

Several Photodetectors Covered by Filters measure incident light in several wavelength bands. In this example, there are three broad wavelength bands corresponding approximately to the primary additive colors.

The photodetector array need not be of any particular design: it could be something as simple as an assembly containing several photodiodes or something as elaborate as an active-pixel sensor or other imaging device. What is essential is that each of the photodetectors or each of several groups of photodetectors is covered with a metal/dielectric-film filter of a different color. In most applications, it would be desirable to have at least three different filters, each for a spectral band that contains one of the three primary additive red, green, and blue colors. In some applications, it may be necessary to have more than three different color filters in order to characterize subtle differences in color (or in the sensation of color) that cannot be characterized with sufficient precision by use of the primary colors alone.

This work was done by Yu Wang of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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Refer to NPO-30858, volume and number of this NASA Tech Briefs issue, and the page number.

Calculating Mass Diffusion in High-Pressure Binary Fluids

This model could contribute to understanding of high-pressure combustion.

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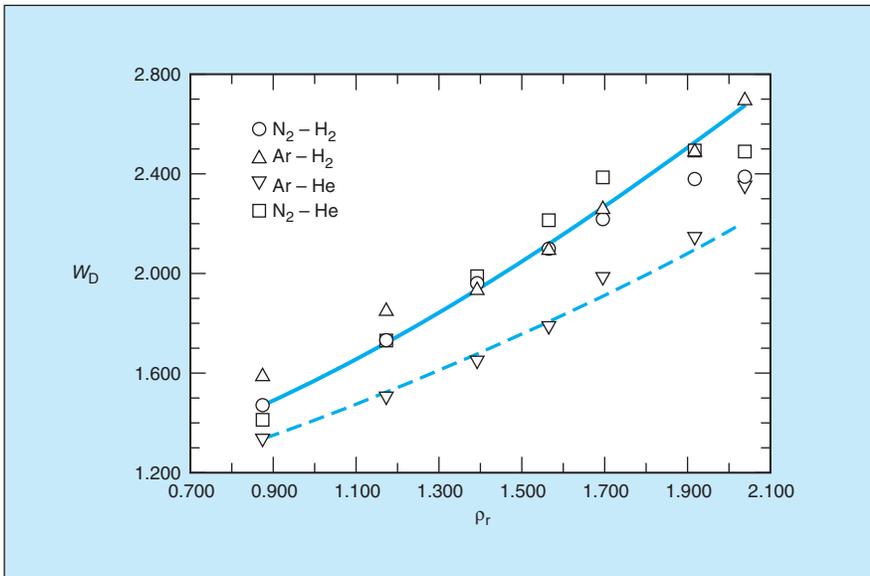
A comprehensive mathematical model of mass diffusion has been developed for binary fluids at high pressures, including critical and supercritical pressures. Heretofore, diverse expressions, valid for limited parameter ranges, have been used to correlate high-pressure binary mass-diffusion-coefficient data. This model will likely be especially useful in the computational simulation and analysis of combustion phenomena in diesel engines, gas turbines, and liquid rocket engines, wherein mass diffusion at high pressure plays a major role.

The model recasts the kinetic theory (i.e. low-pressure) expressions into forms consistent with the principle of corresponding states. Also presented are corresponding states forms for the Stokes-Einstein hydrodynamic model for diffusion in liquids, which are used for purposes of comparison. By ansatz, the model includes an expression that reflects departures from the kinetic-theory diffusion-coefficient relationship by means of a division factor that is partly a function of the reduced species density, becomes unity in the limit of low-

pressure gases, and includes parameters to be determined empirically for higher pressures. The final model equation is

$$D_{ij}^0 = (D_{ij})_{KT} / w_{D,j}$$

where D_{ij}^0 is the high-pressure infinite dilution diffusivity of species i in j , $(D_{ij})_{KT}$ is the binary diffusivity calculated according to kinetic theory, and $w_{D,j} = 1 + \delta_{D,j}$ is the division factor. As the reduced density of species j approaches zero, so does $\delta_{D,j}$. Empirical parameters have been determined



The Division Factor (w_D) was calculated as a function of reduced density (ρ_r) for several binary fluid mixtures. The curves were calculated by use of $\delta_D = c\rho_r^{3/2}$, where $c = 0.42$ and $c = 0.58$.

and the model evaluated by means of correlations with experimental data from the literature (see figure). Typical uncertainties in the correlations have been estimated to lie between 10 and 15 percent and to reach a maximum of about 30 percent at high density.

Simulations of heptane drops in nitrogen under zero gravity and at high pressure were performed using the model in order to investigate the sensitivities of predicted drop diameters to uncertainties in diffusivity values. The results of the simulations showed that the root-mean-square deviations of relative drop diameters were approximately one-fourth of the corresponding imposed relative changes in diffusivities.

This work was done by Josette Bellan and Kenneth Harstad of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30409

Fresnel Lenses for Wide-Aperture Optical Receivers

These would be relatively inexpensive, lightweight alternatives to conventional telescope lenses.

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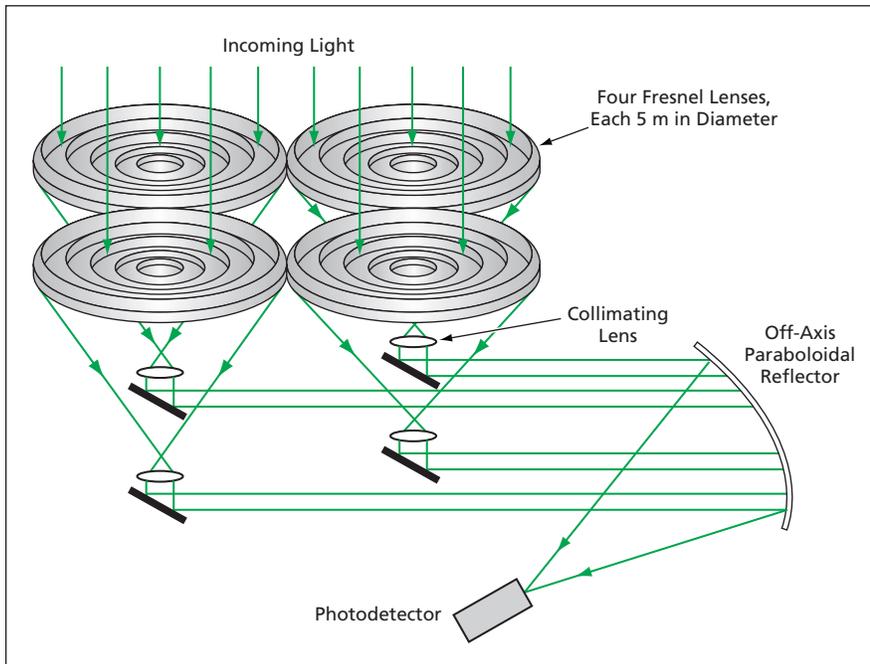
Wide-aperture receivers for free-space optical communication systems would utilize Fresnel lenses instead of conventional telescope lenses, according to a proposal. Fresnel lenses weigh and cost much less than conventional

lenses having equal aperture widths. Plastic Fresnel lenses are commercially available in diameters up to 5 m — large enough to satisfy requirements for aperture widths of the order of meters for collecting sufficient light in typ-

ical long-distance free-space optical communication systems.

Fresnel lenses are not yet suitable for high-quality diffraction-limited imaging, especially in polychromatic light. However, optical communication systems utilize monochromatic light, and there is no requirement for high-quality imaging; instead, the basic requirement for an optical receiver is to collect the incoming monochromatic light over a wide aperture and concentrate the light onto a photodetector.

Because of lens aberrations and diffraction, the light passing through any lens is focused to a blur circle rather than to a point. Calculations for some representative cases of wide-aperture non-diffraction-limited Fresnel lenses have shown that it should be possible to attain blur-circle diameters of less than 2 mm. Preferably, the blur-circle diameter should match the width of the photodetector. For most high-bandwidth communication applications, the required photodetector diameters would be about 1 mm. In a less-preferable case in which the blur circle was wider than a single photodetector, it would be possible to occupy the blur circle with an array of photodetectors.



Incoming Light Would Be Collected by four Fresnel lenses, then the light would be collimated and concentrated onto a single photodetector.