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New developments in quartz enhanced photoacoustic sensors exploiting custom quartz tuning forks

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Trace gas detection has a significant impact on a wide range of applications, such as environmental or industrial monitoring or medical breath analysis. Techniques based on optical absorption offer fast responses, minimal drifts and high gas specificity. Quartz enhanced photoacoustic spectroscopy (QEPAS) is one of the most sensitive optical techniques for trace gas measurements. QEPAS exploits a quartz tuning fork (QTF) as a resonant photoacoustic transducer that converts the acoustic wave into the electrical signal via the piezoelectric effect. For more than a decade since its first demonstration in 2002, all the QEPAS systems employed standard 32 KHz QTFs, similar to the ones incorporated in clock watches and smartphones. Recently, new designs for the QTFs have been proposed and implemented in QEPAS sensors, opening the way to the use of QTF overtone vibrational modes and novel micro-resonator configurations providing excellent results in terms of sensitivity. The implementation of custom QTFs also allow extending the use of QEPAS in the THz spectral range and with laser sources having poor beam profile, like fiber-amplified lasers. Here it will be presented a review of recent results obtained exploiting custom QTFs in QEPAS trace-gas sensors operating in the near-IR mid-IR and THz ranges. Finally, new QEPAS approaches exploiting simultaneous excitation of the two antinodes of the QTF first overtone mode or both fundamental and first overtone mode antinodes will be reported. In particular, the latter approach leads to the first simultaneous dual-gas detection with a QEPAS sensor.

Biography

Vincenzo Spagnolo received his Phd in Physics, in 1994 from University of Bari. Since January 2004, he has been working at the Technical University of Bari, formerly as Assistant Professor of Physics and since 2015 as Associate Professor. He is the Director of the joint-research lab Polysense created by Thorlabs GmbH and Technical University of Bari. His current research interests include quantum cascade lasers, fiber optics and photoacoustic gas sensing. His research activity is documented by more than 160 Scopus publications and two filed patents. He has given more than 40 invited presentations.

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