Biosensing platforms based on nano-functionalized optofluidic fibers

Georges Humbert

XLIM Research Institute, UMR 7252 CNRS University of Limoges, 123 av. A. Thomas, 87060, Limoges, France

E-mail: georges.humbert@xlim.fr

Oral contribution

Optofluidic fibers are micro-structured optical fibers composed of air-channels surrounding a solid-core or a hollow core. These fibers feature large channels that run along their entire length, allowing liquid infiltration and circulation, while the light is guided inside the fiber core. In solid-core optofluidic fibers, the light is guided in the core by total internal reflection, resulting in a broad transmission windows, and long length of light-analyte interaction through a small portion of the evanescent field extending into the channels.

Recent developments on optofluidic fibers have led to the realization of integrated all-fiber optofluidic platforms for sensing micro-fluids and detecting biomarkers [1]. Novel optofluidic fibers have also been fabricated and functionalized with gold nanoparticles, for developing Surface-Enhanced Raman Scattering (SERS) biosensing platforms with excellent sensitivity [2] and reliability [3] of the measurements, allowing the detection of cancer biomarkers in patient fluids [4-5]. Fluorescence based sensing with signal enhancement by one order of magnitude, have recently been demonstrated within an optofluidic fiber, enabling an efficient and sensitive immunodetection of proteins [6]. Nano-functionalization of the fibers was also realized for favoring plasmonic enhanced fluorescence with a significant improvement of the signal. Perspectives on novel optofluidic fiber designs and biosensing applications will be also presented.

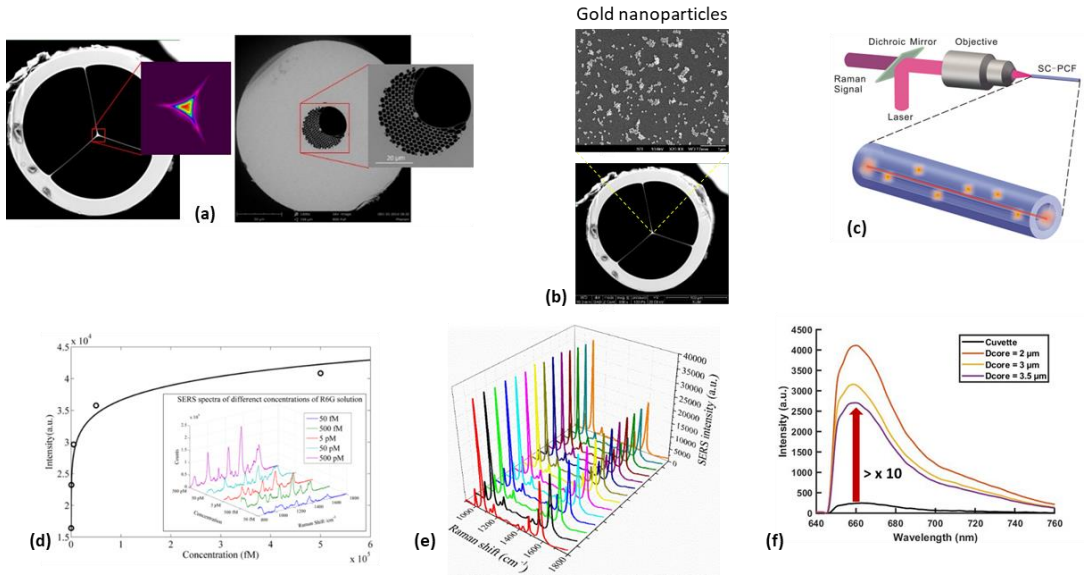

Fig. 1 (a) SEM pictures of optofluidic fiber cross sections. (b) SEM pictures of gold nanoparticles anchored on the inner surface of a channel of an optofluidic fiber, and of the fiber cross section. (c) Schematic illustration of the use of optofluidic fiber for SERS sensing. (d) Intensity of the SERS peak of R6G at different concentrations (inset: measured SERS spectra) injected within a nano-functionalized optofluidic fiber. (e) Reproducibility measurements of the SERS spectrum of 4-ATP molecules injected within a nano-functionalized optofluidic fiber. (f) Fluorescence measurements of Cy5 dyes injected within different optofluidic fibers or within a cuvette.

References

[1] N. Zhang, *et al.*, "Ultra-sensitive chemical and biological analysis via specialty fibers with built-in microstructured optofluidic channels", Lab Chip, 2018, 18, 655-661

[2] N. Zhang, *et al.*, "Side-channel photonic crystal fiber for surface enhanced Raman scattering sensing", Sensors and Actuators B: Chemical, Vol. 223, February 2016, Pages 195-201,

[3] F. Beffara, *et al.*, "Optimization and performance analysis of SERS-active suspended core photonic crystal fibers," Opt. Express 28, 23609-23619 (2020)

[4] F. Beffara, *et al.*, "Development of Highly Reliable and Sensitive SERS-active Photonic Crystal Fiber Probe, and its Application in the Detection of Ovarian Cancer Biomarker in Cyst Fluid" J Biophotonics. 2019 Dec 8:e201960120.

[5] T. Gong, *et al.*, "Highly sensitive SERS detection and quantification of sialic acid on single cell using photonic-crystal fiber with gold nanoparticles," Biosensors and Bioelectronics, 2015, 64, 227–233.

[6] B. Moeglen-Paget, *et al.*, "Optofluidic photonic crystal fiber platform for sensitive and reliable fluorescence based biosensing," Biomed. Opt. Express 15, 4281-4291 (2024)