Mid-infrared laser absorption spectroscopy of methane inside hollow core fiber

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Laser-based gas detection plays important role in various applications, including environmental monitoring, leak detection or industrial process control. In many sensing configurations sensitivity may be improved through increasing the effective sensing path length. This is usually accomplished with multi-pass cells. Alternative approach is to use hollow core fibers (HCF), which may provide better opto-mechanical and thermal stability and exceptional path-length to sample volume ratio.

Previously we have demonstrated gas detection inside HCF using laser diode and quantum cascade laser as sources [1,2]. Here we will present a setup that uses ICL and allows for methane sensing near 3.3 µm. Figure 1 shows the schematic diagram of the setup. Light from the ICL (from Nanoplus) was coupled into the HCF using gold-coated off-axis parabolic mirror. The other end of HCF was placed inside air-tight housing integrated with an MCT detector. HCF was filled with gas sample by applying overpressure to one of its end. Fiber was made of pure silica and the diameter of its air core is ~40 µm.

Figure 1 shows WMS spectra recorded with the 7.5-m-long HCF filled with ambient air. The detection limit of the system as low as 3.5 ppb in 1 second (averaging time) was estimated using Allan-Werle deviation analysis. We have also successfully used the setup for a week-long continuous monitoring of methane and water vapor concentrations in ambient air. These results will be presented during the conference.

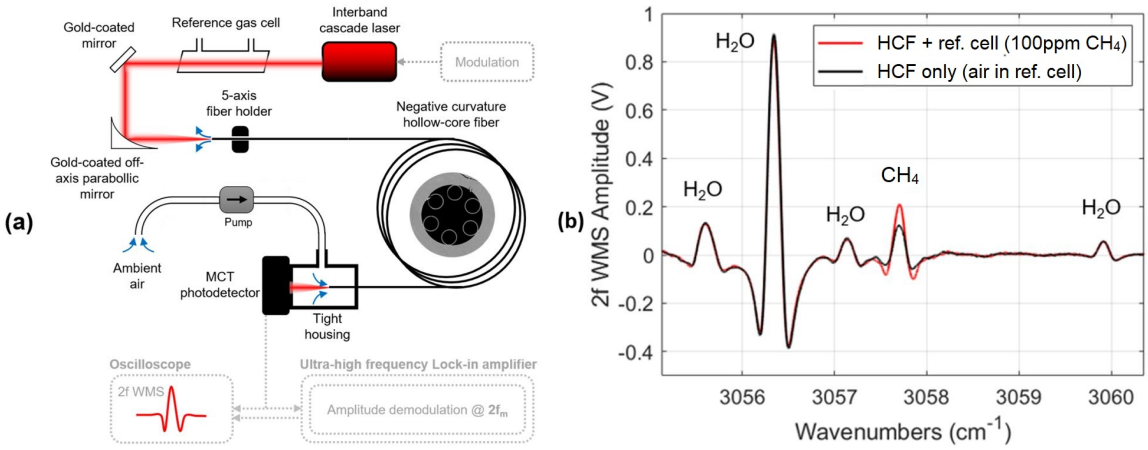

Fig. 1. (a) schematic diagram of the sensor; (b) 2f WMS spectra measured with hollow-core fiber filled with ambient air (black line: reference cell filled with air; red line: reference cell filled with mixture of 100 ppm of methane).

References: [1] Opt. Express 27, 14998-15006 (2019); [2] Opt. Express 27, 36350-36357 (2019).

Acknowledgments: G.G.: Polish Ministry of Science and Higher Education (DI2019 0026 49, Diamentowy Grant); M.N.: National Laboratory for Photonics and Quantum Technologies (NLPQT) project (POIR.04.02.00-00-B003/18), co-financed by the EU; M.K.: Foundation for Polish Science, First TEAM programme co-financed by the EU (First TEAM/2016-1/1, POIR.04.04.00-00-1D64/16-00).