Spectros Associates Proudly Presents the Three Day Short Course

FTIR Analysis of Trace Evidence

Instructor: Dr. Brian C. Smith

A comprehensive 3-day look at how to use an FTIR to obtain spectra of trace evidence, and how to interpret the spectra of these materials.

Day 1

I. The Basics of FTIR

- **A. Introduction to Infrared Spectroscopy**
  1. The Properties of Light
  2. What is an Infrared Spectrum?
  3. Infrared Spectroscopy: Good and Bad Points
- **B. The Advantages of FT-IR**
  1. Signal-to-Noise Ratio (SNR)
  2. The Throughput Advantage
  3. The Multiplex Advantage
- **C. The Disadvantage of FTIR: Water and CO_2 Peaks**

II. How an FT-IR Works

- **A. Interferometers & Interferograms**
- **B. How a Spectrum is Produced**
  1. The Fourier Transform
  2. Background & Single Beam Spectra
- **C. Optimizing Resolution & Minimizing Noise**
- **D. FTIR Hardware**
  1. Infrared Sources
  2. Beamsplitters
  3. Detectors
  4. The He-Ne Laser
- **E. Measuring Spectral & Instrument Quality**

III. Spectral Manipulations: Handling Mixture Spectra

- **A. The Laws of Spectral Manipulation**
- **B. Spectral Subtraction**
  1. Theory
  2. Optimizing Subtraction Results
  3. Spotting Artifacts
- **C. Library Searching**
  1. Background & Theory
  2. The Search Process

3. Properly Interpreting Search Results
4. Subtract & Search Again: The Analysis of Mixtures

IV. Infrared Microscopes

A. How an Infrared Microscope Works

B. Preparing Samples

1. Transmittance Analysis
2. Reflectance Analysis

C. Forensic Applications

1. Powders
2. Paint Chips
3. Single Fibers

D. Reflectance Sampling

V. Microscopic Attenuated Total Reflectance (ATR)

A. Micro-accessory Design

B. Variables Affecting Spectral Appearance

C. Applications

Day 2

I. The Fundamentals of Infrared Interpretation

A. Molecular Vibrations

B. The Meaning of Peak Positions, Heights, and Widths

C. Different Types of Infrared Features

D. A Systematic Approach to Spectral Interpretation

1. Dealing with Mixtures
2. Performing Identities Properly
3. A Systematic 10-Step Approach to Infrared Interpretation

II. Functional Group Analysis of Saturated Hydrocarbons

A. Alkanes: C-H Stretching and Bending Vibrations

1. Straight Chain Alkanes
2. Estimating Hydrocarbon Chain Length
3. Branched Alkanes

III. Unsaturated Hydrocarbons

A. Alkenes:

1. Substitution Patterns
2. Distinguishing Cis/Trans Isomers
3. Natural & Synthetic Rubbers

B. Aromatic Hydrocarbons

1. Mono-Substituted Benzene Rings
2. Distinguishing Ortho, Meta, and Para Isomers

IV. Molecules with C-O Bonds

- **A. Alcohols & Phenols**
  1. Differentiating Primary, Secondary, and Tertiary Alcohols
  2. Phenols
  3. Distinguishing Alcohols from Water
- **B. Ethers**
  1. Saturated & Branched Ethers
  2. Aromatic Ethers
  3. The Methoxy Group

Day 3

V. The Carbonyl (C=O) Functional Group

- **A. Ketones**
- **B. Aldehydes**
- **C. Carboxylic Acids**
- **D. Carboxylates (Soaps)**
- **E. Esters: The Rule of 3**
- **F. Organic Carbonates**

VI. Organic Nitrogen Compounds

- **A. Amides**
  1. Structure, Nomenclature, and Bonding
  2. Primary Amides
  3. Secondary Amides
  4. Proteins
- **B. Imides**
- **C. Amines**
  1. Distinguishing the Three Types of Amines
  2. Methyl Groups Bonded to Nitrogen
  3. Amine Salts
- **D. Nitriles**
- **E. The Nitro Group**

VII. Introduction to the Infrared Spectra of Polymers

- **A. Low and High Density Polyethylene**
- **B. Polypropylene**
- **C. Polystyrene**
- **D. Polyethylene Terephthalate (PET)**
- **E. Acrylates**

VIII. Spectra of Polymers with Complex Structures

A. Polyurethanes
B. Polycarbonates: Lexan
C. Polyimides: Kapton
D. Teflon

IX. Inorganics
A. Sulfates
B. Silica
C. Nitrates
D. Inorganic Carbonates
E. Phosphates