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SBIR Phase II

High-Resolution Tunable Receiver for Remote THz Sensing

Esensors Inc.

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Impact (Applications)

Chemical Identification

Terahertz technology identifies chemicals and biological agents in the air. Ideal for sensing and measuring the chemical composition of the environment. THz, combines chemical spectral identification with imaging and safety, provides more detailed information than competitive technologies.

Surveillance

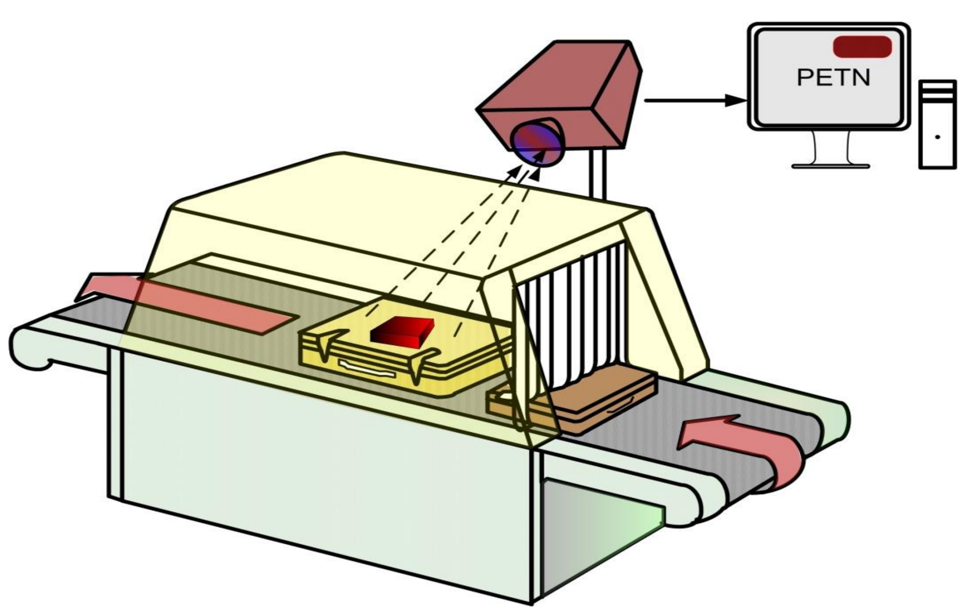
This technology will strengthen the security of airports by enabling automation of both imaging and chemical detection while reducing errors associated with manual methods. THz screening of personnel is non-invasive and harmless. Explosives and biological agents can be detected and identified, even if concealed in clothing and suitcases, because the THz radiation is transmitted through clothing and luggage.

Communication Receiver Technology

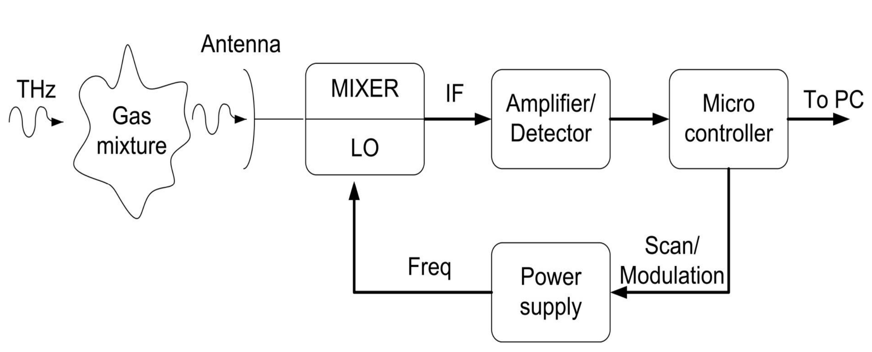
The THz receiver is broad band and phase coherent, similar to the front end of RF and microwave receivers. Its 50 ohm coax IF (dc to 8 GHz) output is compatible with conventional electronics. Thus it will bring wireless devices into the THz region.

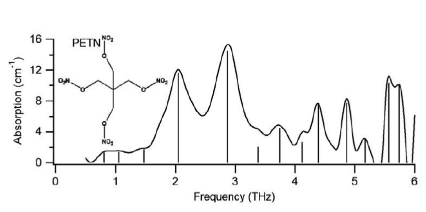
Specific application of project--- remote gas sensing

- Monitors and identifies vapors and toxic gases within a room
- Based on unique THz spectra of compounds
- Consists of THz receiver section plus conventional (OTS) electronics

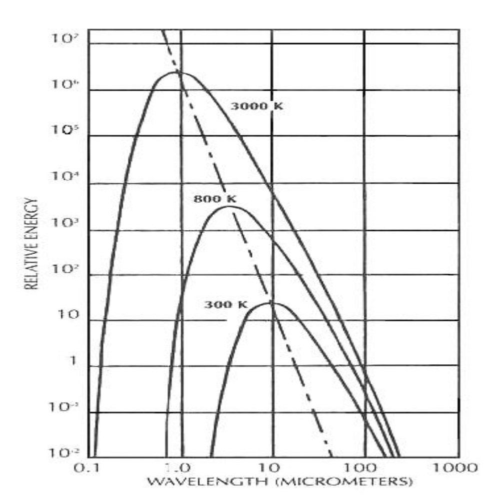


Like IR, terahertz radiation is spontaneously emitted by all warm bodies. As it passes through a vapor or solid it is selectively absorbed, depending on the material. The material can be identified by its characteristic absorption spectrum. Explosives and drugs are examples.





1 THz = 300μm

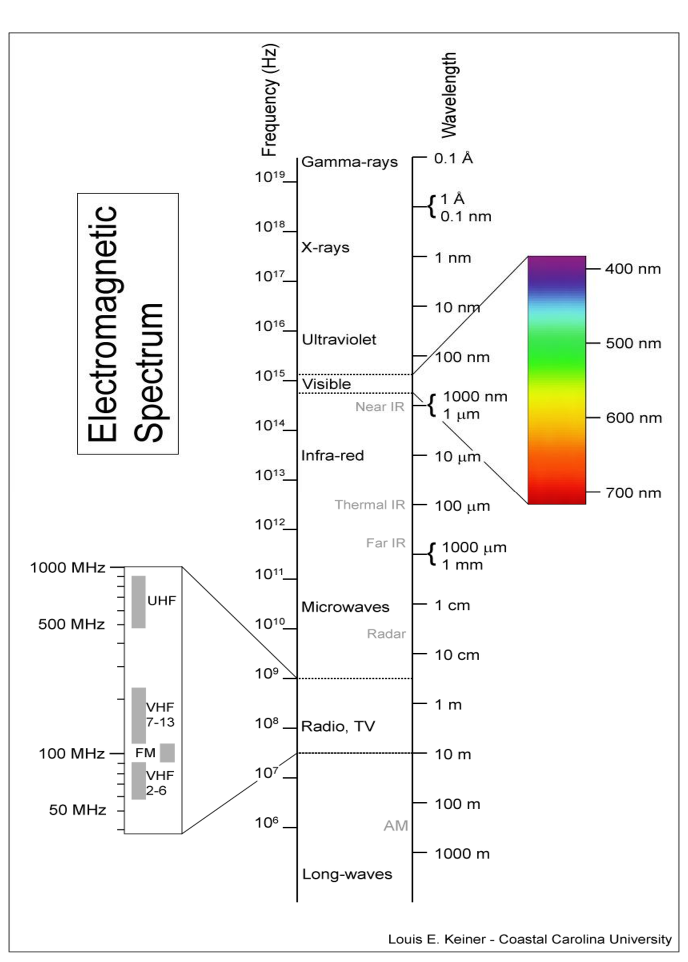


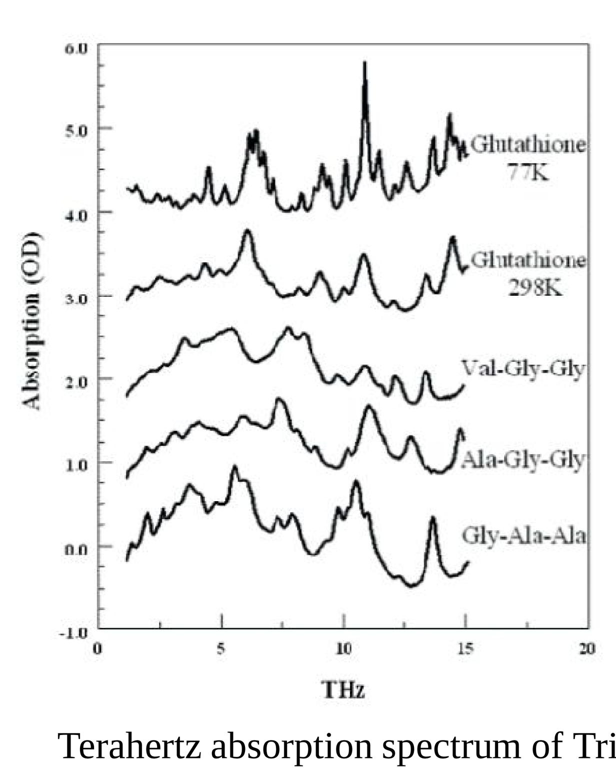
Blackbody radiation in the IR and THz region near and below room temperature.

Linage (Background)

What is Terahertz technology?

- Region of electromagnetic spectrum between microwave and infrared (1 THZ = 1000 GHz)
- Conventional electronic devices and sensors unavailable for this region
- Requires bulky, expensive laboratory equipment to access (in physics labs scattered throughout world)
- Chemicals can be identified by their characteristic THz spectra, similar to IR
- THz waves penetrate fabrics and plastics – imaging used for inspection
- Communication bandwidth 1000x greater than microwave





Terahertz absorption spectrum of Tri-peptides (NIST labs)

Novelty (Technology)

Thz Receiver

The receiver front end, similar to a standard heterodyne receiver (Fig. 1), consists of an antenna (Fig. 2) and integrated local oscillator (LO) and mixer (Fig. 3). The intermediate frequency (IF) output goes via a 50 ohm connector to a high gain amplifier, demodulator and signal processor. The THz antenna is a log periodic design and the center leads couple directly to the bolometer.

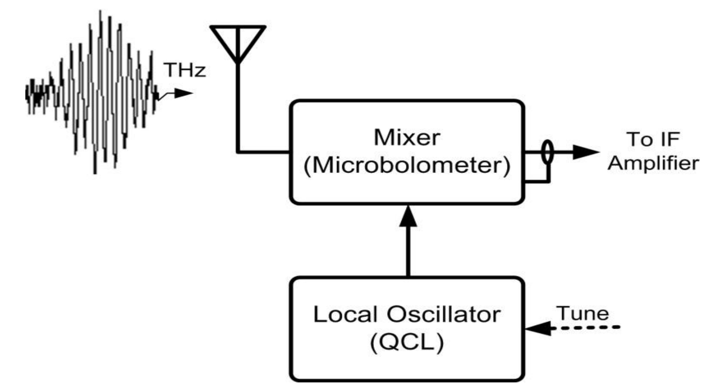


Fig. 1 Block Diagram

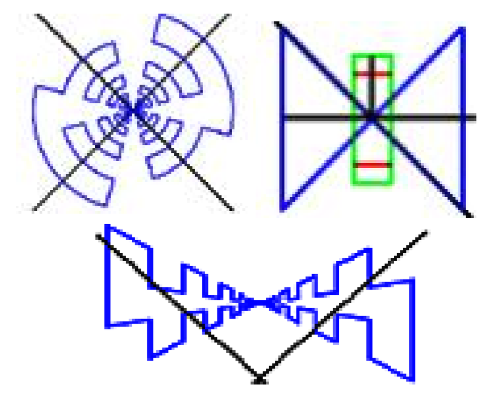


Fig. 2 THz Antennas

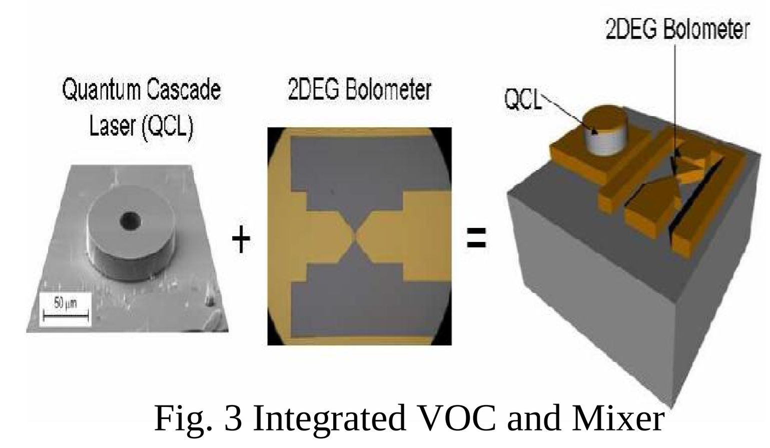


Fig. 3 Integrated VOC and Mixer

Quantum Cascade Laser as Local Oscillator

Two novel THz quantum cascade lasers were developed. The first is a ring laser with radial Bragg gratings on their surfaces. (see Fig. 4 for emission spectra). The second is a dual midIR laser with the THz generated by the difference frequency (Fig. 5).

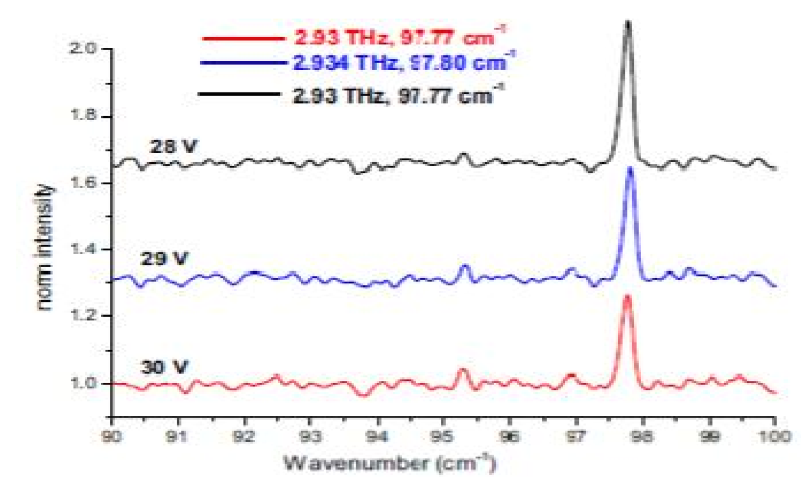


Fig. 4. Emission spectra of 600μm long 120μm wide metal-metal QCL ridge.

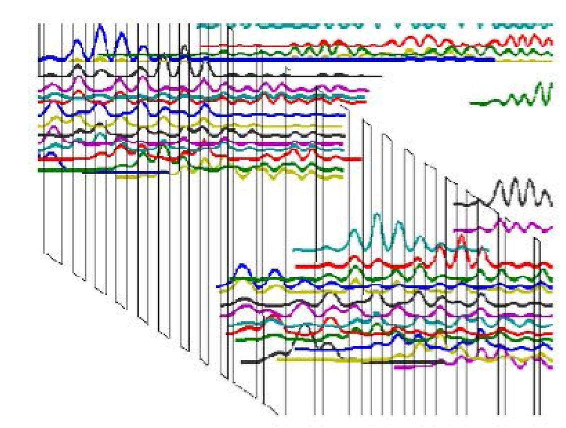


Fig. 5. Novel Design of 1 – 5 THz local oscillator base on two integrated near-IR QCL

Hot Electron Bolometer

Two types of microbolometers have been developed. One is based on AlGaAs/GaAs quantum well structures, (Fig. 6) with two variations, (a) standard triangular 2DEG heterostructure and (b) rectangular quantum well. The second uses a AlInGaN/GaN heterostructure.

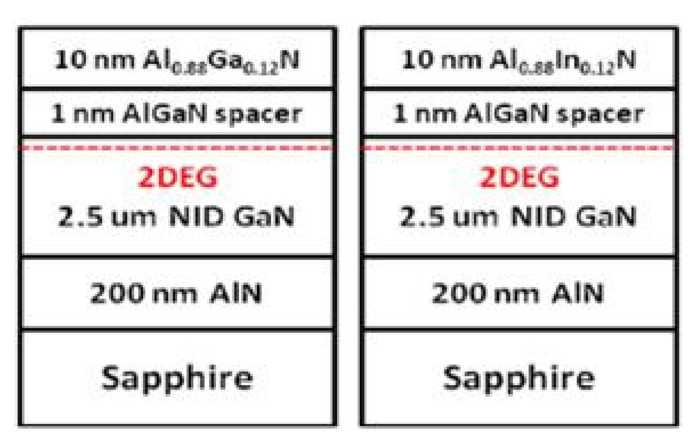


Fig. 6 Cross Section of (a) AlGaAs/GaAs and (b) AlInGaN/GaN heterostructures

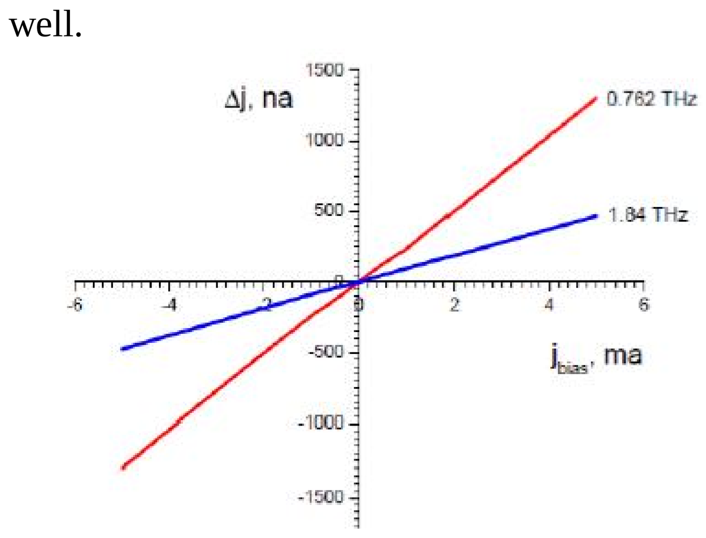


Fig. 7 THz photoresponse of the device #3. The blue line is for laser frequency of 1.84 THz and the laser power of 36 mW and the red line

Test Fixture

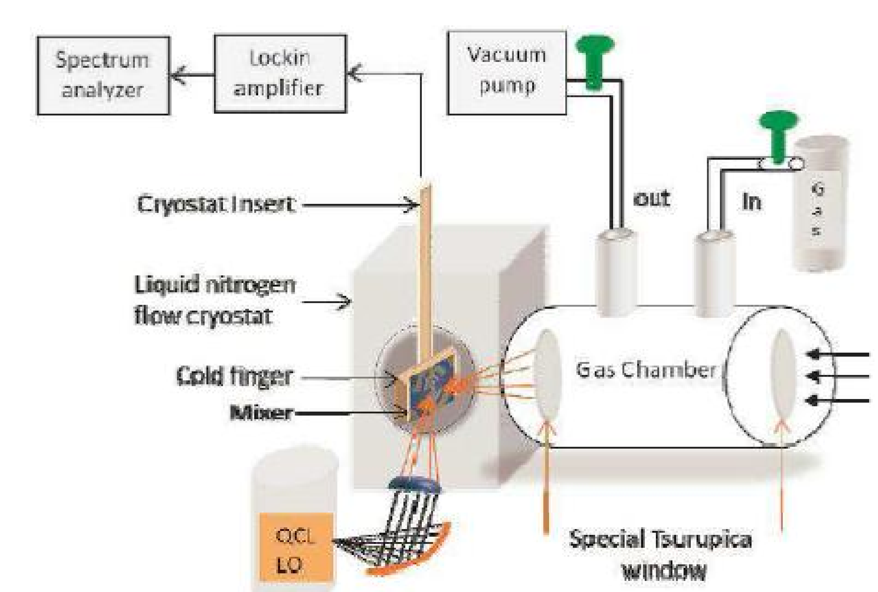


Fig. 8 Platform for THz chemical sensing

Readout Electronics

A block diagram of the signal conditioning electronics is shown in Fig. 9. The electronics scans the VCO over the absorption line, measures the signal and converts to a plot of THz absorption as a function of frequency.

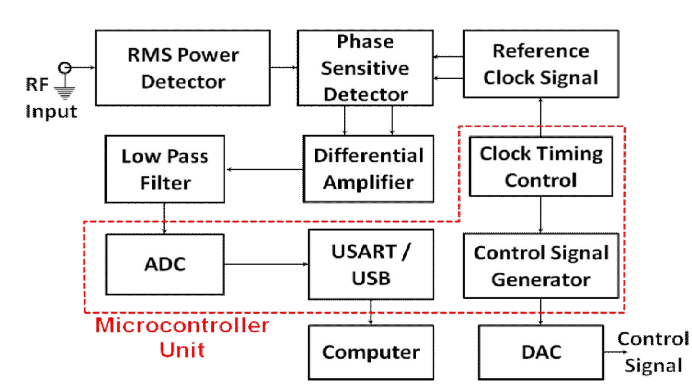


Fig. 9 Readout Block Diagram

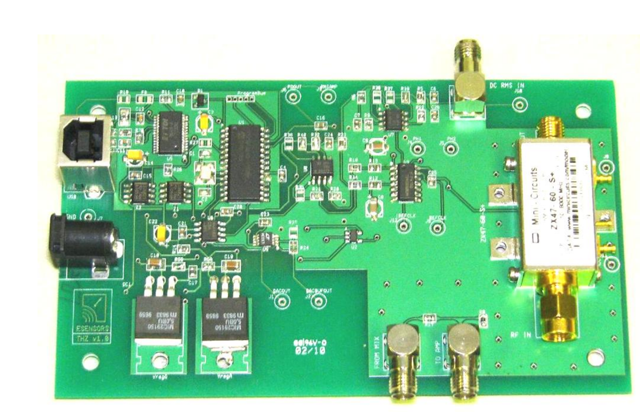


Fig. 10 Signal Conditioning Electronic Board

Company Mission

Description

Esensors' goal is to become a major industry provider of advanced digital sensors incorporating full network capabilities. These include sensors for the smart grid, toxic gas monitors, combined sensor and communication applications, including wireless and Internet applications. Networked Digital sensors will dominate both the sensor industry and the IT industry in the coming years. Our continuing close relationship with the University at Buffalo provides Esensors access to a high level of expertise in the area of electronic engineering and sensor technology. We are located in Amherst (Buffalo), NY.

Esensors Management

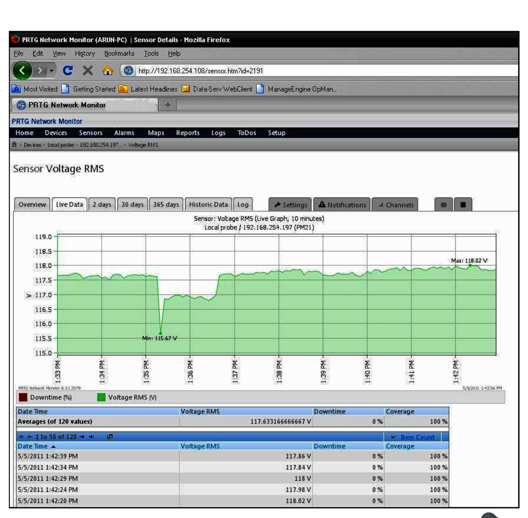
Dr. Darold Wobschall -- President
Founder and former EE faculty at the University at Buffalo. Developed technologies at 5 other companies.
Ronald L. Peterson -- Product manager
Websensor product development and commercialization.

University at Buffalo Team Members

Dr. Vladimir Mitin
Distinguished Professor and UB team leader
Dr. Andrei Sergeev
Expert in semiconductor fabrication

Commercial Sensors at Esensors

- ***Websensors (Sensors with an Internet Address)***
- ***Wireless Sensors (WiFi, Zigbee, 6LOWPAN)***
- ***Gas Monitors (networked)***
- ***Sensors for Smart Grid***
- ***Stock of Prototype Sensors***
- ***Quantum dot based IR detectors (under development)***



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