A PHOTONIC GAS SENSOR FOR THE MID-INFRARED

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The mid-infrared (MIR) contains the strong absorption signatures of many molecules that are of extreme interest in real-world sensing applications. The miniaturization of spectroscopic sensing equipment made possible by silicon photonics has the potential to revolutionize emission sensing in the MIR.

Nanophotonic devices have greatly benefited from telecommunication technology in the near infrared (NIR) region. The industry has reached a level of maturity where high volume production of integrated circuitry can be done at low cost. Silicon based photonic devices can now support optical signals in the MIR past 8 microns with losses approaching those of the telecommunications band [1] making the region attractive for sensing applications.

Absorption sensing with photonic devices has been demonstrated in silicon on sapphire, silicon nitride [2], and other silicon-on-insulator platforms. These methodologies have demonstrated the ability to sense analyte concentrations as low as 5000 ppmv (parts per million by volume), which is the workplace limit in many constituencies [3].

We present our current state of research on the development of a high-quality factor MIR silicon-on-sapphire (SOS) photonic gas sensor for use in lab-on-a-chip sensing applications. An optical parametric oscillator (OPO) will be used as a MIR source to pump a grating coupled SOS ring cavity immersed in a controlled CO2 environment. The cavity will be geometrically engineered to allow for high sensitivity spectroscopy of trace CO2 near 2350cm-1. Design was conducted in COMSOL Multiphysics and Lumerical software suites. The sensor was patterned at Applied Nanotools in Edmonton, AB and is currently undergoing characterization in the laboratory at the University of Calgary.

[1] R. Shankar et al., Applied Physics Letters, 102, 051108, 2013

[2] C. Ranacher et al., IEEE Photonics Journal, 10 (5), 2018

[3] C. Ranacher et al., Sensors and Actuators A: Physical, 277, pp. 117-123, 2018