The concentration of glucose is obtained through a combination of interferometry and polarimetry.

An optoelectronic apparatus has been invented as a noninvasive means of measuring the concentration of glucose in the human body. The apparatus performs polarimetric and interferometric measurements of the human eye to acquire data from which the concentration of glucose in the aqueous humor can be computed. Because of the importance of the concentration of glucose in human health, there could be a large potential market for instruments based on this apparatus.

The apparatus (see figure) includes a light source equipped with a linear polarizer and a quarter-wave retarder to generate a beam of circularly polarized light. The beam is aimed at an eye at an angle of incidence $\theta$ chosen so that after refraction at the surface of the cornea, it travels through the aqueous humor and impinges on the crystalline lens at the Brewster angle $\theta_B = \arctan(n_l/n_h)$, where $n_l$ and $n_h$ are the indices of refraction of the lens and the aqueous humor, respectively. The portion of the beam that enters and passes through the eye is denoted the probe beam. The portion of the beam reflected from the cornea is further reflected by a mirror and used as a reference beam for low-coherence interferometry.

The Brewster-angle arrangement causes the portion of the probe beam reflected from the lens to be linearly polarized perpendicular to the plane of incidence (which here coincides with the plane of the page). As the reflected probe beam traverses the aqueous humor, glucose molecules rotate its plane of polarization. This rotational effect is well established: It is characterized by previously determined, wavelength-dependent proportionality between (1) the angle of rotation of the plane of polarization and (2) the product of the concentration of glucose and the length of the optical path through the solution (in this case, aqueous humor) that contains the glucose. Hence, if one can measure the rotation of polarization of the reflected light and the length of its path through the aqueous humor, one can calculate the concentration of glucose by use of the aforementioned proportionality.

After leaving the eye, the reflected probe beam enters beam splitter 1. Part of the probe beam passes through beam splitter 1 and goes to a polarimetric sensor, which
measures its angle of polarization. From this angle and the known orientation of the plane of incidence on the lens, the rotation angle can be determined. Part of the probe beam leaving the eye is reflected from beam splitter 1 toward beam splitter 2, wherein it is combined with the reference beam. The combination of the probe reference beams impinges on a photodetector for use in low-coherence interferometry to measure the total length of the path of the probe beam through the aqueous humor. By virtue of symmetry, half of this path length contributes to the measured rotation and is, therefore, the length to use in calculating the concentration of glucose.

As described thus far, the principle of operation does not necessarily involve the use of multiple wavelengths. The value of multiwavelength operation lies in the possibility of compensating for rotation caused by analytes other than glucose. By measuring at a number of wavelengths equal to the number of analytes (including glucose) that contribute to rotation and knowing the wavelength-dependent specific rotation, one can solve the system of linear equations for the rotation at the various wavelengths to extract the concentration of glucose (and, incidentally, of the other analytes).

This work was done by Rafat R. Ansari of Glenn Research Center and Luigi L. Rovati of the University of Brescia. 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-17216.

Floating Probe Assembly for Measuring Temperature of Water

Temperatures are measured at several depths.

A floating apparatus denoted a temperature probe aquatic suspension system (TPASS) has been developed for measuring the temperature of an ocean, lake, or other natural body of water at predetermined depths. These types of measurements are used in computer models to relate remotely sensed water-surface temperature to bulk-water temperature. Prior instruments built for the same purpose were found to give inaccurate readings because the apparatuses themselves significantly affected the temperatures of the water in their vicinities. The design of the TPASS is intended to satisfy a requirement to minimize the perturbation of the temperatures to be measured.

The TPASS (see figure) includes a square-cross-section aluminum rod 28 in. (≈71 cm) long with floats attached at both ends. Each float includes five polystyrene foam disks about 3/4 in. (≈1.9 cm) thick and

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