

## Semiselective Optoelectronic Sensors for Monitoring Microbes

These real-time sensors distinguish among classes (not individual species) of microbes.

Sensor systems are under development for use in real-time detection and quantitation of microbes in water without need for sampling. These systems include arrays of optical sensors; miniature, portable electronic data-acquisition circuits; and optoelectronic interfaces between the sensor arrays and data-acquisition circuits. These systems are intended for original use in long-term, in-line monitoring of waterborne micro-organisms in water-reclamation systems aboard future spacecraft. They could also be adapted to similar terrestrial uses with respect to municipal water supplies, stored drinking water, and swimming water; for detecting low-level biological contamination in biotechnological, semiconductor, and pharmaceutical process streams; and in verifying the safety of foods and beverages. In addition, they could be adapted to monitoring of airborne microbes and of surfaces (e.g., to detect and/or quantitate biofilms).

The designs of the sensors in these systems are based partly on those of sensors developed previously for monitoring airborne biological materials. The designs exploit molecular-recognition and fluorescence-spec-

troscopy techniques, such that in the presence of micro-organisms of interest, fluorescence signals change and the changes can be measured.

These systems are characterized as semiselective because they respond to classes of micro-organisms and can be used to discriminate among the classes. This semiselectivity is a major aspect of the design: It is important to distinguish between (1) the principle of detection and quantitation of classes of micro-organisms by use of these sensors and (2) the principle of detection and quantitation of individual microbiological species by means of prior immunodiagnostic and/or molecular-biology techniques. Detection of classes (in contradistinction to species) is particularly valuable when the exact nature of a contaminant is unknown.

Feasibility was demonstrated by fabricating sensor systems that were then demonstrated to be capable of detecting bacteria with rapid response and high sensitivity, to discriminate between gram positive and gram negative bacteria, and to detect fungi in water. In one of the experi-

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ments, a capability of real-time, cumulative response to bacteria in a flow system was demonstrated.

An important part of the development effort thus far has addressed the issue of designing and building sensors and sensing membranes for extended use in aqueous flow systems. Another major issue is that of calibration: A capability for calibration has been demonstrated. It has also been shown that calibration of sensors at low concentrations is a potential source of quantitation error, though not of detection error.

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*In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to*

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