One sensor for multiple colors: Fluorescence analysis of microdroplets in microbiological screenings by frequency-division multiplexing.

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Abstract

High-speed multiwavelength fluorescence measurements are of paramount importance in microfluidic analytics. However, multicolor detection requires an intricate arrangement of multiple detectors and meticulously aligned filters and dichroic beamsplitters that counteract the simplicity, versatility, and low cost of microfluidic approaches. To break free from the restrictions of optical setup complexity, we introduce a simpler single-sensor setup based on laser-frequency modulation and frequency-division multiplexing (FDM). We modulate lasers to excite the sample with four non-overlapping frequency signals. A single photomultiplier tube detects all the modulated emitted light collected by an optical fiber in the microfluidic chip. Signal demodulation is performed with a lock-in amplifier separating the emitted light into four color channels in real time. This approach not only reduces complexity and provides setup flexibility but also results in improved signal quality and, thus, higher signal-to-noise ratios that translate into increased sensitivity. To validate the setup for high-throughput biological applications, we measured multiple

signals from different microorganisms and fluorescently encoded droplet populations for exploring beneficial or antagonistic roles in microbial cocultivation systems, as is the case for antibiotic screening assays.

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Topics

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