Multisensor Instrument for Real-Time Biological Monitoring

Multiple parameters can be measured simultaneously by use of a single compact sensor head.

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The figure schematically depicts an instrumentation system, called a "fiber optic-based integration system" (FOBIS), that is undergoing development to enable real-time monitoring of fluid cell cultures, bioprocess flows, and the like. The FOBIS design combines a micro flow cytometer (MFC), a microphotometer (MP), and a fluorescence-spectrum- or binding-force-measuring micro-sensor (MS) in a single instrument that is capable of measuring multiple biological parameters simultaneously or sequentially. The fiber-optic-based integration system is so named because the MFC, the MP, and the MS are integrated into a single optical system that is coupled to light sources and photometric equipment via optical fibers. The optical coupling components also include a wavelength-division multiplexer and diffractive optical elements. The FOBIS includes a laser-diode- and fiber-optic-based optical trapping subsystem ("optical tweezers") with microphotometric and micro-sensing capabilities for noninvasive confinement and optical measurement of relevant parameters of a single cell or other particle.

Some of the measurement techniques implemented together by the FOBIS have long been used separately to obtain basic understanding of the optical properties of individual cells and other organisms, the optical properties of populations of organisms, and the interrelationships among these properties, physiology of the organisms, and physical processes that govern the media that surround the organisms. For example, flow cytometry yields information on numerical concentrations, cross-sectional areas, and types of cells or other particles. Micro-sensing can be used to measure pH and concentrations of oxygen, carbon dioxide, glucose, metabolites, calcium, and antigens in a cell-culture fluid, thereby providing feedback that can be helpful in improving control over a bioprocess. Microphotometry (including measurements of scattering and fluorescence) can yield further information about optically trapped individual particles.

In addition to the multifunctionality not previously available in a single biological monitoring system, the FOBIS offers advantages of low mass, sensitivity, accuracy, portability, low cost, compactness (the overall dimensions of the fully developed FOBIS sensor head are expected to be less than 1 by 1 by 2 cm), and immunity to electromagnetic interference at suboptical frequencies. FOBIS could be useful in a variety of laboratory and field settings in such diverse endeavors as medical, veterinary, and general biological research; medical and veterinary diagnosis monitoring of industrial bioprocesses; and analysis of biological contaminants in air, water, and food.

This work was done by Sean (Zhanxiang) Zhang, Guoda Xu, Wei Qiu, and Freddie Lin of Physical Optics Corp. for **Johnson Space Center**. *Further information is contained in a TSP (see page 1)*
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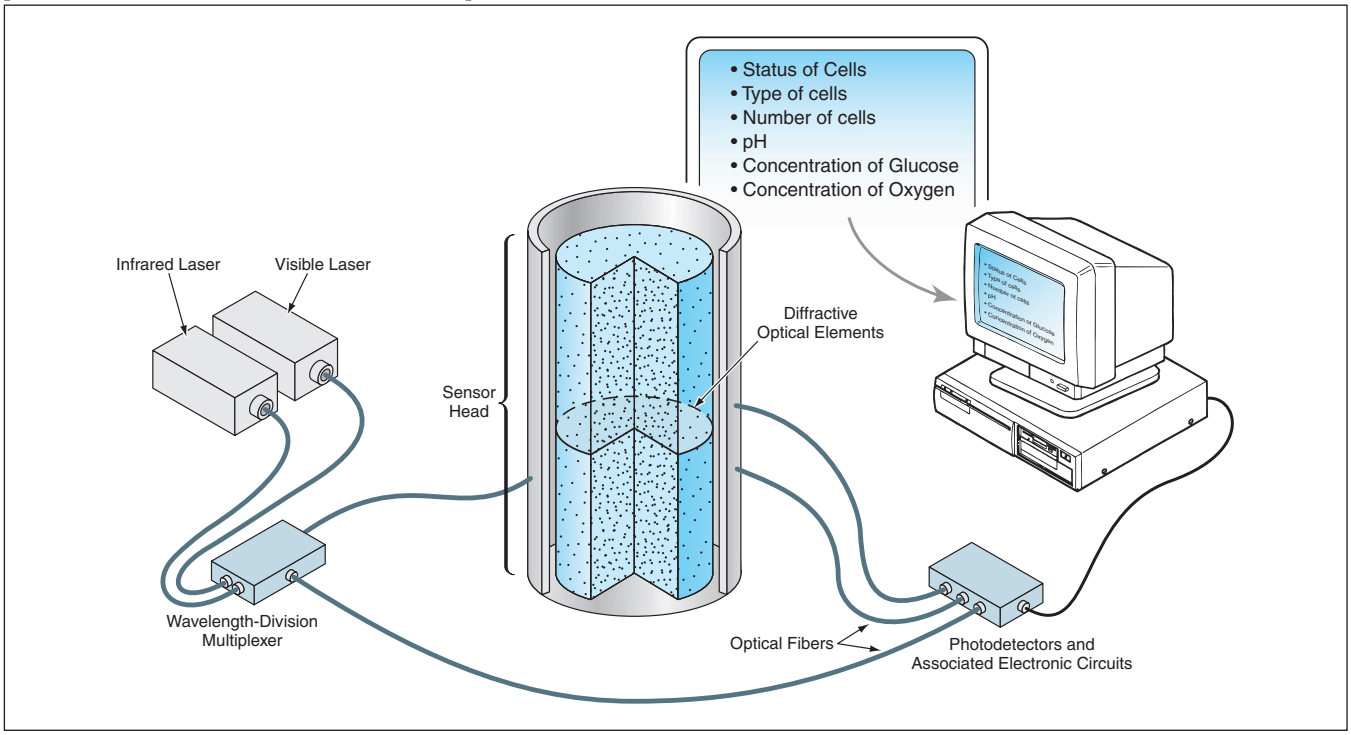

A **Compact Sensor Head** contains multiple optically coupled sensors that, together, yield a previously unavailable combination of real-time measurements of important parameters of cells, cell cultures, and cell-culture fluids.