

# FTIR beamsplitter substrates

## APPLICATION AND PRINCIPLE OF OPERATION

Beamsplitter/compensator set is used in Michelson interferometer scheme in Fourier transform infrared (FTIR) spectrometers.

FTIR spectrometer is generally based on Michelson interferometer where one of the mirrors is movable. Two mirrors are located at both arms of interferometer and oriented perpendicularly to each other. Beamsplitter is placed at the vertex of the right angle and oriented at a 45° angle relative to each mirror. Light passing to the beamsplitter is divided into two parts (50%/50% ideally) those propagate further to the both arms and are reflected off the mirrors. The beam which is one time reflected from the beamsplitter (upper beam on the drawing) must also pass there and back through an inclined compensator plate to compensate for the fact that the other beam passes through the beamsplitter plate three times instead of one. The movable mirror is scanned over some distance that produces an interference pattern of the two beams reaching the detector. Fourier transform of the signal encodes the spectrum of a source (investigated material).

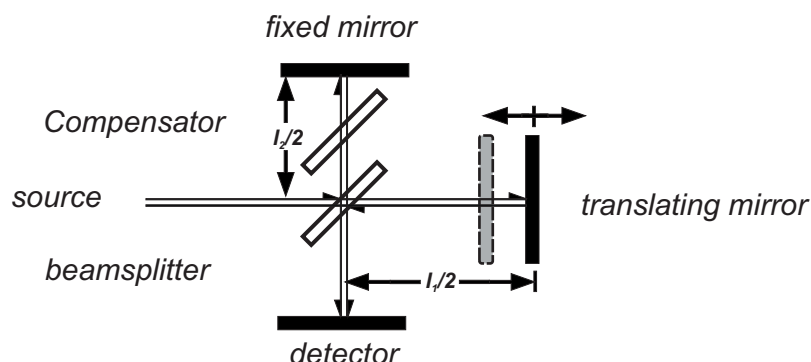


Figure 1. Michelson interferometer as a part of FTIR spectrometer.

## MATERIALS AND SPECTRAL RANGE

The wavelength range from visible to Far IR can be covered by choosing the appropriate material of beamsplitter and compensator.

The material choice includes the following materials: fused silica (quartz) (Visible/Near-IR), CaF<sub>2</sub>, BaF<sub>2</sub>, and ZnSe (Near-IR/Mid-IR).

High Resistivity FZ-Silicon could also be recommended for beamsplitters in Far IR region. Due to Fresnel reflection it can be used for ~50%/50% beam splitting in very wide wavelength range without any coating.



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Visible-IR fused silica	0.4-1.1 $\mu\text{m}$ (25,000-9,000 $\text{cm}^{-1}$ ) or 0.65-3.0 $\mu\text{m}$ (15,000-3,300 $\text{cm}^{-1}$ )
CaF2	0.65-8.5 $\mu\text{m}$ (15,000-1,200 $\text{cm}^{-1}$ )
BaF2	0.65-12 $\mu\text{m}$ (15,000-850 $\text{cm}^{-1}$ )
ZnSe	2-20 $\mu\text{m}$ (5,000-500 $\text{cm}^{-1}$ )
HR FZ-Si	50-1000 $\mu\text{m}$ (200-10 $\text{cm}^{-1}$ )

Table 1. Typical operational wavelength ranges for beamsplitter vs material.

### SPECIFICATION AND TOLERANCES

In order to achieve the high resolution of the FTIR spectrometer the beamsplitter/compensator pairs should be produced with very high degree of accuracy. Particularly surface flatness, wedge tolerance, thickness matching are together of great importance.

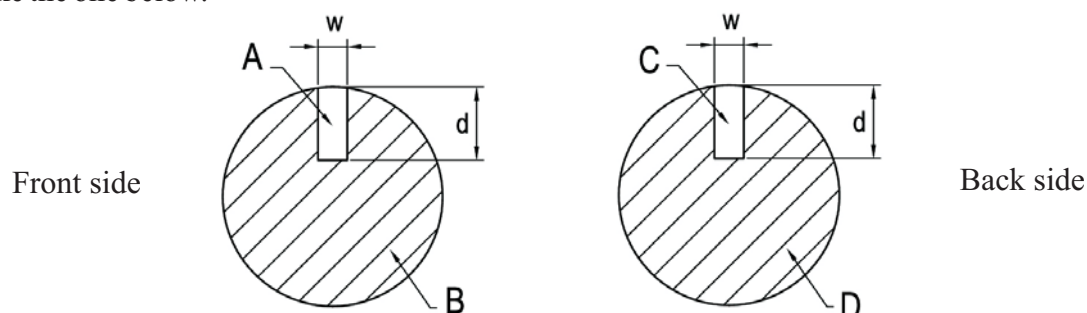
Diameter, mm	to 100
Surface flatness, $\lambda$ at 633 nm	to 1/10
Wedge tolerance, arc sec	to +/-10
Thickness matching, $\mu\text{m}$	to 1

Table 2. Achievable specification.

N.B. The best possible specification depends on material and parameters combination.

### COATINGS

For the alignment purposes the combined pattern of the coatings can be applied on the surfaces of FTIR beamsplitter/compensator. The “windows” for visible beam-visible regions of a special shape depending on dimensional design of interferometer are placed together with IR-regions. Typical coating pattern looks like the one below.



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Part	Region	Coating type	Reflection/Transmission
Beamsplitter	A	Partial reflecting	R/T=50%/50% @ 633 nm
	B	Partial reflecting	R/T=(50/50+/-10)% @ 7-14 μm or R/T=(50/50+/-20)% @ 2.5-14 μm
	C	AR	R<0.5% @ 633 nm
	D	BBAR	R <sub>ave</sub> <4% @ 7-14 μm or R <sub>ave</sub> <5% @ 2.5-14 μm
Compensator	A	AR	R<0.5% @ 633 nm
	B	BBAR	R <sub>ave</sub> <4% @ 7-14 μm or R <sub>ave</sub> <5% @ 2.5-14 μm
	C	AR	R<0.5% @ 633 nm
	D	BBAR	R <sub>ave</sub> <4% @ 7-14 μm or R <sub>ave</sub> <5% @ 2.5-14 μm

Figure 2 and Table 3. Coating pattern of ZnSe beamsplitter/compensator pair (example).

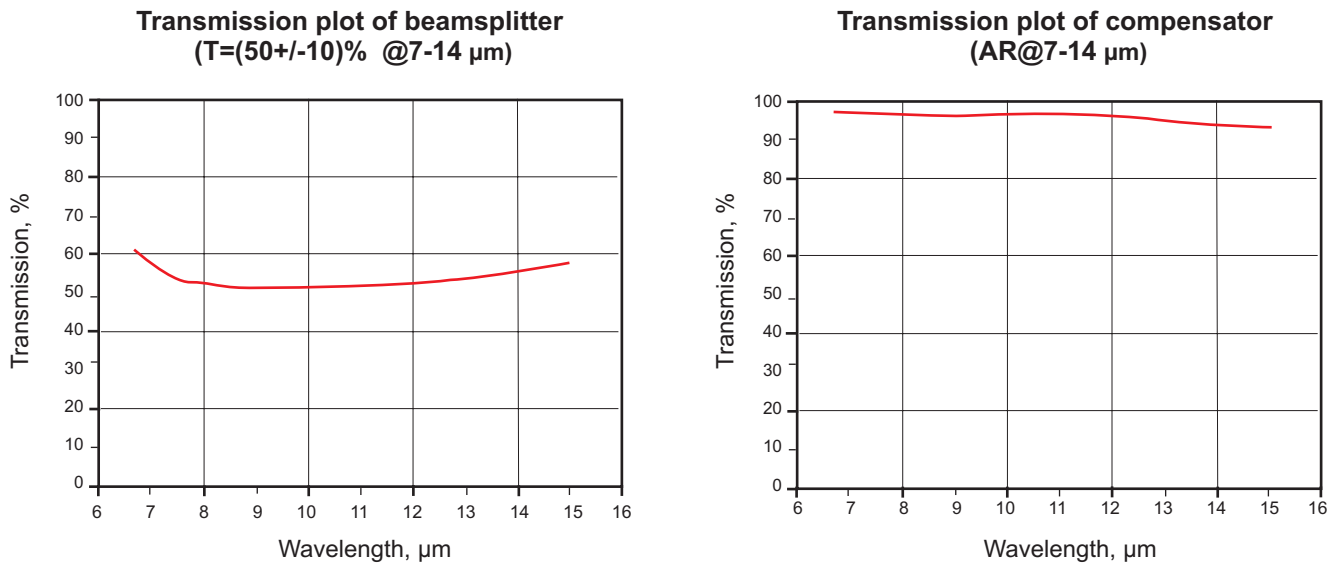


Figure 3. Typical transmission curves for ZnSe beamsplitter/compensator pair.

Other coating patterns and coating types are available upon request.

Tydex has long-time experience of supplying the beamsplitter/compensator pairs (substrates without coatings and coated finished parts) for FTIR spectroscopy to the customers in Europe, USA, and Far East.



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