JOURNAL OF RESEARCH of the National Bureau of Standards—C. Engineering and Instrumentation
Vol. 64C, No. 1, January–March 1960

Transmittance of Materials in the Far Infrared

Earle K. Plyler and L. R. Blaine

(October 27, 1959)

The transmittance of several crystalline materials with thicknesses of about 5 mm has been measured from 17 to 55 μ. The crystals are sodium chloride, potassium chloride, potassium bromide, thallium bromide-iodide, cesium bromide, and cesium iodide. Also the transmittance of a polyethylene film containing carbon black has been measured to 100 μ and an example of its use as a transmission filter for the far infrared is given.

Different optical crystals are used for prisms and windows in the infrared region. Another use of these materials is for chopper blades for measurements in the far infrared region. When they are used as choppers, only that radiation is modulated to which the specific crystal is opaque. This provides a powerful tool for eliminating the amplification of short wavelength stray radiation. For example, a chopper of CsBr would transmit all the radiation, except for reflection losses, from the visible to about 35 μ; any stray radiation or higher orders from the grating would not be observed, thus improving the purity of the spectrum at longer wavelengths.

In figure 1 is shown the transmittance of several materials from 17 to 55 μ. The materials are sodium chloride, potassium chloride, potassium bromide, thallium bromide-iodide (KRS–5), cesium bromide, and cesium iodide. All of these crystals are transparent in the near infrared and become opaque by or before 55 μ except CsI. It becomes opaque at about 75 μ for 5-mm thickness.[1] All of these crystals were obtained from the Harshaw Chemical Company, and the absence of absorption bands in the near infrared indicates a high purity. The wavelength range of transmission of the different crystals agree well with the results obtained in this laboratory and with results obtained in other laboratories on other samples of these materials which were characterized by indices of refraction measurements.

A filter which absorbs the short wavelength radiation, but which is transparent at long wavelengths, is useful in removing stray radiation. A good material for this purpose is polyethylene containing carbon black. A filter of this type may sometimes be used in place of the crystal chopper.

In figure 2 is shown the transmittance of polyethylene and polyethylene containing carbon black. The transmittance varies with the thickness of the film and the amount of carbon black included. A film with thickness of 0.05 mm transmits about 40 percent of the radiant energy at 15 μ, while a 0.2-mm film is only slightly transparent at 15 μ. Thicker

[1] Earle K. Plyler and Nicolo Acquista, J. Opt. Soc. Am. **48**, 668 (1958).

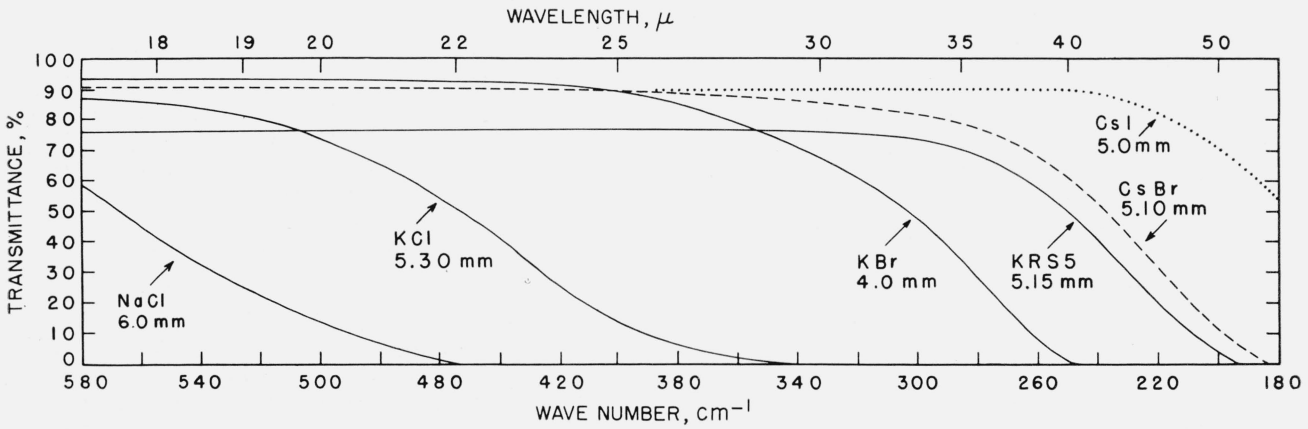

FIGURE 1. *The transmittance of several crystals in the infrared from 17 to 55 μ.*

No correction has been made for reflection losses.

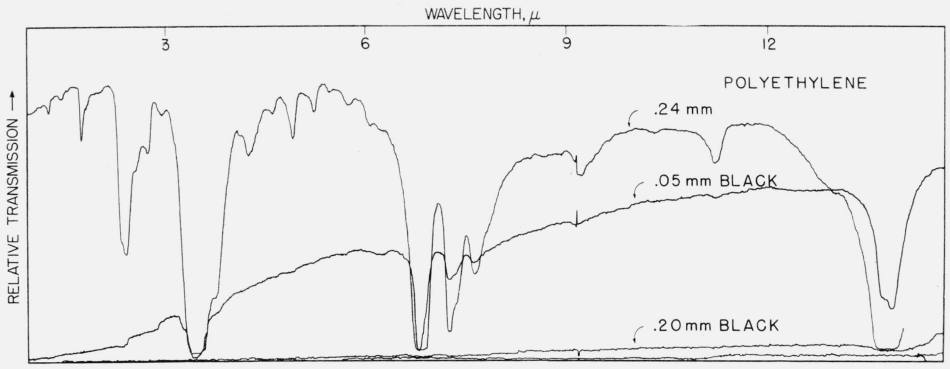

FIGURE 2. *The transmittances of clear polyethylene and polyethylene containing carbon black from 2 to 15 μ.*

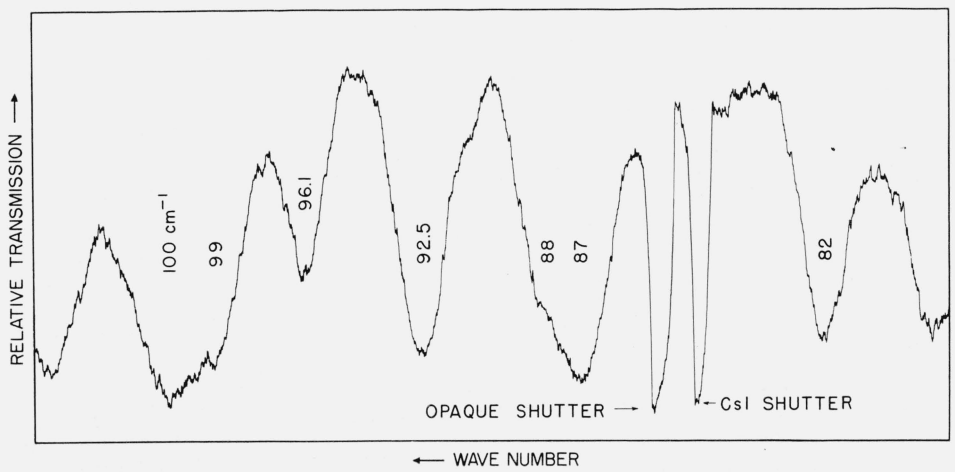

FIGURE 3. *The absorption spectrum of water vapor from 80 to 100 cm⁻¹.*

The amount of stray radiation is shown by a comparison of the two deflections for the interposed shutters.

films remain practically opaque to 30 μ, while they have a transmittance of about 80 percent at 100 μ. Polyethylene containing 2 to 4 percent carbon black is manufactured by the Bakelite Corporation.

Polyethylene films containing carbon black have been found to be efficient for removing the short wavelength radiation and their use has been tested by measuring spectra in the region from 80 to 110 cm^{-1} with a far infrared spectrometer developed at the Bureau.[2] Figure 3 shows a section of the water vapor rotational absorption spectrum which has been recorded with a film of polyethylene placed in front of the entrance slit of the spectrometer. Between the recording of the rotational lines at 82 and 87 cm^{-1}, an opaque shutter was placed in the beam of radiation and the zero deflection was obtained. Then the opaque shutter was removed and a window of CsI was placed in the beam which produces a second zero deflection. The readings of the zero points of the two shutters agreed closely, and the stray radiation in this part of the infrared spectrum has been determined to be less than 2 percent. Without the use of the polyethylene film the stray radiation was about 25 percent. This shows that the polyethylene black is an efficient transmission filter for eliminating all radiation except in the far infrared.

[2] Earle K. Plyler and L. R. Blaine, J. Research NBS **60,** 55 (1958) RP2821.

WASHINGTON, D.C. (Paper 64C1–24)