180 GHz CMOS Pulsed Transmitter and Heterodyne Receiver Pair for in-situ Chemical Detections

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Recent[1-3] work has shown the coherent radiation generated by high-speed phase lock loops (PLLs) embedded in CMOS circuitry can be leveraged for use in a variety of remote and in-situ sensing instrumentation. PLL outputs can be paired with other on chip elements (e.g., down-conversion mixers, power amplifiers, frequency multipliers, pulse modulators) to produce versatile transmitter or receiver devices having a footprint of several square millimeters that consume <500mW input power. A previous joint JPL/UCLA collaboration to develop a miniaturized 90-100 GHz cavity enhanced pulsed-emission spectrometer for *in-situ* sensing deploys such custom CMOS source/detection electronics. This sensor, where all source and detection electronics are housed on a single (100 cm^2) printed circuit board, has been shown to be sensitive to trace amounts (1-100 μTorr) of test gasses with short (1 second) integration times.

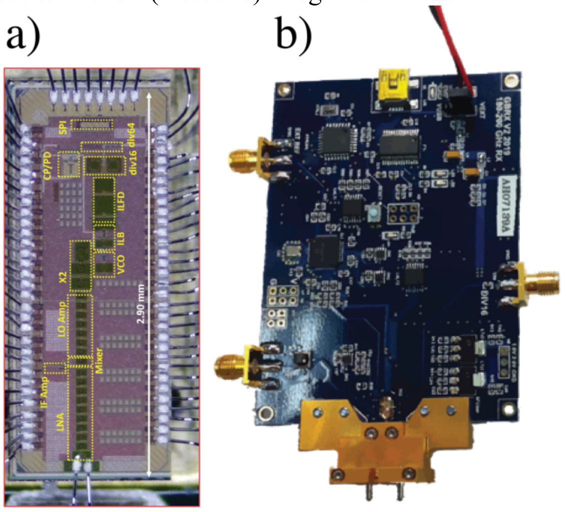

Fig. 1. Pictorial representation of custom designed 180 GHz CMOS heterodyne receiver (a). This custom integrated circuit chip is mounted on a printed circuit board (b) that houses all support electronics. A standard WR5 waveguide flange is used for interfacing with standard mm-wave hardware for laboratory characterization.

This talk will focus on the next generation of instrumentation currently under development that aims to realize a dual band system capable of detecting both H_2O (at 183.310 GHz) and HDO (at 80.3578 GHz) to allow for localized determinations of H/D ratios. A full system description will be provided along with an introduction to the pulsed-emission detection scheme leveraged by the miniaturized spectrometer. The performance properties of the 180 GHz pulsed transmitter and heterodyne receiver chip set (*viz*. Fig. 1) will be discussed along with details of how generated radiation is coupled into (and out of) a resonant optical cavity. These results will be accompanied by demonstrative examples of water vapor detections and future plans to integrate a lower frequency band for dual H_2O/HDO detections.

References

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