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Forensic Applications of Raman Spectroscopy a Review

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Abstract

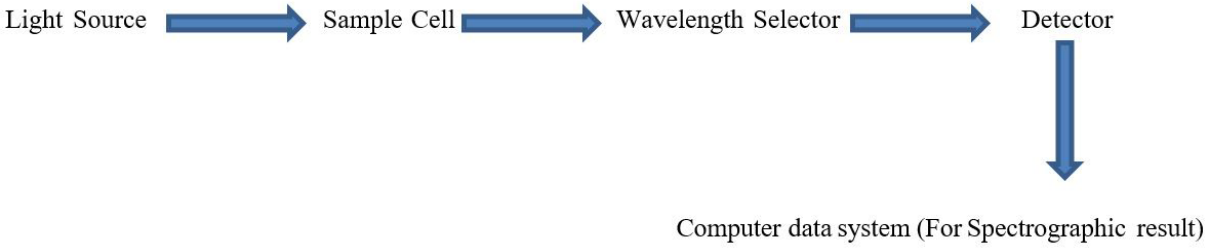
The any field of science they have many different techniques method for examine the substance. There have been several major advances in the use of Raman spectroscopy instruments. This method is now a full established method along with, infrared spectroscopy. The process ultimately led to its entry into the forensic science laboratory, and to simplify the process, this article introduces a comprehensive review of Raman spectroscopy; emphasizes how and why this less commonly used method can be a very useful tool for analysing a various evidence. The concepts and principle of Raman spectroscopy are described in two categories the first categories of this article which includes theory, instrumentation, and spectrum data obtained using infrared and Raman techniques for numerous analyse and the Second categories discusses forensic applications of Raman spectroscopy to examine various types of evidence and substance. In this article we study how to examine forensic evidences by using the Raman spectroscopy and make review report on it.

Keywords: Forensic Science, Raman Spectroscopy, Evidence Analysis, Forensic and Other Applications

Introduction

Raman spectroscopy method firstly discovered by Indian scientist Chandrasekhara Venkata Raman in 1928. It's a relatively effect of another effect of spectroscopy. All spectroscopy method as depends on the absorption but only Raman spectroscopy is depending on scattering. It is a basic principle is scattering phenomenon. Raman spectroscopy has been used considerably for analysis of physical properties like crystallinity. The C.V. Raman, published the paper on technique along with K.S. Krishnan [1]. The Raman Effect is based on the molecular deformations change in molecular polarizability Raman spectroscopy. This spectroscopic system generally used to determine the vibration patterns of molecules. Raman spectroscopy is mostly used in chemistry to provide a fine fingerprint where molecules can be seen. The Raman spectroscopy gives the all-resultant study because of the scattering of light.

The Raman scattering show two types stokes and anti-stoke. They are produced when scattering of mediation lines with lover frequency compared to that incident beam then those called stoke Line. And Antis stoke line is defined as the when scattering of radiation produced lines with higher frequency compared to that incident beam, the scattering of radiation without any changes in frequency [2]. The Raman spectroscopy also useful for the qualitative analysis, and quantitative analysis. The main factor is polarizability of molecule change. Raman is sensitive to homonuclear molecular bond. The Raman molecules have not require the dipole moment



Instrumentation

A source of monochromatic light, generally from a laser in a visible area, near infrared, or near UV radiation, although X-rays may not be used. Laser light interacts with vibrations of cells, pads, or other sensors in the system, causing the laser photon energy to be transferred up or down [3]. Power switch provides information about vibration modes in the system. Infrared spectroscopy usually produces the same yet consistent information. Typically, Laser beam is used to illuminate sample. Electromagnetic radiation from the illuminated area is collected through the lens and transmitted by a monochromator. Scattering radiation with elastic at wavelength along the laser line (Rayleigh scattering) is filtered by a notch filter, edge pass filter, or band pass filter, while other collected light is dispersed in the detector Raman Spectroscopy is a biological medium and inorganic ready for Raman analysis. This can be solids, liquids, polymers or vapour. In Raman spectroscopy doesn't need the sample preparation. Very clear as a fingerprint chemical. Samples can be analysed by glass or polymer packaging. a region from 4000 cm - 1 to 50 cm-1 can be covered with a single recording Raman spectra can be collected in very small volume (<1 μm diameter). Insensible objects are fluently analysed by Raman spectroscopy reliable operations for Raman spectroscopy to forensic analysis is multifaceted, with a methodical approach to carrying details of a range of sample types. The Raman spectrum in plot of intensity and frequency (wavelength).

The most beneficial use of Raman spectroscopy in the science of espionage lies in the examine of ink samples in questionable texts. Any additions or modifications made, regardless of whether the two ink donations may come from the same source, even the chronological contributions of the ink donations. Pen inks are complicated liquids made up of a variety of colours and solvents that can result in a wide range of ink formations. These songs will almost certainly differ amongst pen manufacturers, enabling for the study of ostensibly similar ink samples to see if they came from the same source or not.

Discussion

Application of Raman spectroscopy

The many spectroscopy techniques used in analysis examination and identification purpose in many fields. The Raman spectroscopy is also used for the identification examination and analysis purpose. This Raman spectroscopy is not only use in physics, chemistry they can also use in Forensic Science [4], medical profession. In this article we give comprehensive review on many several applications of Raman spectroscopy in forensic science. The forensic science is the science which is useful for law and criminal justice system. In forensic science they have many field/ divisions in it such as chemistry toxicology, Biology, DNA, serology, Ballistic, Question Document, Physics etc. The following review on application of Raman spectroscopy.

In the study of the documents in question, it is generally not appropriate to destroy a writing sample in order to perform chemical analysis, as may be required for mass spectrometry. Without the necessity for sample alteration or compromising the value of documentary evidence. Raman spectroscopy enables for chemical analysis of contentious writing samples. This Raman spectroscopy application is used for the pen and printing ink analysis; but this technique shows the drawbacks, some limitation like the fluorescence signals exhibited on the paper. But this spectroscopic method is applicable for examination of inks and ink materials [5]. The determine source of origin of unknown printed document based on their classification into laser or other inkjet photocopier devices. They or complied Raman spectroscopy with chemo metrics as well as principle of component analysis [6]. By using or applying Raman Spectroscopy can be measure the security features of currency banks notes. The Raman micro spectrometry were used for the differentiate ink colour of banknotes by showing the Raman spectra of that sample. Also, can find or detect the sample was genuine or fake on the basis of colour combination [7].

In the Biology examination, identification of the body fluids like saliva sweat, urine, semen. The Raman Spectroscopy is used for the determine heterogeneous single sample of dried saliva as well as examine the qualitative variations in saliva. Using this saliva sample create unique spectroscopic signature for body fluids [8]. The NIR RS was also used for the measure the spectra of dried blood sample of human for these using various mapping software and get the statistical analysis spectra of dry blood sample [9]. Raman Spectroscopy beneficial for the give the difference between peripheral Blood and menstrua l blood. The peripheral Blood and menstrual blood are same but spectra of Raman spectroscopy show the difference [10]. The Raman spectroscopy is also b useful for serological evidence analysis [11]. Blood tests have been impressively included in Raman's analysis, investigating whether it is possible to use Raman techniques to detect the presence of something in the blood and to try to age the blood sample. The study concluded that Raman spectroscopy has been able to detect the presence of blood, which is usually found in the bloodstream, especially haemoglobin. This was achieved even when the blood samples were thoroughly purified. In addition, studies have investigated the possibility of using Raman spectroscopy to detect abnormal blood age, based on differences in peak distribution between pure and dried blood samples [12]. With the possibility of portable Raman technology, the ability to detect blood using this process can allow analysis rapid identification of controllable substances and the ability to analyse samples without sample preparation or destruction.

In physical evidence can be analysed by Raman spectroscopy with various methods. The Raman spectroscopy concerned with analysis of pigments or paints for differentiate and is examination of forgeries, in paint [13]. The fibre cases analysis by Raman spectroscopy with the certain characteristics of Fibre dyes can be subsequently identified by an unambiguously by applying Raman spectroscopy (14). The Raman spectroscopy gives the more in detailed infor mation about molecular structure of fabric and without distiches sample [15]. The analysis of soil they have many techniques to analyse The Morphologically Directed Raman spectroscopy gives the in detail morphological characteristic of soil [16]. The Glass is also physical evidence. The Raman spectroscopy is a useful for the analysis of glass surface and a difference between artifacts [17].

In chemistry the Raman spectroscopy is used to determine element structure, Nature of chemical bond as well as the studying the chemical combination. The Raman spectroscopy on-destructive technique. This technique applicable for the detection of drug and uncontrolled substances from nails of drug abused person [18]. The Raman spectroscopy is powerful technique in the come drug abuse examination. This Raman spectroscopy applicable for drug abuse due to the fluorescence and also using Surface Enhanced Raman scattering for drug abuse [19, 20]. Kevin Buckley and Pavel Matousek [21] demonstrate the use of spatially affect Raman spectroscopy for the detection of illicit Dung from the various materials like cloths, plastic bottles, these techniques use because the Raman spectroscopy is non-destructive technique.

The pharmaceutical analysis is included in chemistry. In the pharmaceutical industries checking and testing content of pharmaceutical substances like tablets, medically authorised drug as well as checking purity of substances. The Identification of Raw Material, Quantitative determination and analysis of pharmaceutical substances like drugs and tablets analysed by using Raman spectroscopy [22]. The Kaho Kwok and Lynne S. Taylor [23] he describes the care on to get information of characterising of genuine tablet. The detection and examine tablet were fake or not by applying Raman spectroscopy [24].

In addition, Raman spectroscopy is used successfully in the analysis of Gunshot residue [25] and explosives [26], soil samples, fibres [27], and aggressive drug analysis [28]. Raman spectroscopy can provide information about the chemical structure and ownership of compounds. The field of scientific research has benefited greatly from using this method because of its advantages over other scientific techniques. For example, Raman spectroscopy does not require careful sample adjustment that is required by other methods, such as infrared spectroscopy. Also, it can analyse a wide range of samples. Aqueous solutions can also be analysed in this way, which is the limit of many similar strategies. Raman spectroscopy also generally produces a cleaner spectrum than other similar techniques, and has greater variability. In addition, Raman spectroscopy is a non- invasive procedure, which is another benefit due to the need to analyse the material that can be considered as evidence in a court case. It always prefers to preserve the evidence in its oriinal form Since the data generated by forensic analysis is often used as evidence in court, it is very important that it is very accurate and reliable, for this reason, Raman scattering finds itself used in many areas of forensic science because of its intensity. Below, we discuss the many applications for Raman's dissolution in intelligence science. Advanced Raman Scattering (SERS) and the common Raman rely heavily on forensics labs to explore the vast amount of physical evidence collected in crime scenes. For example, it can be used to analyse dyes, paints, fibres, fabrics, and textiles even lipsticks and shoe polish smears. Raman and SERS can compare samples with known samples, determine their identity, and provide important information about the smallest tracking evidence, such as the colour of the paint chip, trace analysis as well as toxic material the origin of the fabric and the way it is made. It can even be used to compare hair samples, helping to identify suspects.

The remains of a firearm can be important evidence in criminal cases. While scanning electron microscopes with energy dispersive spectroscopy (SEM/EDS) is often used to analyse gun fragments. Raman scattering can help detect small traces in almost any type of area, without the need to change the evidence by any means Raman scattering and SERS.

They have long been used to analyse illicit drugs. Although infrared spectroscopy has often been a common way to detect and detect illegal drugs, Raman spectroscopy has gained popularity due to their non-destructive nature. As compare to forensic science the Raman Spectroscopy use in various areas such as the Geological, Mineralogy (Carbon Material) [29], Life sciences, Art, Archaeology. In Geology the examination and identification of various types of stones, Gems and rocks. In mineralogy the Raman Spectroscopy is applicable for the detection of the defects in carbon materials, minerals can be identified in transparent matrices. [30]. I n the life science the Raman spectroscopy plays important role because by using this spectroscopic method we can analyse the biomolecules [31], biocompability of materials and its features, also analyse the nucleic acids. The abovementioned theory is related to the specific application of Raman Spectroscopy in various fields' areas.

Conclusion

The Raman spectroscopy although there are some limitations, such as low sensitivity and fluorescence disorders, Raman spectroscopy has emerged as a non-invasive method, non- destructive technique. Also, the Raman spectroscopy technique is less time consuming. There are some automatic mapping techniques and many software like wire 2.0, GRAMS/Ai7.0, matlab7.4.0 toolbox used for make accurate results. The quantitative analysis and fit in a few settings with the new technological advances soon, Raman spectroscopy is expected to become a popular analytical tool for a growing number of applications.

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