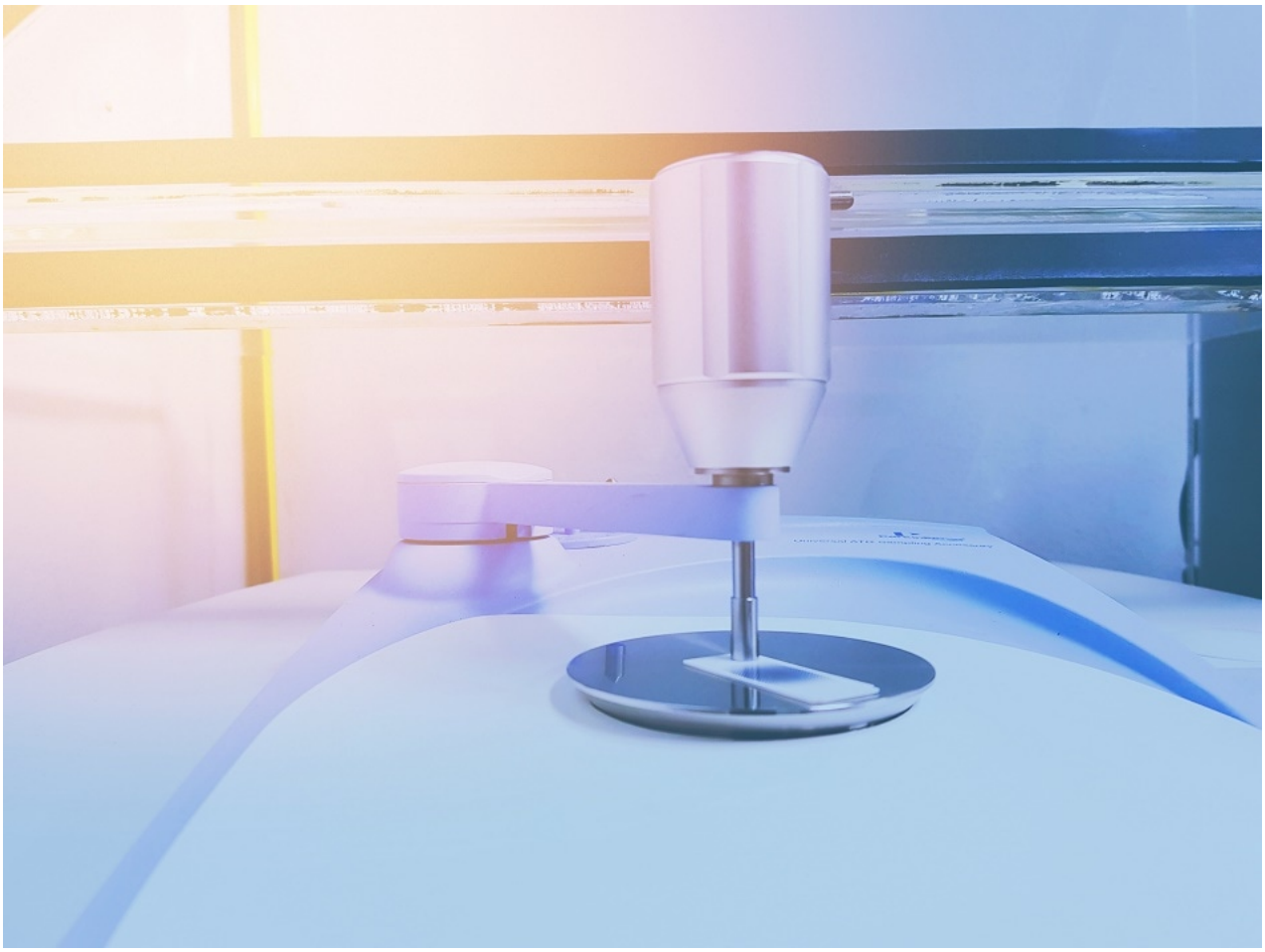
Why is Fourier Transform Infrared (FTIR) Spectroscopy Used?

By Louise Saul, M.Sc. Mar 19 2019



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Fourier Transform Infrared Spectroscopy (FTIR) is a type of infrared spectroscopy that simultaneously collects high-spectral-resolution data over a wide range and is the preferred method of IR spectroscopy for laboratories. The definition of FTIR comes from the fact that a mathematical process known as Fourier Transform is used to convert raw data into a readable spectrum.

What is FTIR Spectroscopy?

FTIR deals with the infrared region of the electromagnetic spectrum, and it works by measuring how much light is absorbed by the bonds of vibrating molecules to provide a molecular fingerprint. The infrared spectrum can be split into near IR, mid-IR and far IR.

Near IR has the greatest energy and can penetrate a sample much deeper than mid or far IR, but it is less sensitive than mid or far IR.

The principles of IR show that molecules vibrate and bonds stretch and bend when they absorb infrared radiation. It works by passing a beam of IR light through a sample, and for an IR detectable transition, the molecules of the sample must undergo dipole moment change during vibration. When the frequency of the IR is the same as the vibrational frequency of the bonds, absorption occurs and a spectrum can be recorded.

With IR, different functional groups absorb heat at different frequencies. It is dependent upon their structure and a vibrational spectrum can be used to determine the functional groups present in a sample. When interpreting the data obtained by an IR spectrometer, results are compared to a frequency table to find out which functional groups are present.

Combination with Other Techniques

FTIR can be combined with other analytical techniques to gain more information about a sample. These include:

- FTIR microscopy
- Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS)
- Infrared-spectroscopy coupled to Thermogravimetric Analysis (FTIR/TGA)
- Gas chromatography infra-red (GC-IR) analysis
- Combination with Raman spectroscopy

FTIR Uses

FTIR is widely used in many industries and is used for the analysis of both organic and inorganic compounds. It can confirm the composition of both solids, liquids, and gases.

FTIR is mainly used for:

- The identification of unknown compounds
- Quantitative information, such as additives or contaminants
- Kinetic information through the growth or decay of infrared absorptions
- To give complex information when coupled with other devices such as TGA, GC or Rheometry

The industries that utilize FTIR include organic synthesis, polymer science, petrochemical engineering, biological research, the pharmaceutical industry and analysis

of food. Portable FTIR spectrometers have also been researched and used for field analysis.

In biological research, FTIR can be used to investigate proteins in hydrophobic membrane environments. Time-resolved (tr)-FTIR spectroscopy can monitor reactions of the amino acids, ligands and specific water molecules in the active center of a protein. Then time can range from nanoseconds to seconds and provide a detailed understanding of the molecular reaction mechanism.

In the environmental industry, FTIR also has many different applications. It can be used to analyze soil samples and to monitor air and water quality. It can address environmental and health concerns that have been caused by the increasing pollution levels.

The food industry uses FTIR to make sure that they are complying to the required government standards. It can monitor the physical, chemical and rheological properties of food. An example is looking at the trans-fat content of manufactured food products by infrared attenuated total reflectance (ATR). Another case of utilizing FTIR in the food industry is to compare the differences in grains of wheat varieties. Foodborne pathogens can also be identified by FTIR.

In the forensics industry, FTIR is used to quickly identify illegal drugs, crime scene evidence, banned materials, and counterfeit goods. These techniques can provide fast, easy and consistent analysis for chemical evaluation, seized drugs, paint and materials from hit and runs, and textile identification.

In pharmaceutical research, FTIR has multiple applications. It is mainly used to identify the structure of unknown compounds, but can also be used for:

- Quality verification of materials
- Deformulation of polymers, rubbers, and other materials through thermogravimetric infra-red (TGA-IR) and gas chromatography infra-red (GC-IR) analysis
- To identify contaminants
- To analyze thin films and coatings
- To monitor automotive and smokestack emissions
- For failure analysis

Sources and Further Reading

- https://www.thermofisher.com/uk/en/home/industrial/spectroscopy-elemental-

isotope-analysis/spectroscopy-elemental-isotope-analysis-learning-center/molecular-spectroscopy-information/ftir-information/ftir-basics.html
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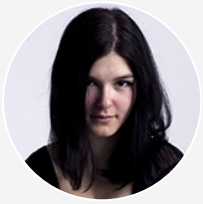

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Louise pursued her passion for science by studying for a BSc (Hons) Biochemistry degree at Sheffield Hallam University, where she gained a first class degree. She has since gained a M.Sc. by research and has worked in a number of scientific organizations.