Analytical Answers, Inc.

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FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR)

Fourier Transform Infrared Spectroscopy (FTIR) is a technique which is used to analyze the chemical composition of many organic chemicals, polymers, paints, coatings, adhesives, lubricants, semiconductor materials, coolants, gases, biological samples, inorganics and minerals. FTIR can be used to analyze a wide range of materials in bulk or thin films, liquids, solids, pastes, powders, fibers, and other forms. FTIR analysis can give not only qualitative (identification) analysis of materials, but with relevant standards, can be used for quantitative (amount) analysis.

AAI's state-of-the-art FTIR can be used to analyze samples up to ~11 millimeters in diameter, and either measure in bulk or the top ~1 micrometer layer. AAI's infrared microscope can analyze samples as small as ~10 x 10 micrometers, making it ideal for the analysis of fibers, fragments, captured filter debris, surface imperfections, microelectronic systems, biological tissues, paint fragments, multilayer polymers, and others. Standard FTIR analysis covers the wavelength range of 2.5 to 25 um (4000 - 400 cm^{-1}) for macroscopic samples and 2.5 to 14 um for microscopic samples, making it an ideal compliment to elemental analysis techniques offered at AAI.

FTIR Applications Include:

1. Materials Evaluation

Identification of most solid, liquid and gas-phase organic compounds.
Identification of many liquid and gas-phase inorganic compounds.
Identification of many crystalline and amorphous solid inorganics.
Identification of polymers, polymer blends and multilayer laminates.

2. Failure Analysis

Qualitative composition verification.
Quantitative composition verification.
Coating composition and thickness measurement.
Verification of parts cleanliness.
Solvent purity evaluation.
Optical filter performance verification.

3. Quality Control Screening

Identification of organic deposits on microelectronic packages and devices.
Identification of stains.
Analysis of inclusions in polymers.
Analysis of delamination problems in laminates and coatings.
Analysis of surface degradation due to heat, aging, or chemical attack.
Analysis of process material degradation or contamination.
Analysis of lubricants, coolants, power transfer fluids and greases for degradation or contamination.

4. BASIC AND APPLIED RESEARCH

Infrared emission profiling.
Solvent diffusion studies in polymers and elastomers.
Time-based studies of polymer, paints and coatings cures.
Environmental-based (pH, temperature, etc.) studies of material changes.
Protein adsorption, folding and denaturation.
Conservation and art materials studies.
Semiconductor wafer coating, doping, process development and verification.

Principle Of Operation:

A beam of infrared light is focused on the sample using all-reflective optics. Depending on the sample composition, differing amounts of light are absorbed at different wavelengths. This pattern of light absorption is unique for almost every organic compound (except optical isomers) and many inorganics. From the pattern of light absorbed, identification of the composition (qualitative analysis) can be made. With additional control over the sample thickness or sampling depth, the intensity of the individual absorbing components can be used to perform quantitative analysis (amount of each compound present). User-provided reference samples aid in positive substance identification and compositional verification.

Data Output:

The FTIR spectrum is a plot of infrared light absorbed by the sample as a function of wavelength or frequency. FTIR data can be presented as a single plotted spectrum, multiple unknowns and reference spectra overlaid or 'stacked' on the same plot, and plotted in comparison to AAI's extensive commercial collection (+16,000 entries) of infrared spectra and other associated physical data. For investigators who wish to perform additional spectroscopic analysis of the data, AAI can provide infrared data in a variety of computer-readable formats, such as ASCII X-Y data pairs (for Excel and other spreadsheet programs), ThermoGalactic's SPC format (for Grams/32 and Grams/AI), JCAMP-DX, and many others.

Micro-FTIR Sample Constraints:

AAI's state-of-the-art infrared microscope can collect FTIR data down to a physical sample size of 10 micrometers in diameter, on either infrared transmissive or infrared reflective materials. For sampling spots or particulates on the native substrate (i.e., without removing them from the substrate), the sampled point must be able to be positioned within 5 mm of the microscope collection optics.

ATR-FTIR Sample Constraints:

Attenuated Total Reflectance (ATR) FTIR is used to obtain IR spectra of surface and to perform Depth profiling. Surface characterization in the range of 0.3 to 4 microns is easily performed on flat samples 10 mm by 10 mm.

AAI's collection of Attenuated Total Reflectance (ATR) accessories allows collection of the IR spectra of many strongly infrared absorbing materials, such as carbon-filled polymers and aqueous systems. For aqueous systems, ATR is the preferred technique for quantitative analysis and requires a minimum of 10 ml of sample. For polymers and surface studies, flat or flexible samples must be provided to ensure good contact with the ATR crystal. Different ATR crystals and optics also allow depth profiling of polymers over the range of 0.3 to 4 micrometers.