Application Note

No. 170TR0171-E

Application in Far-Infrared Spectroscopy 1
Standard (basic) edition

The light is generally called as gamma-ray, X-ray, ultraviolet, visible light, infrared, or microwave depending on the wavelength from shorter to longer. Among Infrared, the light nearer to visible region is called as Near Infrared and the light closer to microwave region, as Far-Infrared. In general, the light in the range of 500 cm^{-1} to 25 cm^{-1} (20 mm ~ 4 mm) is known as Far-Infrared. The energy levels in this region are shown in Table. 2 and the light quantum energy is very small in this region. Accordingly, Far-Infrared spectra reflect very little energy change or very small conformation change of molecule. The instrument is provided with Myler or CsI prism as Beam Splitter.

Outline of instrument

Table 1 Example: Combination of optical elements

Wavelength range	Beam splitter	Light source	Detector
5000 - 220 cm^{-1}	CsI	Nichrome heating element	TGS, KRS-5 window
650 - 100 cm^{-1}	Mylar 5 μ	Nichrome heating element	TGS, PE window
200 - 50 cm^{-1}	Mylar 12 μ	Nichrome heating element	TGS, PE window
100 - 20 cm^{-1}	Mylar 25 μ	High pressure mercury lamp	Bolometer (custom-made)

Table 2

Wavenumber (cm^{-1})	eV
4000	0.5
400	0.05
100	0.012
10	0.0012

Sample preparation for Far-Infrared spectroscopy

Usually for IR sample preparation, the sample is sandwiched between two IR transparent window plates such as KBr or NaCl, or mixed with the powder of those materials to form a pellet. But in Far Infrared measurement, those materials are not suitable to be used because of their absorption in the wavenumber range shorter than 400 cm^{-1} or 650 cm^{-1} respectively. Window materials to be used in Far Infrared region are follows.

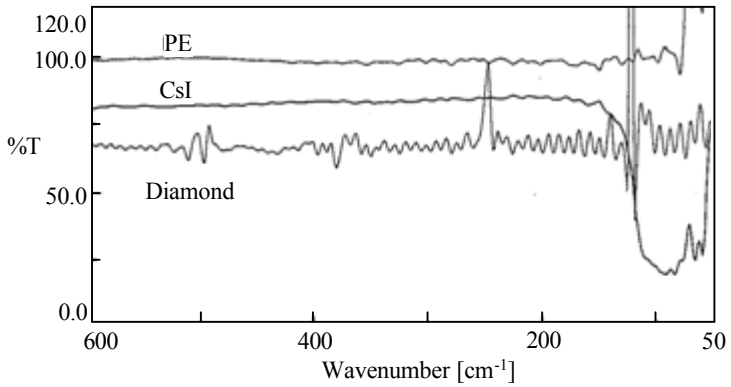

Fig.1 Window materials transmit Far-Infrared ray (PE, CsI, Diamond).

Cesium Iodide can be used in the range from Infrared region to 120 cm^{-1}. The procedure is to form a CsI pellet just like a KBr pellet which will be measured by transmission method. Nujol method, in which there appears absorption peak of CH band of liquid paraffin, is a very efficient method in the rest of the range. The procedure is to mix the sample with Nujol, and then to sandwich such mixture between two polyethylene plates (2 ~ 3 mm thickness) for measuring by transmission method. This method can be used in the range to about 50 cm^{-1}. Far-Infrared light can go through also the thin plate of diamond. The procedure is that the sample is applied on a diamond plate thinly for measurement in transmission method. Fig. 1 shows the absorption spectra of those Far Infrared transmitting materials.

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Measurement example 1

Effects of vacuum in Far-Infrared region

Fig. 2 shows single beam spectra in Far-Infrared region. In this region there are so many peaks of absorption due water vapor and it is significant to eliminate the humidity by using N2 purge, or to use a vacuum model.

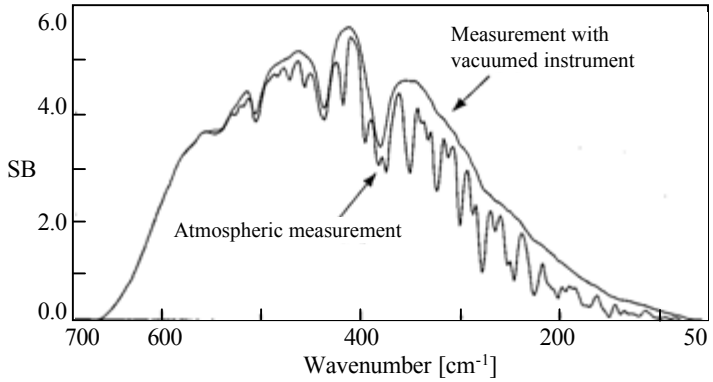

Fig. 2 Spectra of single beam of Far-Infrared region

Measurement example 2

Crystal structural difference of inorganic molecule

Fig. 3 shows spectra of three different structures of AlPO4 such as Cristopalite, Trodymite, and Berlinite, witch was obtained by CsI pellet method.

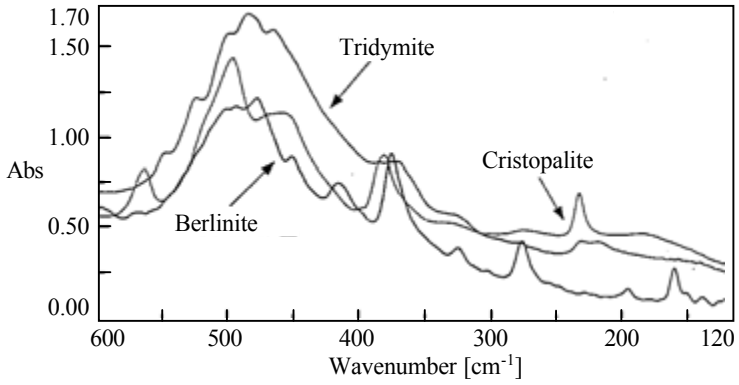

Fig.3 Spectra of each crystal structure of AlPO4