**Special Issue**

**T-Ray Imaging, Sensing, and Retection**

Edited by D. Abbott and X.-C. Zhang

1514 **Terahertz Spectroscopy and Imaging for Defense and Security Applications**

By H.-B. Liu, H. Zhong, N. Karpowicz, Y. Chen, and X.-C. Zhang

| INVITED PAPER | Laboratory experiments indicate that, with more powerful sources and more sensitive detectors, terahertz techniques have great potential for detection and identification of concealed explosives.

1528 **T-Ray Sensing and Imaging**


| INVITED PAPER | An Australian research group has investigated a number of terahertz application areas including liquid T-ray spectroscopy, bioaffinity sensing, image rendering, tomography, microwire T-ray transmission, and detection through plastic layers.

1559 **Detection of Concealed Explosives at a Distance Using Terahertz Technology**


| INVITED PAPER | A prototype terahertz standoff detection system is shown to be able to sense explosives at a distance of one meter, through several layers of clothing, employing safe-to-use non-ionizing radiation.

1566 **THz-Wave Spectroscopy Applied to the Detection of Illicit Drugs in Mail**

By A. Dobroiu, Y. Sasaki, T. Shibuya, C. Otani, and K. Kawase

| INVITED PAPER | Chemical powders in envelopes can be identified by THz-wave spectrum analysis, a process that can be speeded-up by rapid scanning to determine whether powders are present.

1576 **All-Optoelectronic Terahertz Imaging Systems and Examples of Their Application**

By T. Löffler, K. J. Siebert, N. Hasegawa, T. Hahn, and H. G. Roskos

| INVITED PAPER | THz lasers can be used to image tumors and reveal package contents, inspect rolled steel and other metal surfaces, design antireflection coatings, and detect tooth decay.

1583 **Electronic Terahertz Antennas and Probes for Spectroscopic Detection and Diagnostics**

By J. Grade, P. Haydon, and D. van der Weide

| INVITED PAPER | High-gain THz antennas may increase the detection range of security systems, and coaxial THz probes may allow noninvasive investigation of cell membranes and ion channels.

1592 **Chemical Recognition With Broadband THz Spectroscopy**

By B. M. Fischer, H. Helm, and P. U. Jepsen

| INVITED PAPER | T-rays can be used to probe biochips, to perform biosensing and chemical sensing, and to identify many crystalline substances, but amorphous substances are more difficult to identify.

1605 **Terahertz Measurements of Protein Relaxational Dynamics**

By J. R. Knab, J.-Y. Chen, Y. He, and A. G. Markelz

| INVITED PAPER | THz dielectric measurements of hen egg-white lysozyme are shown to be sensitive to critical picosecond dynamics, suggesting that they may be used to probe changes in protein flexibility.

[Continued on page 1506]
SPECIAL ISSUE: T-RAY IMAGING, SENSING, AND DETECTION

1611 At the Dawn of a New Era in Terahertz Technology

[INVITED PAPER] Development of a direct T-ray laser source is producing results, including advanced lasers and photoconductors as well as a spectrometry system.

1624 Finite-Element Method Simulations of Guided Wave Phenomena at Terahertz Frequencies
By J. A. Deibel, M. Escarra, N. Berndsen, K. Wang, and D. M. Mittleman

[INVITED PAPER] Design of cylindrical-wire wave guides and other THz devices can be aided by finite element models that characterize propagation and interaction characteristics.

1641 Physical Phenomena in Electronic Materials in the Terahertz Region
By R. A. Lewis

[INVITED PAPER] Terahertz radiation is useful for probing electronic materials because energies, resonances and other key physical characteristics of these materials correspond to THz frequencies.

1646 Laser Terahertz Emission Microscope
By H. Murakami, N. Uchida, R. Inoue, S. Kim, T. Kiwa, and M. Tonouchi

[INVITED PAPER] High resolution images and electric field distributions for integrated circuits, response of photoconductive switches, and current distribution in superconductors can be safely examined by this THz device.

1658 Terahertz Time-Domain Spectroscopy for Material Characterization
By M. Naftaly and R. E. Miles

[INVITED PAPER] The composition of glass and polymers, and the density and viscosity of lubricating oil, can be determined from the THz spectrographs of these materials.

1666 Compact, High-Power Electron Beam Based Terahertz Sources

[INVITED PAPER] These sources can generate high average power and very high peak power at controlled THz wavelengths and bandwidths to serve mobile or laboratory-based analytical tools.

1679 The Free Electron Laser at Jefferson Lab: The Technology and the Science
By A. W. Thomas and G. P. Williams

[INVITED PAPER] Photoemission from a semiconductor wafer, accelerated and magnetically compressed, can deliver a ten-thousand-watt beam of IR light for imaging, spectroscopy, and measurements.

1683 Millimeter-Wave and Submillimeter-Wave Imaging for Security and Surveillance
By R. Appleby and R. N. Anderton

[INVITED PAPER] Explosives hidden under clothing can be imaged by submillimeter waves, but millimeter waves are better suited for guiding helicopter navigation in poor weather.

1691 Standoff Detection Using Millimeter and Submillimeter Wave Spectroscopy
By H. J. Hansen

[INVITED PAPER] Pollution and some traces of explosive materials can be detected in the upper atmosphere by these spectroscopy techniques; to improve existing capabilities, more sensitive receivers are needed.