A PHOTONIC GAS SENSOR FOR THE MID-INFRARED

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The mid-infrared (MIR) contains the strong absorption signatures of many molecules, such as Methane and Carbon Dioxide, that are of extreme interest in real-world sensing applications. The miniaturization of spectroscopic sensing equipment made possible by engineered silicon photonics has the potential to revolutionize the way we conduct emissions 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. Advances in materials engineering have shown that silicon based photonic devices can support optical propagation in the MIR past 8 microns with losses approaching those of the telecommunications band [a] making the region attractive for nanoscale sensor development. Absorption sensing with photonic devices has been demonstrated in silicon on sapphire [b], silicon nitride [c], and metal assisted silicon on insulator [d] platforms, among others. 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 North American constituencies.

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 CO_2 environment. The cavity will be geometrically engineered to allow for high sensitivity spectroscopy of the CO_2 fundamental at 2350 cm^{-1}via absorption of the cavity evanescent field. Design and optimization is conducted through the use of COMSOL Multiphysics and Lumerical software suites.

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[c] C. Ranacher, C. Consani, N. Vollert, A. Tortschanoff, M. Bergmeister, T. Grille, B. Jakoby, *IEEE Photonics Journal*, **10** 2018.

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