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A Short Review on UV Spectroscopy

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Abstract: *One of the first instrumental techniques for analysis was UV-VIS spectroscopy. A wide variety of materials can be characterized using UV-Visspectroscopy. UV-Vis provides information about the absorption or emission of light wavelengths and the response modes of the samples. The absorption of dielectric energy by materials can be quantitatively described using a general law known as Beer's law. It is easy to use and works with UV-VIS radiation. Both qualitative and quantitative analysis can be used. Metal and metal oxide nanoparticles are identified using wavelengths between 200 and 700 nm. The complex mechanism of complex formation between samples, monomer and cross-linking during polymerization can also be better understood with the help of UV/Vis spectra. This certification process is quick, easy and free. The structure and composition of the materials can be checked using the spectrum. These products are used in universities, businesses, medical laboratories and chemical analysis of environmental samples.*

Keywords: UV-Visible Spectroscopy, UV-VIS Spectrometer, UV-VIS Spectrum

I. INTRODUCTION

The UV spectrum is an absorption or reflection of the visible, ultraviolet and near-end regions of the electromagnetic spectrum. Also known as UV-visible spectrophotometry (UV-Vis or UV/Vis). Due to its low cost and ease of implementation, this method is used in a wide range of basic and practical applications. The only thing is that the sample enters the UVVis range, indicating that it is a chromophore. Absorptive lean is complementary to spatial lean. In addition to wavelength, the parameters of interest are absorption (A), transmission (%T) and reflection (%R) as well as their changes over time.

Spectroscopy: Spectroscopy is a branch of science that studies the interaction between UV radiation and matter. Spectroscopy is the most useful tool for studying atomic structure and molecular structure.
A) Atomic spectroscopy: Atomic spectroscopy studies the interaction between UV radiation and atoms.

B)Molecular Spectroscopy: Molecular spectroscopy studies the interaction between UV rays and molecules. A spectrophotometer is an instrument designed to determine the spectrum of a compound. Molecular Spectroscopy: Molecular spectroscopy studies the interaction between UV rays and molecules. A spectrophotometer is an instrument designed to determine the spectrum of a compound UV wavelength = 200 to 400 nm UV visible wavelength = 400 to 800 nm.[1]

Principle:

The principle of UV exposure is based on the absorption of ultraviolet light or visible light by a chemical compound that gives off a spectrum.

Beer's Law

The intensity of a monochromatic light beam decreases rapidly as the concentration of the absorbing material increases, or as the light beam passes through a solution of the absorbing material, it exhibits a decrease in radiation intensity. n is equal to the thickness of the aqueous solution and the collision energy, and the concentration of the solution or Beer's law states that the concentration and absorbance are proportional to each other.[2,3]

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Lambert's law

When a light beam is sent from a radiation source to pass through a transparent medium, its intensity decreases with the thickness of the medium depending on the intensity of light, or intensity of monochromatic light decreases with the thickness of the medium. It is the same as the intensity of incident light. .Beer's and Lambert's laws are related to the ratio.[4,5]

A= -log10 P/P0 = abc

A = absorbance / optical density

P = radiant power / intensity

a = absorptivity / extinction coefficient

b = length of the beam in the absorbing medium

c = concentration of the absorbing species [6]

Ultra-Visible Spectroscopy Instrumentation

There are two types of spectroscopic instruments available for collecting UV absorption spectra. These are: one beam UV spectrophotometer and two beam UV spectrometer. To analyze a single wavelength, a monobeam instrument places a monochromator between the source and the sample. Once the beam reaches the reference sample and the analyzed sample. In a two-beam device, there is only one source. This arrangement allows for a more detailed explanation. Synchronous devices are generally faster and more efficient than dual UV spectrophotometers .

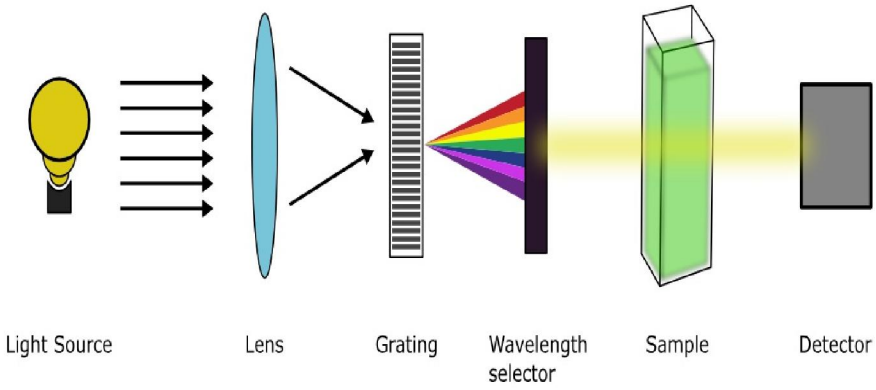

Fig-1

Light sources:-

UV radiation sources: It is important to keep the radiation source under control. greater than its wavelength.

The wavelength range for radiation emitted by deuterium and hydrogen gas is 160–375 nm. These lamps require quartz windows and quartz cuvettes, because glass absorbs light with wavelengths shorter than 350 nm b[7] Sources of visible radiation: Usually emitted by tungsten filament lamps. The wavelength range for this type of light is 350-2500 nm. The voltage determines the amount of energy produced by the tungsten filament bulb. This means that the voltage on the lamp must be very stable for the power output to be stable.

This stability is ensured by constant voltage converters, electronic voltage regulators [8]

Monochromator:-

This can be done by removing the unwanted wavelength from the radiation source through filtering[9] Multi-colored light is converted to the desired monochromatic light by using a single color. The main purpose of monochrome is to distribute the light from the primary source between the components.

The following parts make up a monochromator:

a. An input phase C. An output phase D. A focal lens [10.]

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Sample cell:-

"Cuvette" holds the sample solution in place. Varies from 0.5 to 5 ml. Typically, they are rectangular or cylindrical. The path length/width of it is 1 cm. Quartz was used to make the cuvette because glass absorbs UV light**.**

Detector:-

A photomultiplier tube is commonly used as a detector in a UV spectrophotometer. A discharge tube with a photo cathode and 9-16 electrodes (dynodes).

The metal surface of the photocathode is exposed when exposed to radiation. Then the dynode (voltage +ve) pulls electrons.

When an electron hits the first dynode, it releases more electrons and is pulled to the second dynode, and so on for subsequent dynodeConsequently, electrons are finally reaches the collector. The intensity of light falling on the detector is measured by the number of e that reaches the collector[11]

Wavelength (□)[lambda]

The distance between two peaks or troughs in a wave is the distance between two adjacent points on the same wave. According to the symbol (λ)

wavelength unit: length

angstrom (A): 1 A = 1x10-10 m

nanometer (nm): 1 nm=1x10-9 m

micrometer (μm): 1 μ m = 1x10-6 m.

TYPES OF LAMPS USED IN AN UV-VIS SPECTROSCOPY

It has a wavelength range of 190 to 370 nm and is also known as D2 light. Due to the behavior at high temperature, the conventional glass filler is not enough, quartz, MgF2, and other materials should be used. A deuterium lamp lasts 1000 hours. To cover the entire wavelength of UV and visible light, the UV/Vis spectrophotometer consists of a deuterium lamp and halogen lamp.[12 13]

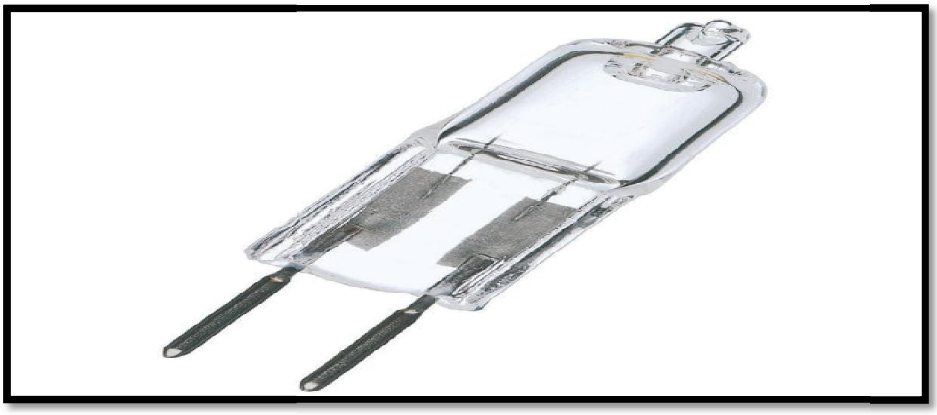

Fig-2

Halogen lamps, also known as tungsten or quartz lamps, have a wavelength range in the visible light range, varying from 320 nm to 1100 nm. If the device only has a halogen lamp, it can only measure visible light.The lifespan of a halogen lamp is 2000 hours or more.halogen lamp (also called tungsten halogen, quartz-halogen, and quartz iodine lamp) is an incandescent lamp consisting of a tungsten filament sealed in a compact transparent envelope that is filled with a mixture of an inert gas and a small amount of a halogen, such as iodine or bromine. The combination of the halogen gas and the tungsten filament produces a halogen-cycle chemical reaction, which redeposits evaporated tungsten on the filament, increasing its life and maintaining the clarity of the envelope. This allows the filament to operate at a higher temperature than a standard incandescent lamp of similar power and operating life; this also produces light with higher luminous efficacy and color temperature. The small size of halogen lamps permits their use

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in compact optical systems for projectors and illumination. The small glass envelope may be enclosed in a much larger outer glass bulb, which has a lower temperature, protects the inner bulb from contamination, and makes the bulb mechanically more similar to a conventional lamp[1].

Fig-3

A Xenon lamp is a high-intensity light source that can reach a steady state in a short time. The light range is from 190 nm to 1100 nm in the UV visible and spectra. A xenon lamp that shines at a frequency of 80 Hz has a longer life than deuterium or halogen lamps. On the other hand, xenon lights are more expensive.\These lamps have a stable intensity across a wavelength range of 200–800 nanometers, covering the UV/vis absorption of flavins. They are used in a variety of applications, including research and development in organic chemistry, biochemistry, medical testing, food testing, and environmental protection.

Mercury xenon lamps

These lamps combine the UV spectrum of mercury vapor lamps with the IR spectrum of xenon lamps. They are efficient UV light sources that can produce sharp and intense UV spectrums.

Xenon short-arc lamps

These lamps are available in two types: pure xenon gas and xenon-mercury. The xenon-mercury variant has a bluish-white spectrum with exceptionally high UV radiation.

Fig-4

LEDs emit only one wavelength of light, they do not need to be monochromatic. He had a very long life. The LED light source is variable in width and stable. The charging light source is an LED lamp. LED bulbs are increasingly used in UV spectroscopy due to their advantages over traditional light sources. Here's some information:

Advantages:

1. Higher energy efficiency
2. Longer lifespan (up to 50,000 hours)
3. Instant on/off and stable intensity

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4. Narrow spectral bandwidth
5. Low heat generation
6. Compact size

Applications in UV Spectroscopy:

1. UV-Vis spectroscopy: LED bulbs are used as light sources for measuring absorbance and transmission in the UV-Visible range.
2. Fluorescence spectroscopy: LEDs excite fluorescent samples, emitting light at specific wavelengths
3. Raman spectroscopy: LEDs are used as excitation sources for Raman measurements.

Types of UV LEDs:

1. UVA LEDs (320-400 nm): Suitable for UV-Vis and fluorescence spectroscopy.
2. UVB LEDs (290-320 nm): Used for protein detection and DNA analysis.
3. UVC LEDs (220-290 nm): Applied in disinfection, water purification, and advanced spectroscopic techniques.

Key Specifications:

1. Wavelength (nm)
2. Intensity (mW/cm²)
3. Bandwidth (nm)
4. Stability (%)
5. Lifetime (hours)

Popular UV LED Manufacturers:

1. Nichia
2. Osram
3. Lumileds
4. Cree
5. Seoul Semiconductor

Challenges and Limitations:

1. Limited power output
2. Spectral stability and drift
3. Temperature sensitivity
4. Interference from ambient light

Future Developments:

1. Higher power UV LEDs
2. Improved spectral stability
3. Advanced driver technology
4. Miniaturization for portable devices

When selecting UV LED bulbs for spectroscopy, consider factors like wavelength, intensity, and stability to ensure optimal performance.

Types Of UV Spectrophotometer Machine

There are two types of UV-Vis spectrophotometers are single beam and double beam:

Single beam: a cuvette, so that samples can be measured one after the other.

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Fig-5: Single beam UV-Vis Spectrophotometer

In single-beam spectrophotometers, a single beam of light passes through the sample holder. The instrument is calibrated by placing a reference in the sample holder and subtracting the resulting value from subsequent sample measurements to eliminate solvent and cell effects. The advantages of single beam devices are high dynamic range, flexible surface, few moving parts and compact design. These spectrophotometers are used in applications such as determining the concentration of an analyte in a solution by measuring absorption at wavelength and using the Beer-Lambert law and acoustic analysis. It can be measured in the wavelength range 190 to 750 nm (although some up to 1100). The UV region, defined as wavelengths below 340 nm, is suitable for measuring nucleic acids, purified proteins and other organic molecules. It depends on the type of sample and its use of the correct spectrophotometer. Find a range of book templates to suit your needs, the ability to quickly change templates, an easy-to-read display and an easy-to-clean and maintain unit..

Fig-6: Double beam UV-Vis Spectropohotometer

Double beam:

splits light into two equal parts moving in opposite directions. The main difference between single beam and double beam is the shape of the light coming from the light source. A birefringence is a bifurcation of the incident light in the absence of a single beam..

A dual-beam UV spectrophotometer looks similar to a dual-beam spectrophotometer in operation. In this dual UV-vis spectrophotometer, the light beam from the light source is split into two light beams. Like a dual-beam spectrophotometer, a monochromatic one also measures the wavelength of light passing through the samples. If the molecular concentration of the solution is higher, more light rays will be absorbed by the samples. Many observations provide samples for spectroscopic analysis, which must be very pure to avoid negative and incomplete results. A UV-visible spectrophotometer consists of two beams:

a lamp or power source, usually a lamp.

A filter or monochromatic light is attached to the device to select the wavelength of the light. space for cuvettes to read the measurements

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detectors to obtain accurate information from spectroscopic analysis. A radiation detector or fluorescent tube can also be used to detect changes in the wavelength of light. It also helps to convert the energy received by the two-beam UV-visible spectrophotometer into a quantitative signal.

These parameters are considered to remove the data observed in the spectrophotometric process. There are two types of light conditions in a two-beam UV-visible spectrophotometer setup:.

Characteristics of UV-Visible Spectrum

The UV-VIS spectrum is the result of the interaction of electromagnetic radiation in the UV Visible range with molecules, ions or complexes. It serves as a basis for the analysis of various substances such as inorganic, organic and biological substances. These determinations are used in research, industry, clinical laboratories and chemical analysis of environmental samples. Therefore it is important to learn about the origin of the UV-VIS spectrum and its properties.

Radiation and energy; Radiation is a form of transmitted energy, so called because it has electric and magnetic fields in a plane parallel to the direction of circulation in the electrical field. Radiation has two forms: wave properties and describes its particle properties. Form of light Light is the form of energy. Energy can be transferred from one place to another either by particle motion or by wave motion. Based on this, there are many theories about

the nature of the moon.; The main points are as follows:

1. Be specific as a concept.
2. Theory of electromagnetic waves.

Not Only the electric vector can react with matter and transfer energy.

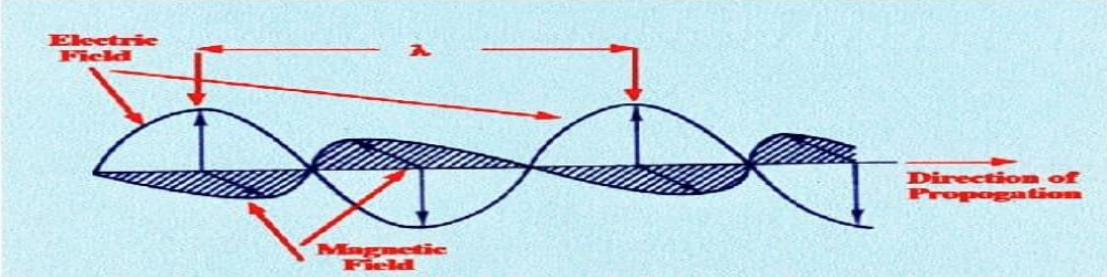

Fig-7: Wavelength (□)[lambda]

is the distance between two peaks or troughs in a wave, or the distancebetween two equal points in a wave. According to the symbol (□)wavelength unit: length

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nanometer (nm): 1 nm=1x10-m

micrometer (□m): 1 □ m = 1x10-6 m.

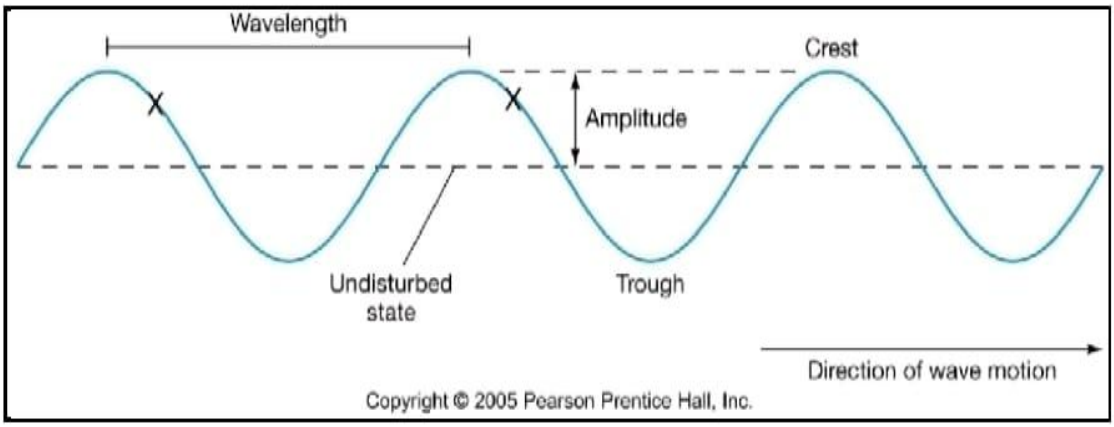

Fig-8

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Frequency (f or ν [nu]): Oscillations per sec (Hz) = cycles / s
1 Fresnel= 10 12 Hz
reciprocal of the wavelength (the interval from a given point on one sound wave to the equivalent point on the next sound wave) For an oscillating or varying current , frequency is the number of complete cycles per second in alternating current direction.

Wavelength
Wavenumber (ύ) is the number of wavelengths that pass through a given point in a unit oftime (usually per second).Wavenumber unit: reciprocal length (number of centimeters), reciprocal of 356avelength = 1\
ʎ.f frequency is the hertz , abbreviated Hz.

Applications of UV-Vis Spectroscopy Technique
The applications of UV-Vis spectroscopy are enormous. The following are the main fields in which UV-Vis spectroscopy is used:
DNA & RNA analysis
Pharmaceutical analysis
Bacterial culture
Beverage analysis
Other applications

DNA & RNA analysis
Uv-Vis spectroscopy deals with the purity of nucleic acids.
Quick verification of concentration and purity of DNA and RNA
This is essential before preparation of DNA and RNA in downstream applications like sequencing
The 260 nm/280 nm absorbance ratio is essential to display contamination in nucleic acids by proteins as the ratio in pure DNA is 1.8 and that in pure RNA is 2.

Pharmaceutical analysis
UV-Vis spectroscopy is an indispensable equipment in production of pharmaceutics.
Overlap of absorbance peaks in uv spectra can be used to find out the pharmaceutical compounds using mathematical derivatives
Chlortetracycline (antibiotic) and benzocaine (anaesthetic) are identified simultaneously in veterinary powder formulation using first mathematical derivative
By calibration function of each compound, simultaneous quantification was done on micrograms per milliliter concentration.

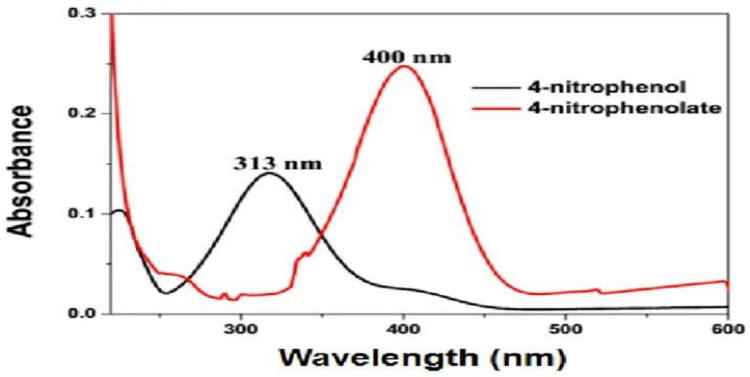

Fig-7

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Bacterial culture

UV-Vis spectroscopy is essential in the biomass growth curve studies.
Routine OD measurements are taken at 600 nm for estimation of cell concentration and growth tracking.
600 nm is chosen due to the optical properties of media in which bacteria is growing and to avoid damage to the cells when there is need for continuous experimentation.

Beverage analysis

Uv-Vis spectroscopy is also used in FMCG industries.
Identification of particular components in drinks
Quantification of caffeine content as they should be within legal limit
Identification of anthocyanin in blueberries, blackberries, raspberries and cherries for quality control in wine

Other applications

Besides, there are extensive applications of UV-Visspectroscopy in other fields also. Below are the other applications of UV-Visspectroscopy:

1. Detection of impurities
2. Structural elucidation of organic compounds
3. Quantitative analysis
4. Qualitative analysis
5. Chemical analysis
6. Quantitative analysis of pharmaceutical substance
7. Dissociation constant of acids and bases
8. Molecular weight determination
9. As HPLC detector 10. Deviations from the Beer-Lambert law[14 15 16 17]

II. CONCLUSION

The review article contains all the information about UV-visible vision, its purpose, concept, equipment, advantages, disadvantages and applications. Identifying impurities is more accurate using UV-visible light, and UV-visible light is very important..

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