Integrated optofluidic devices for single molecule analysis

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LECTURE ABSTRACT

Lab-on-chip devices have long held the promise of providing a convenient and rapid way to analyze small amounts of biological samples. However, when pushed to the ultimate limit of single molecule sensitivity, the detection mechanism is often based on off-chip elements. I will discuss a chip-scale platform that offers both integrated optical and electrical single molecule analysis. Optical integration is achieved by using liquid-core waveguides interfaced with traditional photonic elements to implement advanced functionalities. Examples include multiplex detection of single viruses, simultaneous detection of proteins and nucleic acid biomarkers, and front-to-back sample handling and single DNA detection on a single chip. Electrical single molecule analysis is achieved by integration of solid-state nanopores. Novel nanopore detection capabilities such as feedback-controlled delivery of single molecules to a fluidic channel and trapping enhanced particle sensing are demonstrated. The combination of both optical and electrical detection modalities results in a novel, high throughput platform for single molecule analysis. Specifically, I will review ultrasensitive performance using the example of both fluorescence and label-free detection of SARS-CoV-2 from clinical nasal swab samples with single molecule sensitivity.In addition, I will discuss approaches geared at adapting this platform for point-of-care use, including novel signal analysis algorithms and implementation of real-time analysis of single-molecule fluorescence signals.

SPEAKER BIOSKETCH

Holger Schmidt received an M.S. degree in physics from the University of Stuttgart, Germany, in 1994, and M.S. and Ph.D. degrees in electrical and computer engineering from the University of California, Santa Barbara, in 1995 and 1999, respectively. After serving as a postdoctoral Fellow with the Massachusetts Institute of Technology, Cambridge, he joined the University of California, Santa Cruz, in 2001. He is a Professor of Electrical and Computer Engineering and holds the Narinder Singh Kapany Chair of Optoelectronics. He served as Associate Dean for Research for the School of Engineering and is Director of the W.M. Keck Center for Nanoscale Optofluidics. Prof. Schmidt has authored over 400 publications and several book chapters in various fields of optics and photonics. He also edited the first Handbook of Optofluidics published with CRC Press. His research interests include single molecule detection and analysis in optofluidic devices, hollow-core waveguide photonics, nanopore sensors, nano-magneto-optics, and spintronics. He received an NSF Career Award in 2002, a Keck Futures Nanotechnology Award in 2005, and the Engineering Achievement Award of the IEEE Photonics Society in 2019. He was elected Fellow of the Optical Society of America in 2014, Fellow of the IEEE in 2017, and Fellow of the National Academy of Inventors in 2019.