The attenuation on the path of interest is then computed by integrating the specific attenuation over the length of the path. This method can be used to determine statistics of signal degradation on Earth/spacecraft communication links. It can also be used to obtain real-time estimates of attenuation along multiple Earth/spacecraft links that are parts of a communication network operating within the radar coverage area, thereby enabling better management of the network through appropriate dynamic routing along the best combination of links.

This work was done by Steven M. Bolen and Andrew L. Benjamin of **Johnson Space Center** *and V. Chandrasekar of Colorado State University. Further information is contained in a TSP (see page 1).*
MSC-23340

Wedge Heat-Flux Indicators for Flash Thermography

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Wedge indicators have been proposed for measuring thermal radiation that impinges on specimens illuminated by flash lamps for thermographic inspection. Heat fluxes measured by use of these indicators would be used, along with known thermal, radiative, and geometric properties of the specimens, to estimate peak flash temperatures on the specimen surfaces. These indicators would be inexpensive alternatives to high-speed infrared pyrometers, which would otherwise be needed for measuring peak flash surface temperatures. The wedge is made from any suitable homogenous material such as plastic. The choice of material is governed by the equation given below. One side of the wedge is covered by a temperature sensitive compound that decomposes irreversibly when its temperature exceeds a rated temperature (T_{rated}). The uncoated side would be positioned alongside or in place of the specimen and exposed to the flash, then the wedge thickness (d) at the boundary between the white and blackened portions measured. The heat flux (Q) would then be estimated by

$$Q = (c\rho/\varepsilon_{\mathrm{b}})(T_{\mathrm{rated}} - T_{\mathrm{ambient}})\,d,$$

where c and ρ are the specific heat and mass density, respectively, of the wedge material; ε_{b} is the emissivity of the black layer of the sheet material, and T_{ambient} is the ambient temperature.

This work was done by Ajay M. Koshti of Boeing Co. for **Johnson Space Center**. *Further information is contained in a TSP (see page 1). MSC-23056*

Measuring Diffusion of Liquids by Common-Path Interferometry

Diffusivities are computed from time series of interferograms.

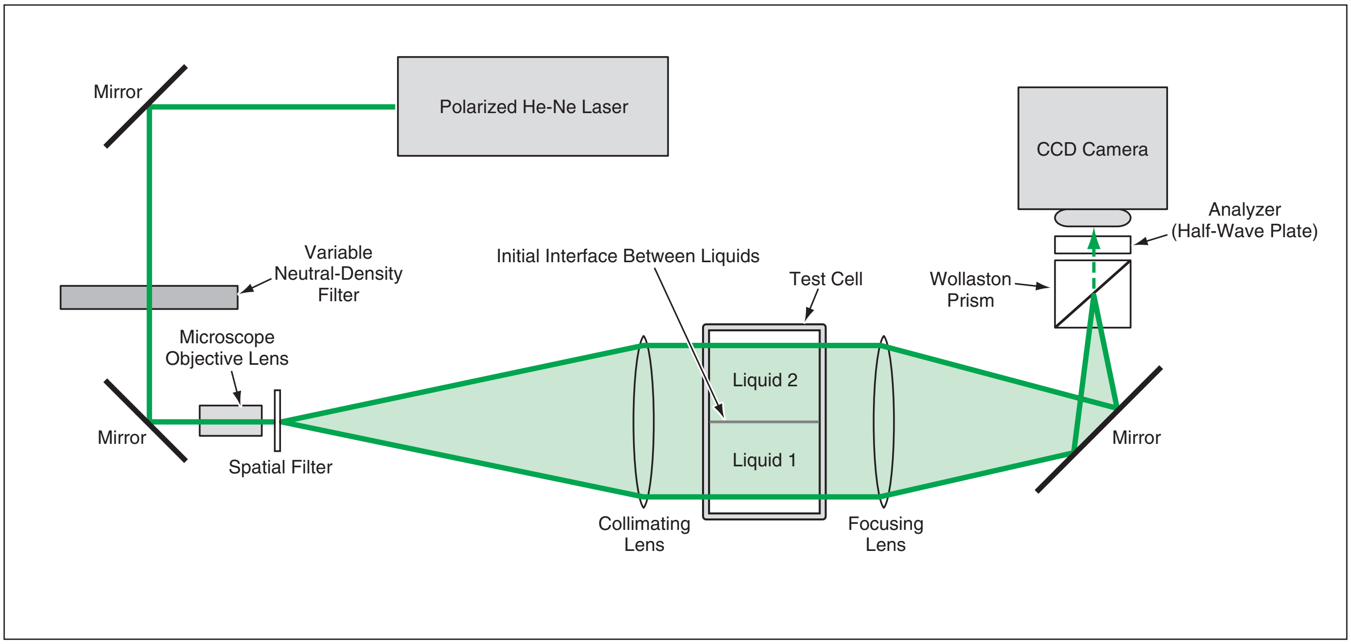
John H. Glenn Research Center, Cleveland, Ohio

A method of observing the interdiffusion of a pair of miscible liquids is based on the use of a common-path interferometer (CPI) to measure the spatially varying gradient of the index refraction in the interfacial region in which the interdiffusion takes place. Assuming that the indices of refraction of the two liquids are different and that the gradient of the index of refraction of the liquid is proportional to the gradient in the relative concentrations of either liquid, the diffusivity of the pair of liquids can be calculated from the temporal variation of the spatial variation of the index of refraction. This method yields robust measurements and does not require precise knowledge of the indices of refraction of the pure liquids. Moreover, the CPI instrumentation is compact and is optomechanically robust by virtue of its common-path design.

The two liquids are placed in a transparent rectangular parallelepiped test cell. Initially, the interface between the liquids is a horizontal plane, above which lies pure liquid 2 (the less-dense liquid) and below which lies pure liquid 1 (the denser liquid). The subsequent interdiffusion of the liquids gives rise to a gradient of concentration and a corresponding gradient of the index of refraction in a mixing layer. For the purpose of observing the interdiffusion, the test cell is placed in the test section of the CPI, in which a collimated, polarized beam of light from a low-power laser is projected horizontally through a region that contains the mixing layer.

The CPI used in this method is a shearing interferometer. Like other shearing interferometers, this CPI can also be characterized as a schlieren interferometer because its optical setup is partly similar to that of schlieren system. However, the basic principle of operation of this CPI applies to the case in which refraction is relatively weak so that unlike in a schlieren system, rays of light propagating through the test cell can be assumed not to be bent, but, rather, delayed (and correspondingly changed in phase) by amounts proportional to the indices of refraction along their paths. After passing through the test cell, the beam is focused on a Wollaston prism, which splits the beam into two beams that are slightly displaced from each other. When the beams are recombined, they produce interference fringes that indicate gradients of refraction in the test cell. A charge-coupled-device (CCD) camera captures the interferograms, and a video recorder stores them for later analysis.

The interferometer optics are arranged for operation in a mode, known in the art as the finite-fringe mode, in which equidistant, parallel interference fringes appear when the index of refraction in the test cell is uniform (as is the case when only one fluid is present). When a second liquid is introduced and diffusion occurs, the deviation or shift of a fringe from its undisturbed location is a measure of the gradient of the index of refraction in the test cell. For the purpose of this method, it is assumed that the index of



A **Common-Path Interferometer** projects a polarized, collimated horizontal light beam through a test cell that contains two pure liquids and a mixing layer between them.

refraction is horizontally uniform and varies only as a function of height above or below the initial interfacial plane.

An important element of the present method is rotation of the Wollaston prism around its optical axis by a small amount chosen so that the interference fringes form at a slight angle with respect to the initial interface between the liquids. The advantage of this angle is not intuitively obvious, and can be understood only in terms of the applicable equations. In summary, what the equations show is that proper choice of the angle results in magnification of the visual effect of the gradient of concentration in the mixing zone. Without the proper choice of the angle, the interference-fringe image cannot be interpreted simply or used to obtain the diffusivity of the fluids.

This work was done by Nasser Rashidnia of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17375.

Zero-Shear, Low-Disturbance Optical Delay Line

The only optical components would be two flat mirrors.

NASA's Jet Propulsion Laboratory, Pasadena, California

A design concept has been proposed for an optomechanical apparatus that would implement a variable optical delay line with a fixed angle between its input and output light beams. The apparatus would satisfy requirements that emphasize performance in interferometric applications: to contain a minimum number of optical surfaces, each used at low angle-of-incidence, and to be nominally free of shear (transverse motion of the beam) on any optical element. As an additional advantage, the apparatus would afford partial compensation of vibration disturbances associated with adjustment of the optical delay by both reducing the amount of motion required to achieve a desired optical delay and by splitting the total motion between two assemblies. As compared to prior art implementations of delay lines, the only disadvantage of the concept is that the motions of the optical elements must be well coordinated through mechanical linkages or electronic controls.

The figure depicts a typical configuration of the apparatus. The optical elements would be two flat mirrors — M1 and M2 — mounted on linear actuators. The actuation axes of M1 and M2 would be parallel to the incoming and outgoing light beams, respectively. M1 would be mounted on its actuator at a fixed angle required to aim the beam reflected from it to the center of M2. In turn, M2 would be mounted on its actuator at a fixed angle required to aim the outgoing beam in the desired direction. Moreover, the angles of M1 and M2 would be chosen so that the angle between M1 and the incoming beam equals the angle between M2 and the outgoing beam.

All of the properties of this apparatus that make it preferable to prior variable optical delay lines depend on making M1 and M2 move by equal and opposite amounts to vary the length of the optical path: In shortening (or lengthening) the optical path, one must move M1 a required distance along the input beam path toward (or away from) M2 while moving M2 along the same distance along the output-beam path toward (or away from) M1. It is noted that the path length change introduced by the linear