

# FINDING THE PATH

TO OPTIMUM RESULTS

## THE Explorer-HT™

## THE Explorer™

### Horizontal ATR with Continuously Variable Angle



### Applications

- Temperature dependent phase transitions
- Chemical reaction monitoring
- Controlled environment sample analysis
- Surface analysis of films and sheets
- Monolayer films on metal and dielectric surfaces
- Determine optical constants of thin films and bulk samples

### The Standard

- 25° - 85° angle of incidence
- Variable sampling of solids, liquids, pastes, and film coatings on metal surfaces
- Adjustable effective pathlength
- Interchangeable ATR crystals

### Explorer-HT™

- Temperature controlled heating to 350°C
- Purgeable gas enclosure

### The Options

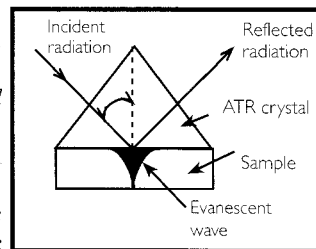
- Crystals of KRS-5, Ge, ZnS (30°, 45°, 60°)
- Heated pressure plate
- Heated flow cells
- External reflection (ER) device
- Wire grid polarizer

### The Technical Problem

Research laboratories and product control groups are regularly faced with a stream of various types of chemical samples to be analyzed. These samples must be characterized qualitatively and quantitatively both in absolute and comparative measures. Typical samples include films and pliable solids; liquids, pastes, and gels; film coatings on metal surfaces; and liquids of varying viscosity and color. In many cases the measurements need to be made at elevated temperatures for sample handling or over a range of temperatures for studying chemical reactions. As a consequence, the analyst requires a versatile instrument with a variety of attachments to handle liquids, solids, and pastes at ambient, elevated, and high temperatures. The Explorer™ and the Explorer-HT™ provide these important options.

### The Theoretical Solution

Attenuated Total Reflectance or ATR spectroscopy is one of the most useful and well-established sampling techniques in infrared spectroscopy. When infrared energy is propagated through a highly refractive infrared transmissive crystal such as AMTIR-1, Zinc Selenide, or KRS-5 at the proper angle of incidence, *total internal reflectance* occurs. As the energy propagates through the crystal, it encounters the crystal walls. If these reflections occur at an angle greater than the critical angle and a sample is pressed against the sides of the crystal, the infrared spectrum of the sample can be

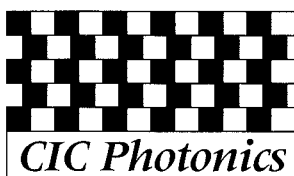


measured. At each of these encounters with the crystal walls, an evanescent or standing wave is established. If an absorbing material is placed in contact with the crystal wall, some of this evanescent wave will be conducted into the material in the region of the absorption bands in the material, and will create a measurement of the material's infrared spectrum.

### The Product Solution

ATR has the reputation of being a "fussy" technique. The sample must be clamped in contact with the ATR crystal. The degree of this contact determines the sensitivity of the spectrum. Also, the crystal must not move between the running of the sample and background spectra.

**Eliminate the "fuss."** CIC Photonics offers the Explorer™ and the new Explorer-HT™ for the researcher who wants a horizontal ATR accessory with more functionality than competing products at comparable prices. The Explorer™ was the first horizontal reflection accessory with a continuously variable angle of incidence (25° to 85°) to be developed. The new Explorer-HT™ adds the ability to use ATR at high temperatures—up to 350°C. The Explorer™ and the Explorer-HT™ use a simple rotary motion against a calibrated dial to vary the angle. In order to increase the stability of the sample, the ATR prism is mounted in a horizontal position; the top plate is the sampling surface. This means that the sample can be analyzed simply by placing it horizontally on the top sampling surface. All the transfer optics can be sealed and purged, eliminating interference from atmospheric absorbances.



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## Operation

The Explorer-HT™ works in ATR mode while the Explorer™ works in either the ATR mode, or the optional ER mode (external reflectance). The mode is chosen by inserting either the appropriate ATR crystal or ER waveguide (constructed from gold-coated plane mirrors) into the top plate of the accessory. ATR crystals are available with various face angles and infrared transmitting materials. A flush-mounted 45° ZnSe crystal is standard, along with a pressure plate.

## Design

The continuously variable angle of incidence (VAOI) is an important feature for both ATR and ER modes. Angle of incidence determines the effective path length of the system. For most solids and many liquids, the appropriate path length is the micrometer region. The angle of incidence also determines the orientation of the electric vector of the infrared beam. In external reflection, VAOI can determine the degree of interaction of the beam with metallic surfaces and the sensitivity to analytes on these surfaces. In ATR, angle variability is used to find the appropriate angle away from the critical angle; in addition, a range of angles can be utilized eliminating the need to purchase multiple crystals.

**Films and pliable solids** In the ATR mode, the Explorer™ and the Explorer-HT™ are equipped to handle films and solids. In conjunction with the pressure plate, the flush sampling crystal will sample these materials directly. If the solid is extremely hard or non-flat, sample contact may be a problem (see the films section for a possible solution). The standard 45° ZnSe crystal, included with the base accessory, will operate over a variable angle range of 37° to 60°. It is sufficiently versatile to serve as your only crystal. Additional crystals are available for special needs. A heated pressure plate is also available.

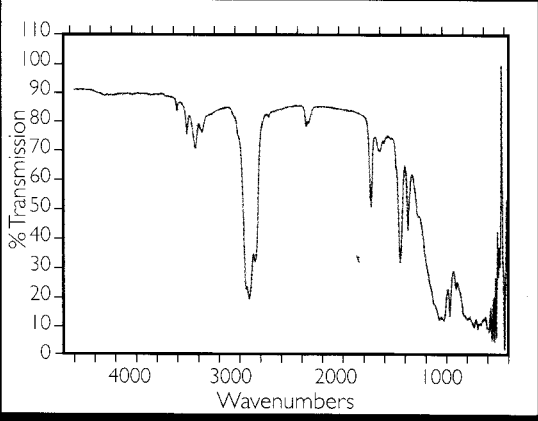
**Liquids, pastes, gels.** The ATR analysis of liquids, pastes and gels is a prime use of the Explorer™ and the Explorer-HT™. Most liquids, pastes and gels require a short path length. Aqueous samples, for example, must be measured at path lengths of no more than 15 micrometers. For these samples, the optional saucer-mounted crystal should be used. A 3-mm deep saucer holds liquids in contact with the sampling crystal. The crystal material is determined by chemical resistance to the sample. Optional stainless steel flowing cells are available in heated and ambient versions.

**Film coatings on metal surfaces.** For very thin samples on metallic substrates, and for very rigid samples, the ER method can be more successful than ATR. The rigidity of these samples can make it difficult to achieve good contact with the crystal in ATR mode. By contrast, external reflection or reflection-absorption measurements do not require a sampling crystal. Energy is focused directly on the sample at some angle of incidence, and the energy reflected in a mirror direction is collected and sent to a detector.

Thin films on metal cannot be detected well with a normal AOI. At grazing incidence, good sensitivity can be obtained because the electric vector interacts at the metal surface. For very thin films the Explorer™ operates at a grazing angle of 85° AOI. For highest sensitivity, a narrow cavity waveguide is available. With this waveguide set at 80° AOI, there are an average of ten multiple reflections against the sample, providing one order of magnitude more absorbance than the more common single reflection devices. Another optional accessory, the wire grid polarizer further improves contrast. For thicker films, the Explorer™ operates at 25° from the normal.

## Attenuated Total Reflectance Spectrum

45° ATR Mode: adhesive tape, sticky side.



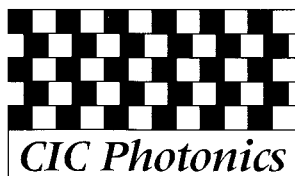
## The Purchase Solution

The Explorer™ and the Explorer-HT™ come equipped with transfer optics, a flush mount ZnSe sampling crystal mounted on a stainless steel plate, a pressure-generating clamp, instruction manual, and a shipping case. The Explorer-HT™ is designed for studies up to 350°C and is provided with an insulated and gas purgeable housing. The Explorer™ and the Explorer-HT™ are available for all commercial FT-IR spectrometers. In ordering, please specify make and model of your spectrometer. The external reflection (ER) device is an optional accessory for the Explorer™, but not the Explorer-HT™.

### Product Numbers

- Explorer™ .....42B100
- Explorer-HT™ .....42B200
- Heated pressure plate .....42B400
- Heated flow cells .....42B403
- External reflection (ER) device .....42B919
- Wire grid polarizer (ER) .....42B800

Please contact CIC Photonics for a complete part listing.



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