Introduction

There may be situations where it is advantageous or even necessary to use an alternative source to the standard FT-IR/NIR sources. Infrared emission measurements are varied, and used in applications ranging from characterizing external light sources in astrophysics and environmental monitoring applications, to measuring laboratory samples excited in some way to emit radiation. Laboratory emission measurements are generally considered an alternative to conventional transmission, reflection or photoacoustic techniques and rarely used if the current conventional techniques work satisfactorily.

However, there are situations where measuring emission from a sample may be more convenient or practicable. Examples could include highly absorbing materials supported on metal substrates (such as some catalysts) where reflection measurements yield poor spectra, or thin films on electrode surfaces or metal substrates. In some instances it is simply more convenient to physically orientate the sample for emission compared with positioning in a suitable reflectance accessory. An accessory is available for the Frontier IR and IR/NIR spectrometers which allows the input beam from an external source to be directed into the interferometer via a port in the interferometer cover, replacing the standard internal source.
A more detailed description of IR emission and relevant applications is provided in the review article of Mink. One of the main requirements for collecting an emission spectrum is a temperature difference between the source and the detector. For the majority of routine measurements using a room temperature detector, this means heating the sample to an elevated temperature. This is one reason for making provision for an external input beam, as suitable heating apparatus may be required. In addition, for more accurate intensity measurements, it is necessary to correct the spectrum with a reference obtained from a blackbody source at the same temperature as the sample, though for many qualitative measurements, this is not strictly necessary.

Description

The auxiliary input beam mirror is located inside the instrument, designed to accept a horizontal collimated beam input into the rear of the instrument at an angle of ca 10 degrees from the normal to the plane of the cover surface. The external window aperture is approximately 40 mm in diameter. For highest throughput, the input beam should be collimated to less than ca 2 degrees half cone angle (Figure 1).

The input mirror replaces the standard source mirror and the software is re-configured to indicate when the external beam path is selected. For custom optics and additional apparatus, additional fixing screw positions are provided in the base casting of the spectrometer at well-defined locations with respect to the beam center.

Provision for custom accessories

Being located close to a rear corner of the instrument helps optical/mechanical coupling of external accessories. For example, a telescope accessory has been designed for open path measurements (Figures 2a and 2b). This design features a Newtonian telescope with adjustable focus range from 2.5 meters to infinity, and includes a separate integrated source to enable system start up and background measurements. Used on a tripod assembly, this system is used in remote sensing applications.

A second example of use of the external input accessory illustrates a novel pre-interferometer sampling arrangement, enabling NIR reflectance measurements of relatively large sample areas. For very inhomogeneous materials, it is desirable to sample as large an area as possible and have a large working range. A pre-interferometer sample illumination arrangement provides more flexible and convenient sampling. This example is used in the development of an on-line application in the agricultural industry. For background measurement, a calibration drawer incorporating a highly reflecting material is moved into position allowing the background to be taken. The system is installed above a moving conveyor which carries the sample, as shown in Figure 3.

Figure 1. Beam configuration for input beam accessory.

Figure 2a. Telescope accessory utilizing input beam accessory (front view).

Figure 2b. Telescope accessory utilizing input beam accessory (rear view).
Laboratory emission measurements

Butane-air flame

The spectra of flames show very complex structure as molecules are present in many different excited states. However, even using no special optical arrangement to transfer the radiation into the interferometer, it is possible to collect emission spectra easily using a standard DTGS detector in a short timeframe (Figure 4). This example shows a 2 cm⁻¹ resolution spectrum collected using the normal instrument source background curve as a reference.

Atmospheric spectrum

The spectrum of the atmosphere is dominated by water and carbon dioxide. However there are a number of infrared ‘windows’ where other species may be observed (Figure 5). The ozone band around 1040 cm⁻¹ is clearly visible and the N₂O bands are seen at higher wavenumbers.

Conclusion

The input beam port greatly extends the potential applications for the Frontier systems, Spectrum 400, 100 and 100N spectrometers. In addition to simple emission measurements where these systems demonstrate considerable potential for qualitative measurements of emission spectra, the input beam port can be used in the design of custom apparatus which can be coupled with the base casting of the spectrometer. This helps both the practicality of the system and simplifies optical alignment of the system components.

Reference