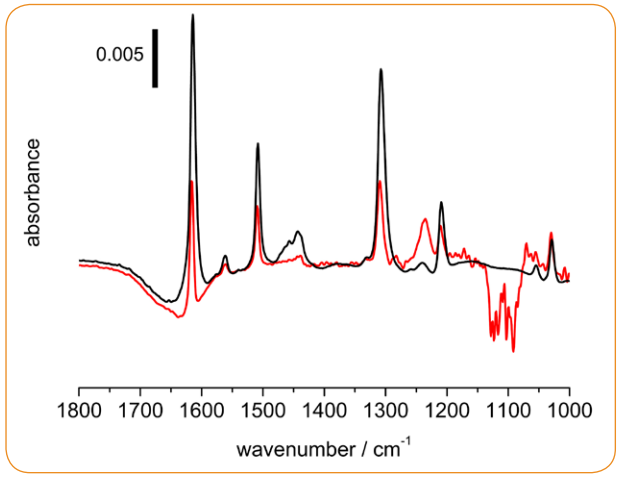
Jackfish Spectroelectrochemical Cell –
For Surface-Sensitive Electrochemical ATR-SEIRAS



Comparison of electrochemical ATR-SEIRAS response with the VeeMAX III Si 60 degree FAC (black) and a Si hemisphere (red). The sample spectrum is of the Au thin film electrode covered in a monolayer of adsorbed pyridine derivative at positive potential; the reference spectrum is taken at negative potential where the pyridine is completely desorbed.

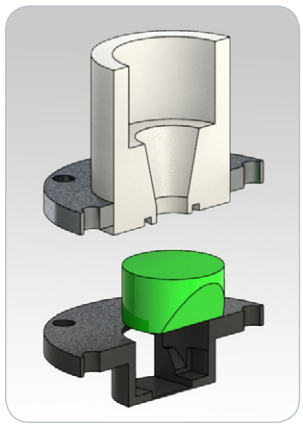
Features

- **Teflon® and glass design offer excellent compatibility with organic solvents and acidic/basic media**
- **Reliable electrical contact with Au thin-film electrode**
- **Dedicated ports for gas bubblers, counter and reference electrodes and exhaust gas trap**
- **Easy installation on the VeeMAX III ATR accessory**
- **Two versions available to accommodate VeeMAX ATR crystals or ATR Se wafers**

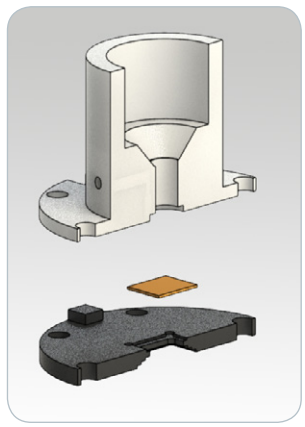
The Jackfish Spectroelectrochemical Cell (SEC) enables fundamental studies of the electrified metal-solution interface and applications in molecular self-assembly, interfacial sensing, and next-generation energy solutions. It is designed for surface-sensitive FTIR spectroelectrochemistry using the attenuated total reflectance surface-enhanced infrared spectroscopy (ATR-SEIRAS) technique. High-quality IR spectra can be obtained from sub-monolayer amounts of adsorbed molecules. By controlling the electrical potential applied to the Au thin film electrode on the ATR crystal surface, the user can perform vibrational characterization of potential-dependent changes at the interface.

By design, the cell is fully compatible with the PIKE VeeMAX III variable angle ATR sampling accessory. Two versions are available to provide maximum flexibility to the end-user. The J1 is designed around the PIKE Si face-angled crystal (FAC). In a previous study investigating the adsorption of a pyridine derivative, the spectral response was two times stronger when using a Si 60 degree FAC compared to a Si hemisphere with an angle of incidence of 65 degrees. Additionally, the FAC exhibited higher energy throughput and lower spectral noise above the long-wavelength cutoff. The J1W accommodates an IRUBIS GmbH single reflection microgrooved Si wafer. The shorter pathlength, relative to FAC, of the beam through the wafer mitigates absorption losses due to Si phonon absorption, allowing the user complete access to the fingerprint and far-IR spectral regions. Wafers are inexpensive and can be recycled or disposed depending on the application.

The Jackfish SEC is constructed from highly chemical-resistant Teflon and glass for a broad range of aqueous or organic solution conditions. There are three ports at the top of the cell and side ports for a reference electrode arm and a short bubbler. Typical uses of the ports are to support the counter electrode, and to accommodate a long glass bubbler and an exhaust gas trap. The long glass bubbler allows sparging of the solution volume with inert gas to remove atmospheric oxygen, enabling high-quality electrochemistry and ensuring stability of the Au thin film electrode. The short gas bubbler is used to create an inert atmosphere above the electrolyte. Ground glass joints ensure the cell remains sealed from air. Connection to the working electrode is made easily using spring-loaded pins which contact the Au thin film electrode outside of the solution. This innovative design maintains superior electrical contact over long experiments without degrading the thin film electrode.



Jackfish model J1



Jackfish model J1W

The crystal is fully removable for ease of metal coating. Coating may be performed using a vacuum chamber for sputter coating or through electroless deposition. For users performing electroless deposition, a convenient fixture is available to provide a crystal housing that allows the deposition solution to contact only the crystal top surface during the coating process. The cell is compatible with any of the four FAC materials listed below. However, the recommended material for either metal deposition process is Si due to its excellent chemical stability and favorable wetting characteristics with Au films.

Ordering Information

Part Number	Description
162-4710	Jackfish Spectroelectrochemical Cell
162-4715	Jackfish J1W SEC
162-4717	Jackfish SEC Combination Cell
013-11XX	VeeMAX III Variable Angle Specular Reflectance Accessory *Includes purge tubes, purge kit and spectrometer base mount.*

Notes: Replace XX with your spectrometer's Instrument Code. Click for List >
The VeeMAX III is required for use of the Jackfish Spectroelectrochemical Cell.

Crystal Options *(choose at least one)*

Part Number	Description
160-5552	Si Crystal, 60°
160-5550	ZnSe Crystal, 60°
160-5553	ZnS Crystal, 60°
160-5551	Ge Crystal, 60°
162-4814	J1W Si ATR elements (2)

Note: The 60° Si crystal is the user-preferred option.

Custom Electrodes for the Jackfish Spectroelectrochemical Cell

Part Number	Description
162-4720	Platinum Counter Electrode
162-4722	Gold Counter Electrode
162-4723	Ag/AgCl Reference Electrode

Note: The Platinum Counter Electrode and Ag/AgCl Reference Electrode are the user-preferred options.

Replacement Parts and Options

Part Number	Description
162-4724	Lower Viton® O-ring
162-4726	Upper Viton O-ring
162-4728	Lower Perfluoroelastomer O-ring
162-4730	Upper Perfluoroelastomer O-ring
162-4732	Electroless Deposition Fixture
162-4734	Reference Electrode Arm with Stopcock
162-4736	Jackfish SEC, Long Bubbler
162-4738	Jackfish SEC, Short Bubbler
162-4740	Jackfish SEC, Exhaust Gas Trap

Note: Please contact PIKE Technologies for parts not found here.

The cell includes
- Teflon body
- Glass cell body
- Glass cell cap with ports
- Glass cell cap without ports
- 4 glass stoppers
- Glass exhaust gas trap
- 2 glass long bubbler (1 spare)
- 2 glass short bubbler (1 spare)
- Glass reference arm with glass stopcock
- Glass counter electrode holder
- 6 Au-coated spring-loaded pins for electrical connection (3 spares)
- 6 #2-56 screws for electrical connection (3 spares)
- Aluminum ring (J1 only)
- 12 #8-32 screws for aluminum ring (6 spares)
- Delrin face angled crystal holder or wafer holder
- 4 Viton O-rings (2 spares)
- Adapter plate for VeeMAX III

The VeeMAX III and the ATR FAC or ATR Si wafer are ordered separately.

Jackfish SEC was founded in 2018 in Saskatoon, Canada by electrochemists at the University of Saskatchewan. The team has spent 10 years designing, innovating and testing spectroelectrochemical cells for attenuated total reflectance surface-enhanced infrared spectroscopy (ATR-SEIRAS). A decade of experiment-based design improvements have led to our innovative and commercially available ATR-SEIRAS cell design. We are dedicated to making advanced infrared spectroelectrochemical technology easily accessible to new users with off-the-shelf solutions that allow you to easily equip your laboratory with ATR-SEIRAS capabilities.

Selected References

Electrochemical ATR-SEIRAS Using Low-Cost, Micromachined Si Wafers. Analytical Chemistry, 2017, 89, 11818–11824.

Femtomole Infrared Spectroscopy at the Electrified Metal–Solution Interface. Analytical Chemistry, 2016, 88, 9351–9354.

Surface Enhanced Infrared Studies of 4-Methoxypyridine Adsorption on Gold Film Electrodes. Langmuir, 2016, 32, 2184-2191.

Surface Enhanced Infrared Spectroscopy and Neutron Reflectivity Studies of Ubiquinone in Hybrid Bilayer Membranes under Potential Control. Langmuir, 2016, 32, 2225-2235.

Charge Transfer and SEIRAS Studies of 1,4-Benzoquinone Functionalized Mixed Monothiol/Dithiol Self Assembled Monolayers. Electrochimica Acta, 2011, 56, 4361-4368.

Surface Enhanced Infrared Absorption Spectroscopy Studies of DMAP Adsorption on Gold Surfaces. Langmuir, 2009, 25, 2241-2247.

PIKE

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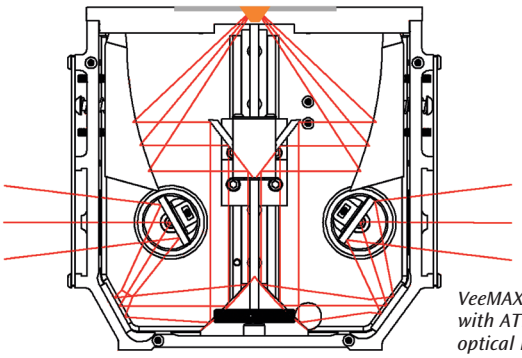
AUTOMATED OPTION

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

FEATURES

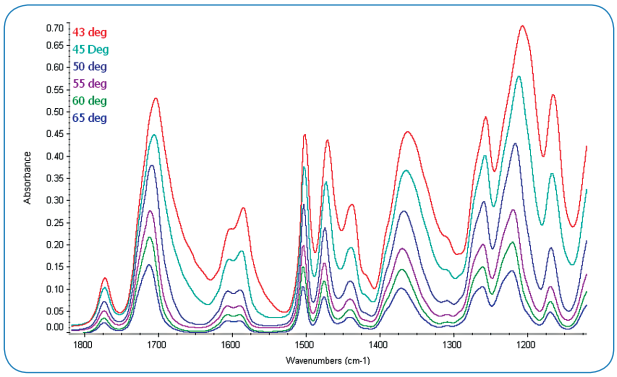
- Continuously variable set angle – 30 to 80 degrees
- 0.4 to 46 micron depth of penetration – ideal for depth profiling studies
- High throughput for excellent quality spectra
- Optional, high-pressure clamp for sampling of films, coatings or powdered samples
- Integrated position for manual or automated polarizer
- Automated 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

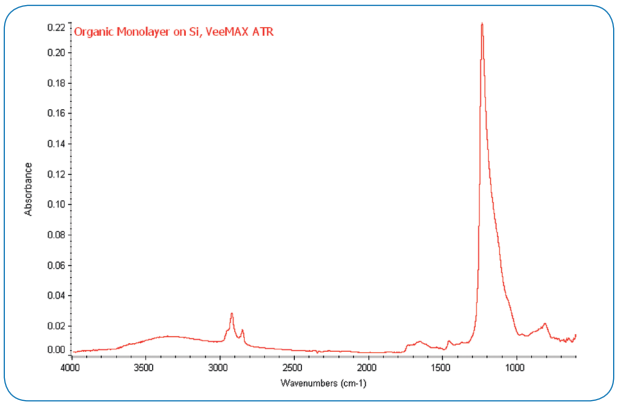
The VeeMAX III with ATR offers continuous variable angle of incidence and a variety of crystal plates to selectively control the depth of penetration of the IR beam into the sample. ATR applications include the study of layered samples, coatings, release agents, monolayers on silicon and chemical migration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



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.



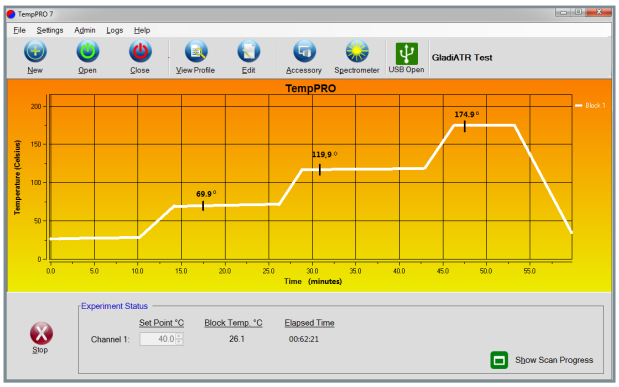
Analysis of monomolecular layer on silicon – VeeMAX III with 60 degree Ge crystal, pressure clamp with 7.8-mm tip and p polarization.

A spectroelectrochemical cell option for the VeeMAX III is also available. The innovative design offers a chemical-resistant vessel sealed to an ATR crystal using an O-ring. The assembly 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 reflection sampling. The electrochemistry cell is equipped with a precision micrometer for electrode positioning, and is user-configurable.

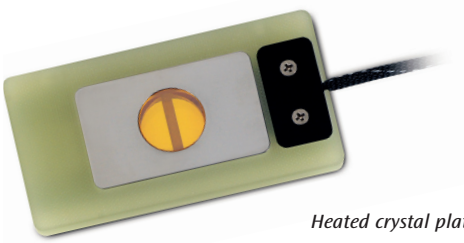
Spectroelectrochemical cell mounted on the VeeMAXIII

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' temperature controller allows unlimited ramps to be easily programmed using PIKE TempPRO software (sold separately). Data collection as a function of time or temperature may be prescribed for most FTIR spectrometers.

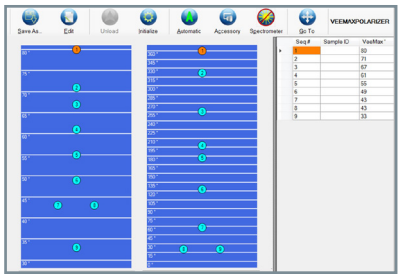


TempPRO software for graphical setup and control of kinetic measurements.



Heated crystal plate

Motorized control of angle of incidence via personal computer is available for the accessory. AutoPRO control software interfaces with most FTIR software packages for automated data collection. The Automated 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 (left) configured for the Automated VeeMAX III (shown above with polarizer option) 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 Accuracy	130 °C +/- 0.5% of set point
Sensor Type	3 wire Pt RTD (low drift, high stability)
Temperature Control	Touch-panel display with USB interface. PIKE TempPRO software (sold separately) for PC control with unlimited ramps and automated data collection.
Input	100–240 VAC, auto setting, external power supply
Output	24 VDC/50 W maximum
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.*
013-12XX	Automated VeeMAX III *Includes controller, cabling, sample masks (2", 5/8" and 3/8"), gold substrate alignment mirror, FTIR base mount, and purge tubes*

Note: Replace XX with your spectrometer's Instrument Code listed on page 164.

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. 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°
076-1610	Digital Temperature Control Module
007-0207	PIKE TempPRO Software

Notes: Heated VeeMAX III crystal plates may be heated to 130 °C. Temperature control module selection is required for heated crystal plates. If PC control is desired, TempPRO software must be purchased (sold separately from Temperature Control Module).

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 solid samples. The 7.8-mm pressure tip is required for monolayers on silicon or small samples.

VeeMAX III Sampling Options

Part Number	Description
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. Automated option includes PIKE Technologies AutoPRO software and controller. Other polarizer options are found in the polarization section of this catalog. Automated 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 selection of a Digital Temperature Control Module. If PC control is desired TempPRO software must be purchased (sold separately from Temperature Control Module). 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"