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A Review of Ftir – An Useful Instrument

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ABSTRACT : FTIR is used to analysed the small molecules or complex molecules. Wide range of sample types such as solid, liquid and gas can be checked from about 4000-400 cm^{-1}.Fourier transform infrared (FTIR) spectroscopy represents a modern and popular technique that addressed IR spectroscopy as a powerful and reliable analytical technique.It is most common spectroscopic used in industry or used by organic and inorganic chemist. They are also used to identify the bioactive compounds . There are different modes of vibration Symmetric and asymmetric vibrations are the types of stretching vibration, while wagging, rocking, twisting, and scissoring are the characteristic types of bending vibrations. There are different IR spectroscopic method . It is used in different Agricultural / Food , Polymer , Petroleum and fuel industry, Environmental ,Textiles, Biomedical / Clinic.

Keywords: FTIR , molecules , IR , spectroscopy, vibrational state , radiation

I. INTRODUCTION

Infrared (IR) or Fourier transform infrared (FTIR) spectroscopy has a large operation range, from the analysis of small molecules or molecular complexes to the analysis of cells or tissues[1].

It is one of the most common spectroscopic ways used by organic and inorganic druggist.It is grounded on the nature of interaction of the IR radiation with the vibrational modes of molecules. IR spectra are due to the changes in vibrational energy,accompanied by changes in rotational energy.HPLC-FTIR is a highthroughput automatable hyphenated technique in burgeoning field of combinatorial chemistry. Wide range of sample types such as solid, liquid and gas can be checked from about 4000-400 cm^{-1}.This energy range is higher than necessary to promote molecules only to their minimu006D excited vibrational states and lower than typical values necessary for electron excitation in molecules[4].

Fourier transform infrared (FTIR) spectroscopy represents a modern and popular technique that addressed IR spectroscopy as a powerful and reliable analytical technique.Recent FTIR technique developments rendered the tool as applicable to both quantitative and qualitative purposes of analyses[5].

An infrared spectroscopy measured the immersion of IR radiation made by each bond in the molecule and as a result gives spectrum which is commonly designated as % transmittance versus wavenumber (cm^{-1})[3].

INSTRUMENT OF FTIR

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MODES OF VIBRATIONS [6]

Organic molecules mostly contain covalent bonds between the atoms, which are not stiff but rather behave like springs and always agitating at room temperature. This movement of the bonds in molecule gives various modes of vibration. There are two modes of vibrations: stretching and bending vibration.Symmetric and asymmetric vibrations are the types of stretching vibration, while wagging, rocking, twisting, and scissoring are the characteristic types of bending vibrations.

STRETCHING VIBRATION[6]

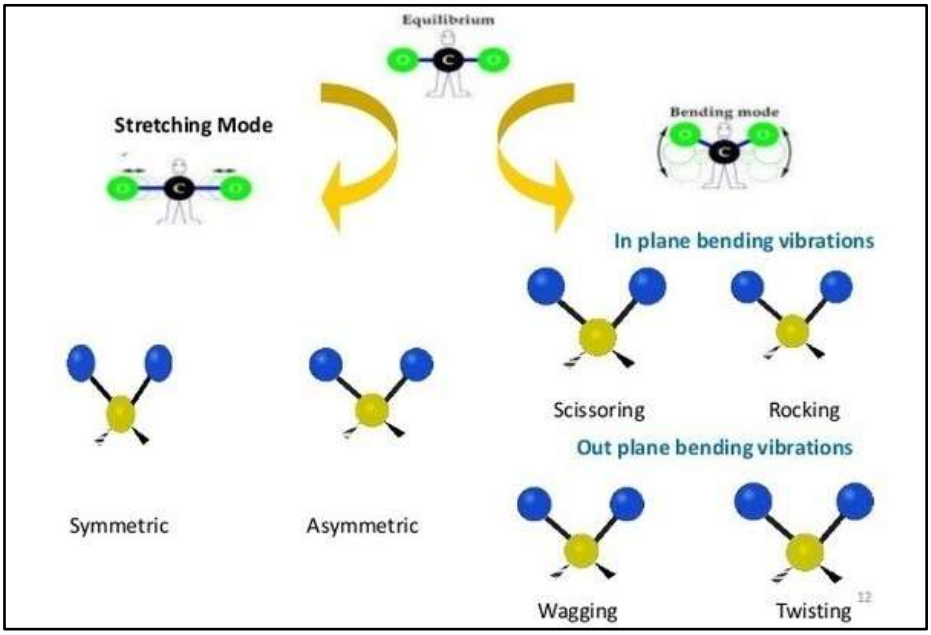
The asymmetric stretching has higher energy than the symmetric stretching. In symmetric stretch, the bond lengths of the participating atoms either increase or decrease simultaneously, while in asymmetric stretch one of the bond length increases, while the other decreases.

BENDING VIBRATION[6]

This type of vibration is also called deformation vibration and causes change in the bond length.There are two types of bending vibrations: (i) in-plane bending and (ii) out-plane bending.

In-plane bending vibration – Scissoring and rocking vibrations are the two types of in-plane bending vibrations. In scissoring vibration both atoms are moving toward each other or away from each other. While in rocking vibration, the bond angles are unchanged due to moments of participating atoms in the same direction..

Out of plane bending vibration – This vibration includes wagging and twisting vibrations, where the bond angle is changed. In wagging vibration, both the atoms move toward a common side of the plane. While in twisting vibration, both the atoms go opposite to each other.



DIFFERENT MODES OF VIBRATION

INSTRUMENTATION[3]

FTIR instrumentation is quite simple except when the source employed is the synchrotron, and produce highly accurate and precise data having high spatial resolutions. For the IR region, the light source is like tungsten filament which is heated and radiates polychromatic light. Then the light beam is focused on the Michelson interferometer, containing a beam splitter to slight light source into two.Further these both split beams. The split beams stick two different mirrors, the first one is motionless and the other continuously oscillate backward and forward direction with definite frequency and amplitude. After that, these two beams merge again at a beam splitter and interfere due to the difference in optical path length then move towards sample. Wavelength of emitted light is measured by interferometer through interference patterns, aid to enhance accuracy. Total scans can increased as per the quality required for analysing the sample. The x and y-axis of the spectrum signifies the

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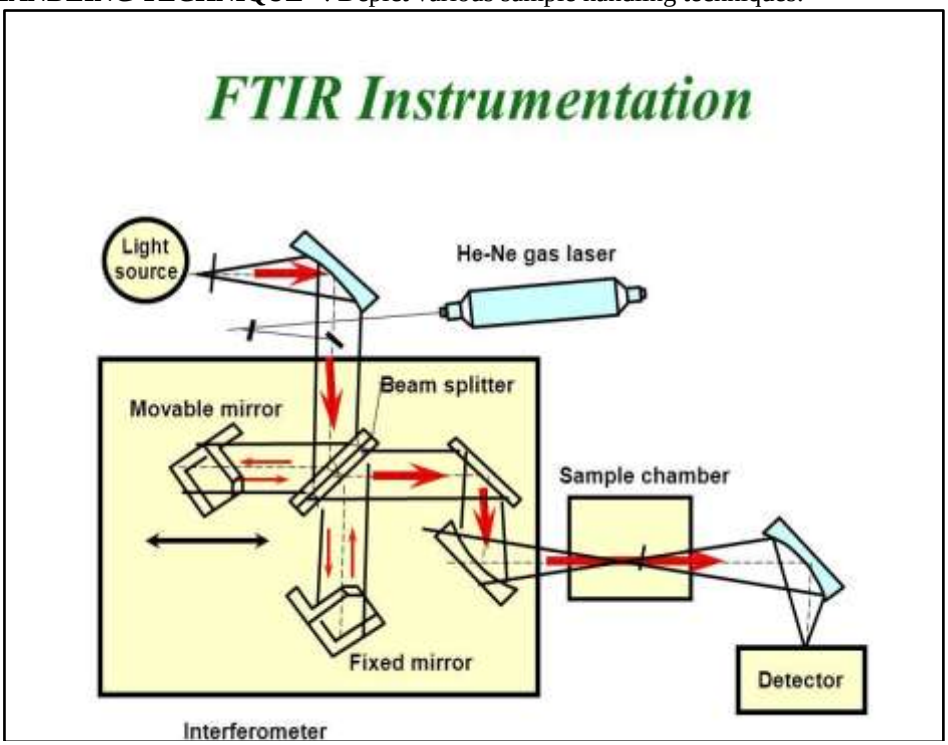
wavenumber and absorbance or transmittance respectively.

SAMPLE PREPARATION METHODS[3]: To read the FTIR spectrum, it's essential to recognise what kinds of sample holders or cells are being used during analysis . Also, the sample type and sample preparation method should also be known. Firstly, the sample phase can be of any type i.e. solid, liquid or gas. Three types of sample preparation methods.

SAMPLE HANDLING TECHNIQUE[3]: Depict various sample handling techniques.



SCHEMATIC DIAGRAM OF FTIR

[7]**1.The Source**: Infrared energy is emitted from a glowing black-body source. This beam passes through an aperture which controls the amount of energy presented to the sample (and, ultimately, to the detector).

2.The Interferometer: The beam enters the interferometer where the "spectral encoding" takes place. The resulting interferogram signal then exits the interferometer.

3. The Sample: The beam enters the sample compartment where it is transmitted through or reflected off of the surface of the sample, depending on the type of analysis being accomplished. This is where specific frequencies of energy, which are uniquely characteristic of the sample, are absorbed.

4.The Detector: The beam finally passes to the detector for final measurement. The detectors used are specially designed to measure the special interferogram signal.

5.The Computer: The measured signal is digitized and sent to the computer where the Fourier transformation takes place. The final infrared spectrum is then presented to the user for interpretation and any further manipulation.

DIFFERENT IR SPECTROSCOPIC TECHNIQUE[4]

1. KBr Disc Technique:Solid samples that are difficult to melt or dissolve in any acceptable IR-transmitting liquids are employed as pellets. Around 100 mg of dry potassium bromide (or other alkali halide) powder is thoroughly mixed with the sample (0.5 to 1.0 mg), which is then crushed to a fine powder. The mixture is squeezed into a clear disc by using enough pressure. The band distortion brought on by radiation scattering will be reduced if the sample particles are grounded to 2 m or less in size. Due to absorbed moisture, the IR spectra

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created by the pellet approach frequently show bands at 3450 cm-1 and 1640 cm-1.

2.Attenuated Total Reflectance (ATR technique):ATR spectroscopy can be used to get the IR spectra of samples that are difficult to investigate using the standard transmission approach. primarily useful for researching dense or highly absorbing solid and liquid materials, such as aqueous samples, films, coatings, powders, threads, adhesives, and polymers. The sample is often held in close proximity to a more dense crystal with a high refractive index, such as germanium, thallium bromide-thallium iodide (KRS-5), or zinc selenide. One of the most flexible sampling techniques is ATR, which requires little to no sample preparation for the majority of samples.

3. Specular Reflectance: Without sample preparation, this non-destructive technique measures thin coatings on chosen, smooth surfaces. In essence, it produces reflection measurements for a reflecting material and involves a reflection that resembles that of a mirror. At a grazing angle (usually 70 to 85°) or 30° angle of incidence, thin surface coatings in the nano- to micrometre range may be regularly studied.

4. Diffuse Reflectance (DRIFT spectra): A method that is employed as an alternative to pressed-pellet or mull procedures for collecting IR spectra of substances with rough surfaces, such as coal, paper, and fabric. Large ellipsoidal mirrors diffusely scatter light, and special reflection accessories are made to gather and concentrate that light while reducing or removing the specular reflectance, which confuses and distorts the IR spectra. Until the introduction of FTIR equipment, this energy-limited approach was not widely used. Diffuse reflectance infrared Fourier transform spectroscopy is another name for this method (DRIFTS).

5. Photoaccoustic Spectroscopy (PAS): An efficient improvement to IR spectroscopy that may be used to examine highly absorbing substances that are challenging to study using standard IR methods. The sample's size and shape are not important. Several different types of materials, including powders, polymer pellets, viscous glues, single crystals, and single fibres, can be used to acquire PAS spectra with little sample preparation and without undergoing any physical modification.

APPLICATIONS[4] :

1. Agricultural / Food
2. Polymer
3. Petroleum and fuel industry
4. Environmental
5. Textiles
6. Biomedical / Clinical

CURRENT RESEARCH ON BIOACTIVE COMPOUND USING FTIR[2]

Because to its simplicity in sample preparation, speed, minimal sample size requirements, and lack of solvent usage, FTIR has recently gained popularity

Many studies have demonstrated that the FTIR is often used in bioactive chemical analysis study. Among these are studies in the fields of food technology, pharmaceuticals, and medicine.

ADVANTAGES[7]

- ✓ Speed: Because all of the frequencies are measured simultaneously, most measurements by FT-IR are made in a matter of seconds rather than several minutes.
- ✓ Sensitivity: Sensitivity is dramatically improved with FT-IR for many reasons. The detectors employed are much more sensitive, the optical throughput is much higher which results in much lower noise levels, and the fast scans enable the coaddition of several scans in order to reduce the random measurement noise to any desired level.
- ✓ Mechanical Simplicity: The moving mirror in the interferometer is the only continuously moving part in the instrument. Thus, there is very little possibility of mechanical breakdown.
- ✓ Internally Calibrated: These instruments employ a HeNe laser as an internal wavelength calibration standard These instruments are self-calibrating and never need to be calibrated by the user.

DISADVANTAGES[7]

- ✓ The sampling chamber of an FTIR can present some limitations due to its relatively small size.
- ✓ Mounted pieces can obstruct the IR beam. Usually, only small items as rings can be tested.
- ✓ Several materials completely absorb Infrared radiation; consequently, it may be impossible to get a reliable result.

II. CONCLUSION

Looking at work described that FTIR spectroscopy is useful in many ways and it contains different advanced working of an instrument and its

application are widely used. They are also used in bioactive compounds.

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