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Abstract: Optofluidic ring resonator technology platform for rapid and sensitive biological and chemical sensing

The optical ring resonator is an emerging sensing technology that has recently been under intensive investigation. In a ring resonator, light propagates in the form of whispering gallery modes (WGMs), which results in a light-analyte interaction length much longer than the resonator physical size. Consequently, the ring resonator can achieve a much improved detection limit, lower sample volume, and larger integration density than the traditional waveguide or optical fiber based sensor.

The optofluidic ring resonator (OFRR) is a unique technology platform developed in my lab in the past four years, which integrates microfluidics and photonics. The platform has a wide spectrum of applications, ranging from low-cost, portable, sensitive biomedical devices to highly sophisticated photonic instruments used in optical signal processing, nonlinear optics, and fundamental physics. In this talk, I will focus on three major biomedical applications of the OFRR:

1. OFRR label-free biosensors, including their working principles, performance advantages, and sensing examples (*e.g.*, detection of protein, DNA, viruses, and cells such as MCF7 breast cancer cells and CD4+). Actual clinical applications of the OFRR for development of a portable and rapid breast cancer serological biomarker analyzer will be presented. Its potential applications for high throughput proteomics will also be discussed;
2. OFRR based micro-gas chromatography for chemical vapor sensing and its potential biomedical applications as a portable and sensitive breath analyzer;
3. OFRR microfluidic lasers and their applications in development of novel molecular beacon with ultrahigh sensitivity and ultralow sample volume.

Dr. Fan obtained B.S. and M.S. in physics from Peking University in 1991 and 1994, respectively, and Ph.D. in physics and optics from Oregon Center for Optics at the University of Oregon in 2000. Between 2000 and 2004, he was a project leader at 3M Company on fiber optics and photonic sensing devices for biomedical applications. In August of 2004, he joined the Department of Biological Engineering at the University of Missouri as an assistant professor. In January of 2010, he joined the Biomedical Engineering Department at the University of Michigan as an associate professor.

Dr. Fan's research includes photonic bio/chemical sensors, micro/nano-fluidics, and nano-photonics for disease diagnostics and bio/chemical molecule analysis. He has over 50 peer-reviewed publications and over 10 issued/pending patents. Presently, Dr. Fan serves as an Associate Editor for Optics Express, responsible for optical biological and chemical sensors and optofluidics, and as a chair and organizer of numerous conferences for the International Society for Optical Engineers and Material Research Society. He is a recipient of 3M Non-Tenured Faculty Award (2004, 2005, and 2006), American Chemical Society Young Faculty Award, the Wallace H. Coulter Early Career Award (Phase I and Phase II), and the National Science Foundation CAREER Award. His research is supported by the National Science Foundation, National Institute of Health, private foundations, and industrial companies.