NASA TECH BRIEF

High Efficiency Optical Beamsplitter Designed for Operation in the Infrared Region

Optical beamsplitters used in infrared spectrometers have been seriously limited by high absorption losses caused by the use of transparent thin metal films, and by a restricted spectral wavelength range and low efficiency due to the complexity of the multilayer thin-film design.

A three-phase program was undertaken to design, fabricate and test a high efficiency beamsplitter assembly which could operate in the infrared wavelength region between 5 and 30 microns.

Phase I was concerned with the selection of suitable substrate and coating materials for use as components of the beamsplitter system. The optical and mechanical properties of five substrates were studied: potassium bromide (KBr), cesium iodide (CsI), thallium bromide (TlBr), calcium fluoride (CaF_2) and zinc selenide (ZnSe). Material homogeneity and optical transmission measurements were made and surface flatness tests were performed before and after temperature cycling.

After intensive investigation of each material, all but KBr and CaF_2 were eliminated as potential infrared beamsplitter substrates suitable for vacuum coating and capable of maintaining performance after sustaining severe mechanical stress. KBr was found to satisfy the requirement for a substrate material capable of operating throughout the spectral region between 5 and 30 microns; CaF_2 proved suitable for narrowband applications. Potential beamsplitter film designs were computed and curves predicting optical performance in the 5 to 30 micron range were obtained. A 13-layer film which yielded nearly equal broadband infrared reflectance and transmittance (and satisfied the mechanical requirements) was selected as the prototype beamsplitter for fabrication.

The fabrication of the prototype beamsplitter and compensating element was accomplished in Phase II. After fabrication, each element was tested for optical performance and mechanical stability.

The design, fabrication, and testing of prototype and production beamsplitter mounts were completed in Phase III. Mounted beamsplitters were tested in severe environmental conditions to determine their mechanical characteristics. The performance of the beamsplitter during humidity tests indicated it could survive a 70% relative humidity for 24 hours at 30°C.

Notes:

1. High efficiency and equal reflectance and transmittance properties between 5 and 30 microns make the beamsplitter particularly attractive for use in prism and grating infrared spectrometers.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland 20771
   Reference: TSP70-10211

Patent status:

No patent action is contemplated by NASA.

Source: P. L. Heinrich and R. C. Bastien of Perkin Elmer Corp. under contract to Goddard Space Flight Center (GSC-10721)

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