

International Handling Fee

For orders placed from outside the United States or Canada, a handling fee of $40 will apply per order to cover the costs associated with the additional documentation and bank charges required for international shipments.

Ways to Order

Many products are available for purchase directly through our website. These items are marked on our website with a red shopping cart icon.

Please include the following information when placing an order: your name, phone number, product part number, quantity, ship to address, bill to address, purchase order number and spectrometer model on which the accessory will be used.

Orders may be placed via mail, phone, fax, e-mail or on our website. We accept Visa and Mastercard via phone and direct online purchases. For security purposes, do not send credit card information via e-mail. An electronic order form is available on our website (for P.O. Numbers only – do not use this form for credit card orders). There is no minimum order requirement. Please use the following addresses and phone/fax numbers when placing your orders:

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6125 Cottonwood Drive
Madison, WI 53719
(608) 274-2721 (TEL)
(608) 274-0103 (FAX)
orders@piketech.com (E-MAIL)
www.piketech.com

Delivery

The delivery/shipment date is confirmed upon receipt of an order. Special requirements and custom accessories are subject to different lead times. Please contact us for price quotes and delivery information on these products.

Guarantee

All PIKE products are guaranteed to be free from defects in material and workmanship for a period of 12 months from the date of shipment. Should you be dissatisfied, or have any queries, please contact us immediately and we will promptly repair or replace the product at no charge.

Product Returns

Please contact PIKE to receive your Return Material Authorization (RMA) number if you wish to return any of our products. A restocking fee may apply. Customers are responsible for shipping charges for all returned products. For products under warranty, back-to-customer shipping charges will be covered by PIKE. Please do not return any products without obtaining the RMA number first.

Technical Assistance

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Products and prices are subject to change without notification.

FTIR and UV-Vis Instrument Codes

When ordering a PIKE accessory, replace the XX or XXX portion of the product's part number with your spectrometer's instrument code below. For assistance, please contact a PIKE customer service representative at (608) 274-2721 or sales@piketech.com.

FTIR Instrument Codes (XX)

ABB Bomem	
FTLA2000-100 (Arid Zone)	80
Michelson 100, MB Series	81
MB 3000	82
Agilent	
Excalibur™, Scimitar™, FTS, 600-IR Series	10
Excalibur™, Scimitar™, 600-IR Series with recognition	13
Analect (See Hamilton Sundstrand)	
Bio-Rad (See Agilent)	
Bruker Optics	
IFS™, Vector™, Equinox™ Series.	50
Tensor™, Vertex™ with recognition (Quick-Lock)	51
Buck Scientific	
M500	65
Digilab (See Agilent)	
Hamilton Sundstrand AIT	
Diamond 20	60
Horiba	
7000 Series	35
Interspectrum	
Interspec 200-X	90
Jasco	
300/600 Series	56
400	57
4000/6000 Series	58
JEOL	
Winspec™ Series	46
Lambda Scientific	
Lambda FTIR 7600	66
Lambda FTIR 8600	64
Lumex	
INFRALUM FT-02, FT-08	67
Mattson (See Thermo Electron)	
Midac	
M Series	30
Nicolet (See Thermo Electron)	
Oriel	95
Optical Table	99
PerkinElmer	
1700 Series	70
Spectrum™ GX, 2000	71
Spectrum BX / RX, 1600, Paragon 1000	73
Frontier, Spectrum One, 65, 100, 400 with recognition	74
Spectrum Two with recognition	75
Shimadzu	
8300, 8400 Series, IRPrestige™-21, IRAffinity-1s	15
IRPrestige™-21, IRAffinity-1s with recognition (QuickStart)	16
IRTracer™-100	18
IRTracer™-100 with recognition	19
Thermo Electron / Nicolet / Mattson	
Infinity, Galaxy, RS Series	20
Genesis™, Satellite, IR 300	21
Impact™ 400, Magna, Protege™, 500 / 700 Series	40
Avatar™, Nexus™, Nicolet™, iS™10, iS™50	40
Model 205/210	41
Nicolet iS™5	42
Avatar, Nexus, Nicolet Series with recognition (Smart)	47
Varian (see Agilent)	

UV-Vis Instrument Codes (XXX)

Agilent/Varian	
Cary 50	100
Cary 60	111
Cary 100, 300	110
Cary 4000, 5000, 6000i	120
Jasco	
600 Series	600
Optical Table	999
PerkinElmer	
Lambda 650, 750, 850, 950 and 1050	700
Lambda 25, 35, 45	730
Shimadzu	
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2600	240
3600	220
Thermo Fisher Scientific	
Evolution 300/600	400
Evolution 200	410

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