Abstracts

Millimeter-wave radar sensing of airborne chemicals

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This paper discusses the development of a millimeter-wave radar chemical sensor for applications in environmental monitoring and arms-control treaty verification. The purpose of this paper is to investigate the use of fingerprint-type molecular rotational signatures in the millimeter-wave spectrum to sense airborne chemicals. The millimeter-wave sensor, operating in the frequency range of 225-315 GHz, can work under all weather conditions and in smoky and dusty environments. The basic configuration of the millimeter-wave sensor is a monostatic swept-frequency radar that consists of a millimeter-wave sweeper, a hot-electron bolometer or Schottky barrier detector, and a corner-cube reflector. The chemical plume to be detected is situated between the transmitter/detector and reflector. Millimeter-wave absorption spectra of chemicals in the plume are determined by measuring the swept-frequency radar return signals with and without the plume in the beam path. The problem of pressure broadening, which hampered open-path spectroscopy in the past, has been mitigated in this paper by designing a fast sweeping source over a broad frequency range. The heart of the system is a backward-wave oscillator (BWO) tube that can be tuned over 220-350 GHz. Using the BWO tube, we built a millimeter-wave radar system and field-tested it at the Department of Energy Nevada Test Site, Frenchman Flat, near Mercury, NV, at a standoff distance of 60 m, The millimeter-wave system detected chemical plumes very well; detection sensitivity for polar molecules such as methylchloride was down to 12 ppm for a 4-m two-way pathlength.

❑ Return to main document.