Advanced Chlorophyll Fluorometer

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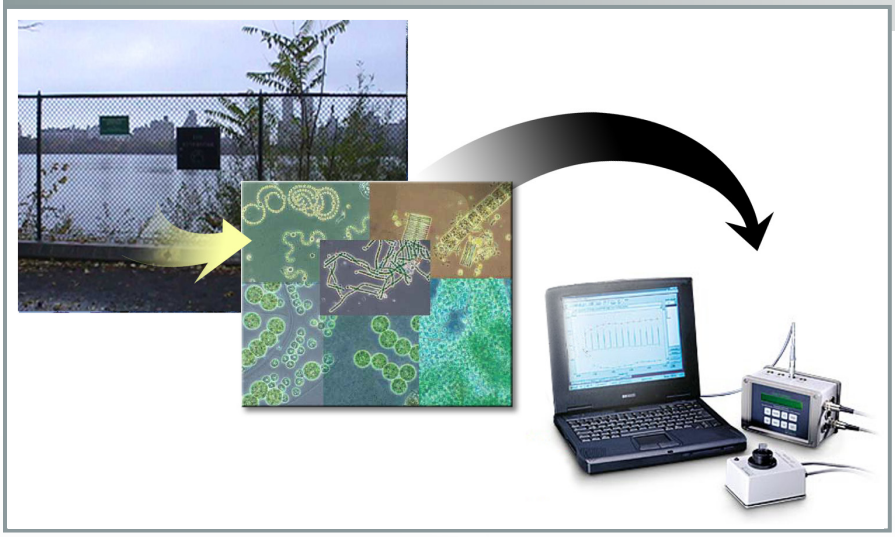

Technology Summary

To advance miniaturization of the AquaSentinel environmental monitoring technology, ORNL and the University of Tennessee researchers developed a microfluidics-based pulse amplitude modulation (PAM) chlorophyll fluorometer—the first of its kind.

Fluorometers have a wide range of applications in the life sciences, including medical, chemical, biological, and environmental, and have proven especially helpful in the analysis of organic compounds. Miniaturization broadens their appeal and flexibility by allowing integration with other laboratory-on-a-chip (LOAC) technologies for in situ measurements in real time. Currently, portable commercial fluorometers are used in the ORNL AquaSentinel water quality monitoring system. Because the fluorometer is one of the key components of the AquaSentinel system, it is not only advantageous to have it customized specifically for the AquaSentinel application, but also more secure than reliance on third-party vendors for a key component.

The main challenge for applying LOAC microfluidics technology to PAM chlorophyll fluorometry was the limited sample volume accommodated by microchannels on a chip. Smaller sample volumes typically mean a lower fluorescence signal. The ORNL team solved this problem with a combination of electrofocusing techniques and careful optical design, including positioning sensors close to the microfluidics channel.

The ORNL LOAC chlorophyll fluorometer incorporates two unique features. The first is use of a meandering microchannel, which allows a relatively large volume of sample to be processed at one time. A photodetector is then positioned so that its active (detection) area covers the entire meandering part of the microchannel. The second unique feature is location of microelectrodes in the channel to concentrate the analyte (in the case of AquaSentinel, microalgae) and thus increase the fluorescence signal.

While developed specifically for the AquaSentinel technology, ORNL's PAM chlorophyll fluorometer can be integrated with other LOAC technologies and used in a variety of microsensing applications, including detection of contaminants in the air.

Advantages

- Noninvasive, in vivo/in situ detection
- Simplicity; low power requirements and no moving parts
- Versatility
- Sensitivity (single cell level)
- Mobile, field-deployable, submersible
- Low cost

Potential Applications

- Early detection of primary source drinking water contamination
- Early detection of food contamination
- Climate change monitoring
- Field-sampling of water by military personnel
- Air quality monitoring
- Analysis of organic compounds
- Demonstration of environmental compliance

Patents

Elias Greenbaum and Jie Jayne Wu, *Pulse Amplitude Modulated Chlorophyll Fluorometer,* U.S. Patent Application 13/438,562, filed on April 3, 2012.

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