Physical Sciences

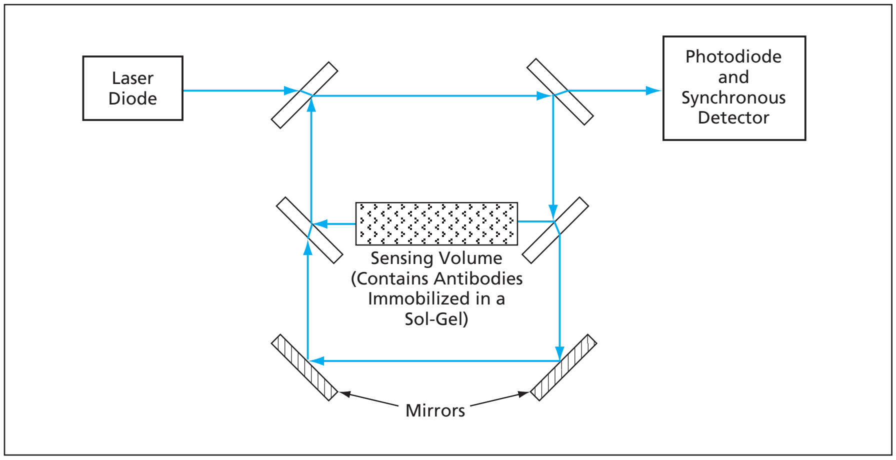
Ring-Resonator/Sol-Gel Interferometric Immunosensor

Light would make multiple passes through the sensing volume.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed biosensing system would be based on a combination of (1) a sensing volume containing antibodies immobilized in a sol-gel matrix and (2) an optical interferometer having a ring resonator configuration. The antibodies would be specific to an antigen species that one seeks to detect. The binding of the antigens to the immobilized antibodies would change the index of refraction of the sensing volume, which would be mounted in one of the interferometer arms. The interferometer would measure the change in the index of refraction, thereby indirectly measuring the concentration of the antigen species of interest.

The basic principle of using interferometry to detect antibody-antigen binding is not new in itself. However, the prior implementation of this principle has involved the use of a Mach-Zehnder interferometer, which affords only a single pass of light through the sensing volume. In the ring resonator of the proposed system, light would make multiple passes through the sensing volume, affording greater interaction length and, hence, greater antibody-detection sensitivity.



A **Ring Resonator/Interferometer** would include a sensing volume on one of its optical paths. Binding of antigens to antibodies would cause a change in the index of refraction of the sensing volume leading to a change in the photodiode output.

In one proposed ring-resonator/interferometer configuration, there would be two interferometer arms with coupled optical paths. One of the optical paths would pass through the sensing volume; the other optical path would not pass through the sensing volume (see figure). Interference between light beams in the two interferometer arms would be characterized by a phase difference proportional to the change in the index of refraction of the sensing volume. The phase difference would result in a change in the interferometer output intensity measured by use of a photodiode. A synchronous detector could be used to increase sensitivity.

The ring resonator/interferometer could be built by use of traditional bulk optical components or fabricated as a unit by standard silicon-fabrication techniques. Inasmuch as a sol-gel precursor can be poured into a mold, an etched recess in a planar waveguide or other structures could be used as the sensing volume.

This work was done by Gregory Bearman and David Cohen of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL. Refer to NPO-30807.

Compact Fuel-Cell System Would Consume Neat Methanol

Size, mass, and parasitic power consumption would be reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a proposed direct methanol fuel-cell electric-power-generating system, the fuel cells would consume neat methanol, in contradistinction to the dilute aqueous methanol solutions consumed in prior direct methanol fuel-cell systems. The design concept of the proposed fuel-cell system takes advantage of (1) electro-osmotic drag and diffusion processes to manage the flows of hydrogen and water between the anode and the cathode and (2) evaporative cooling for regulating temperature. The design concept provides for supplying enough water to the anodes to enable the use of neat methanol while ensuring conservation of water for the whole fuel-cell system. By rendering unnecessary some of the auxiliary components and subsystems needed in other direct methanol fuel-cell systems for redistributing water, diluting methanol, and regulating temperature, this fuel-cell design would make it possible to construct a more compact, less massive, more energy-efficient fuel-cell system.

In a typical prior direct methanol fuel-cell system, neat methanol is stored in a