KBr Beamsplitter Coatings

The transmission range of single crystal potassium bromide (KBr) has defined the normal spectral range specification for mid-infrared instruments going back to the early days of analytical infrared spectroscopy where KBr prisms were used to disperse the beam. Today most infrared spectrometers use the Fourier Transform technique with an interferometer to modulate the infrared beam. These interferometers require a beamsplitter, a thin film coating on a substrate to produce the interfering beams. KBr is the most common substrate material.

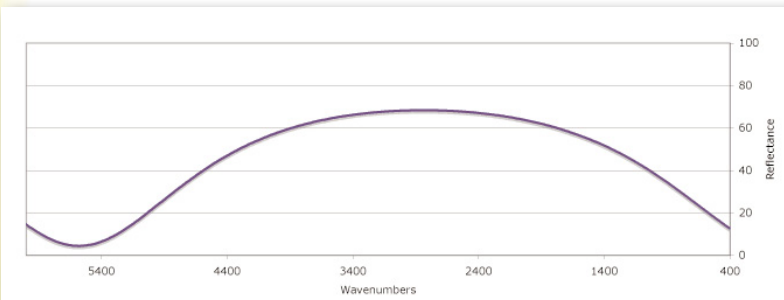

Figure 1: Single layer KBr beamsplitter

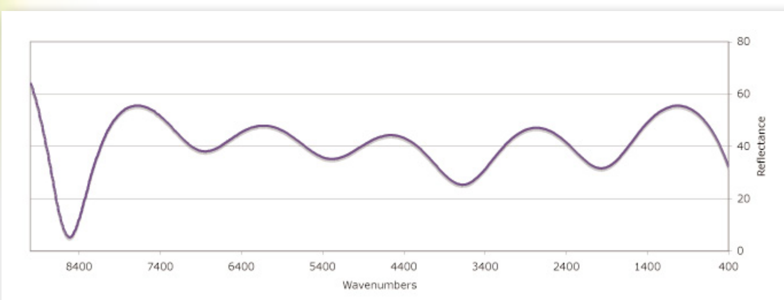

Figure 2: Multilayer KBr beamsplitter design for best spectral range

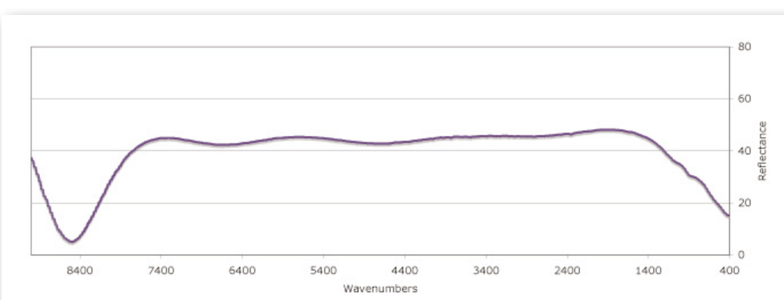

Figure 3: Multilayer KBr beamsplitter design for flat spectral response

To make a useful beamsplitter the KBr substrate must be polished flat to within a very small fraction of a wavelength of the minimum infrared wavelength to be measured. Then the desired 50% - 50% splitting of the beam is done by coating the KBr with a thin film of Ge which transmits well through the range of the spectrometer and has the high refractive index necessary to provide high reflection.

The resultant reflectivity is shown in Figure 1. The efficiency of the beamsplitter is determined by the reflection multiplied by the transmission (R*T), so the beamsplitter has 100% efficiency at 2 points in the spectrum and good response through the range of 400 to 5000 cm^{-1}. The periodicity in the response curve is just the interference in the single Ge layer.

It is desirable to extend the useful range into the near infrared while preserving the efficiency at the low wavenumber end of the KBr range where some important analytical bands are found. To accomplish this multiple layer coatings have been developed. By adding more layers the total optical thickness of the beamsplitter film is increased and, since the periodicity of the beamsplitter response is inversely proportional to the total optical thickness, many more periods appear in the response curve. This is shown in Figure 2. Since the response curve will shift slightly in wavelength with temperature, beam angle, beam vignette or changes in the sample geometry the instrument may exhibit instability. This instability increases at shorter wavelengths (increased wavenumbers).

Often it is more desirable to sacrifice a little performance at the extremes of the range and design the multilayer beamsplitter for a maximally flat response. A typical maximally flat KBr beamsplitter is shown in Figure 3. This beamsplitter then can significantly reduce instrument instabilities caused by ripple in the response curve. As a result these maximally flat coatings have become the most popular.

Additional Coatings

KBr beamsplitters and compensators may also be coated with a protective coating which gives some protection from water vapor.

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