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Short Communication

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The Significance of IR Spectroscopy in Scientific Investigations

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DESCRIPTION

One of the most significant benefits of infrared spectroscopy over most other analytical methods is the ability to examine samples in their natural state. Examinations utilising this method are often quick, involve little sample preparation, and seldom need the use of solvents. Although not as sensitive as chromatographic/mass spectrometric methods, infrared spectroscopy can be used on a wide range of sample types (including finished dosages and packaging), is useful for identifying both active ingredients and excipients, and can distinguish polymorphs, salt forms, and free acids and bases. Analytes with greater and lower m/z ratios than instrument cutoffs, analytes with non-descript mass spectra, and analytes with non-descript mass spectra can all benefit from the approach.

Many of these benefits are frequently limited to pure chemicals or analytes present over 1% in a non-interfering matrix in macro-infrared spectroscopy, which typically employs a sampling aperture on the order of mm and a single element detector [1]. However, because the individual particle sizes are modest in comparison to the sampling aperture, these advantages are not always achieved when identifying the composition of a multi-component sample. In most cases, the outcome is a complicated mixed spectrum that needs spectral subtraction to distinguish specific components. Although spectral subtractions can help detect several constituents, they are only beneficial until subtraction residuals dominate the spectrum, at which time a direct comparison to a standard becomes impossible. Individual particles can be identified using infrared microspectroscopy, which uses a single-element detector but with a smaller aperture that is closer to the size of individual particles (down to about 10 m). Multi-component samples can be manually separated, and individual particles can be identified using infrared microspectroscopy. Unfortunately, infrared microspectroscopic examinations are time-consuming, need a professional analyst, and are difficult to perform when the sample comprises microscopic particles or many particle types with comparable morphologies.

In many circumstances, infrared spectroscopic imaging, which employs a multi-channel detector to acquire an infrared spectrum at each spatial position in a two-dimensional region of interest, is a more efficient and effective method. The size of the pixels on the detector and the instrument's optics determine the size of each spatial element at the sample plane. In many circumstances, the device may be set up so that the pixels are smaller than the particles

of interest, limiting the measurement's spatial resolution to either diffraction or, more frequently, particle size. As a result, particles that are physically separated from one another typically produce spectra that are similar to those of almost pure chemicals, allowing individual constituents in a multi-component sample to be identified.

In a way, infrared spectroscopic imaging changed macro-infrared spectroscopy's most major drawback, the capacity to detect individual components in a multi-component sample, into an advantage [2]. In addition to the advantages of all infrared techniques, infrared spectroscopic imaging allows for the detection of multiple analytes in the presence of each other, as well as low and high concentration analytes in a single measurement, all without the need to change solvents, concentrations, columns, or other parameters, as with chromatographic and mass spectrometric techniques. In reality, most samples can benefit from a single set of parameters. Although the detection limits of this method are still many orders of magnitude larger than those of chromatographic and mass spectrometric methods, its adaptability makes it excellent for use as a screening tool early in a research project.

Several forensic studies needing the capacity to detect specific ingredients spatially segregated from one another within a multi-component sample have lately used infrared spectroscopic imaging. This method has been used to discover trace evidence such as narcotics and explosives between the ridges of latent fingerprints, as well as cross-sectioned paint chips, bi-component fibers, counterfeit tablets, intersecting lines in questioned papers, counterfeit bank notes, and gunshot residue [3-8].

CONCLUSION

At the Forensic Chemistry Center (FCC), forensic analyses using infrared spectroscopic imaging have included determining the composition of combination drugs (those containing more than one API), suspected counterfeit tablets, illicit pharmaceuticals, dietary supplements, human autopsy tissue extractions, and cross-sectioned suspected counterfeit packaging materials such as adhesive labels, foil safety seals, and cigarette tear tape.

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