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Terahertz Whole Body Scanners

Source: TSA

Homeland Security Research Corp.

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1.1 Terahertz Whole Body Scanners

Terahertz (THz) non-ionizing radiation bridges the gap between MMWave and infrared on the electromagnetic spectrum (300 GHz to 10 THz).

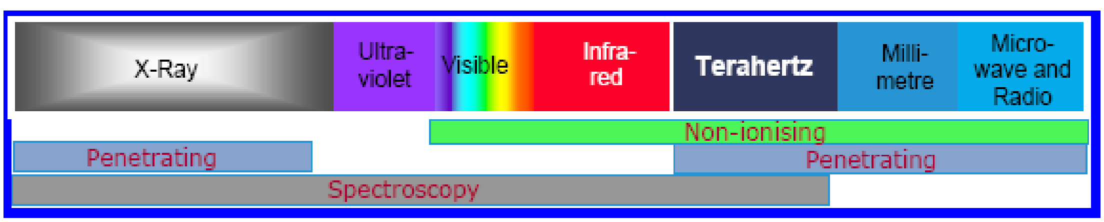
Terahertz imaging and spectroscopy has been shown to have the potential to use very low levels of this non-ionizing radiation to detect and identify objects hidden under clothing at stand-off distances. It has also been shown to be effective in detecting concealed explosives at a stand-off distance of 1m, both in real time as well as in reflection, and under normal atmospheric conditions.

Further development may lead to a practical application of this system for the detection of suicide bombers and mobile suspects.

1.1.1 Terahertz Weapon Detection Portals Technology

The terahertz (THz) region of the electromagnetic spectrum is typically considered to occupy 300 GHz to 10 THz, bridging the gap between millimeter waves and the infrared. Developments during the last decade have started to address the previous lack of THz radiation sources and sensitive detectors in this range.

Figure 1 - Electromagnetic Spectrum of the THz-Region.



(**Source:** Kemp.)

These advances have generated considerable interest in terahertz radiation as it may apply to screening technologies.

There are unique properties of THz radiation that make it a potentially powerful technique for people screening including:

- THz radiation penetrates many everyday physical barriers such as typical clothing and packing materials with modest attenuation.
- Many chemical substances and explosive materials exhibit characteristic spectral responses at THz frequencies that can be used to identify these threat materials.

- The low photon energy, sub-millimeter wavelengths THz radiation is non-ionizing in contrast to penetrating radiation using higher energies.

Note: There has been widespread misuse of the term “terahertz”. A committee reviewing papers that used the term found it used for frequencies as low as 10 GHz (X band) and as high as 150 THz which is in the infrared region. Historically, the millimeter band extended from 30 GHz to 300 GHz and the sub millimeter band extended from 300 GHz to 3 THz. In the current literature, the terahertz region has “invaded” the sub millimeter band and extended it to 10 THz.

THz radiation results in characteristic spectral responses when it bounces off specific materials such as explosives (and other chemicals), making THz a potential tool for material identification of explosives and other chemical threats as well as the detection of concealed threats such as guns and knives.

The images produced by THz radiation are useful for identifying threats and are safe from a health standpoint.

There are two types of THz imaging systems:

- **Passive –** Uses sensors to detect thermal THz radiation as it is emitted from the screened objects.
- **Active –** Screening objects by illuminating them with THz radiation. Active techniques such as Terahertz Pulsed Imaging (TPI) are more sensitive thus enabling the generation of 3-D images.

1.1.2 Terahertz Time Domain Spectroscopy (TTDS)

Terahertz time domain spectroscopy (TTDS) uses a short pulse laser and specially designed transducers to detect (by material identification) concealed explosives. By gating the transducers (transmitter/receiver) with ultrafast optical pulses, it may be possible to generate sub-picoseconds bursts of electromagnetic radiation and subsequently detect them with high signal to noise ratio using gated detectors. These transients consist of only one or two cycles of the electromagnetic field and they consequently span a very broad bandwidth - extending from 100 GHz to 2 or 3 THz, although the power generated is concentrated more in the lower frequencies of the emission band. The average intensity of the radiation is quite low but the high spatial coherence produces a brightness that exceeds that of conventional thermal sources. The gated detection is orders of magnitude more sensitive than typical bolometric detection and it requires no cooling or shielding of any kind.

Because TTDS does not require any cryogenics or shielding for the detector, it has the potential to be the first millimeter-wavelength/terahertz chemical sensor that is portable, compact and reliable enough for practical application in real-world environments. Note that TTDS by itself is not an imaging technique. Research conducted at Physical Sciences, Inc., has suggested that TTDS is able to distinguish by resonances attributed to phonon bands among the following explosives: cyclotetramethylene-tetranitramine (HMX), cyclotrimethylene-trinitramine (RDX) and pentaerythritol.

More information can be found at:

Global People Security Screening: Technologies, Industry & Market – 2015-2020