PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 11164

, "Front Matter: Volume 11164," Proc. SPIE 11164, Millimetre Wave and Terahertz Sensors and Technology XII, 1116401 (31 October 2019); doi: 10.1117/12.2556492

SPIE.

Event: SPIE Security + Defence, 2019, Strasbourg, France

PROCEEDINGS OF SPIE

Millimetre Wave and Terahertz Sensors and Technology XII

**Neil A. Salmon
Frank Gumbmann**
Editors

**9–10 September 2019
Strasbourg, France**

Sponsored by
SPIE

Cooperating Organisations
European Optical Society
Cranfield University (United Kingdom)

Published by
SPIE

Volume 11164

Proceedings of SPIE 0277-786X, V. 11164

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Millimetre Wave and Terahertz Sensors and Technology XII, edited by Neil A. Salmon,
Frank Gumbmann, Proc. of SPIE Vol. 11164, 1116401 · © 2019 SPIE
CCC code: 0277-786X/19/\$21 · doi: 10.1117/12.2556492

Proc. of SPIE Vol. 11164 1116401-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Millimetre Wave and Terahertz Sensors and Technology XII*, edited by Neil A. Salmon, Frank Gumbmann, Proceedings of SPIE Vol. 11164 (SPIE, Bellingham, WA, 2019) Seven-digit Article CID Number.

ISSN: 0277-786X
ISSN: 1996-756X (electronic)

ISBN: 9781510630314
ISBN: 9781510630321 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445
SPIE.org

Copyright © 2019, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$21.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/19/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

SPIEDigitalLibrary.org

Paper Numbering: *Proceedings of SPIE* follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

v	<i>Authors</i>
vii	<i>Conference Committee</i>
ix	<i>Introduction</i>

SESSION 1 MMW & THZ RADIOMETRIC AND RADAR IMAGERS AND SENSORS I

11164 02	Variation in the electromagnetic signatures of the human skin with physical activity and hydration level of the skin (Invited Paper) [11164-1]
11164 03	Measurement results and error analysis from stand-off sensing of material characteristics by polarimetric MMW radiometry [11164-2]
11164 04	Real-time non-invasive detection of hidden objects in parcels and packages with sub-THz systems [11164-3]
11164 05	Role of the pulse duration at measurements of spectral signatures of substances in THz range of frequencies [11164-4]
11164 06	Applications of various sensors for detecting THz waves in adverse conditions [11164-5]

SESSION 2 ENABLING TECHNOLOGY

11164 08	Y-Ba-Cu-O superconducting hot electron heterodyne mixers: simulated THz performance for stand-off target detection [11164-7]
11164 09	Y-Ba-Cu-O semiconducting pyroelectric thermal sensors: design and test of near infrared amorphous thin film detectors and extension to antenna-coupled THz devices [11164-8]
11164 0A	Understanding the effect of THz/mm wave-plasma interaction on the brightness of glow discharge detectors [11164-9]
11164 0B	Prospects of designing gold-nanoparticles-based soft terahertz radiation sources and terahertz-to-infrared converters for concealed object detection technology [11164-10]

SESSION 3 MMW & THZ RADIOMETRIC AND RADAR IMAGERS AND SENSORS II

11164 0D	Full polarimetric radar for concealed weapons detection: experimental determination and simulation of the Huynen target parameters for the human torso [11164-16]
----------	--

- 11164 OE **Multiple objects detection and tracking in passive scanning millimeter-wave imaging systems**
[11164-12]
- 11164 OG **Step-index sapphire fiber and its application in a terahertz near-field microscopy** [11164-14]

POSTER SESSION

- 11164 OH **FDTD-modelling of terahertz solid immersion microscopy (Best Student Paper Award)** [11164-15]
- 11164 OI **Development of the integration variable selection method in numerical simulation of
electromagnetic wave propagation in the time domain mode** [11164-17]

Authors

Numbers in the index correspond to the last two digits of the seven-digit citation identifier (CID) article numbering system used in Proceedings of SPIE. The first five digits reflect the volume number. Base 36 numbering is employed for the last two digits and indicates the order of articles within the volume. Numbers start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B...0Z, followed by 10-1Z, 20-2Z, etc.

Akbar, Demiral, 0A	Zaytsev, K. I., 0G, 0H
Altan, Hakan, 06, 0A	Zhelnov, V. A., 0H
Aytaç, B., 06	
Belevtsev, Andrey M., 0I	
Biesuz, N., 04	
Bitossi, M., 04	
Blackhurst, Eddie, 0D	
Boldyreff, Anton S., 0I	
Cherkasov, Anatoliy P., 0I	
Chernomyrdin, N. V., 0G, 0H	
Dégardin, Annick F., 08, 09	
Dill, Stephan, 03	
Dolganova, I. N., 0G, 0H	
Epaneshnikova, Irina K., 0I	
Galiano, Xavier, 09	
Jagtap, Vishal S., 08, 09	
Kairiyev, N. J., 0B	
Katyba, G. M., 0G, 0H	
Klimov, Konstantin N., 0I	
Klochko, Vladimir K., 0E	
Konov, Kirill I., 0I	
Kreiser, Alain J., 08, 09	
Kucheryavenko, A. S., 0H	
Kurlov, V. N., 0G	
Kusoglu-Sarikaya, Cemre, 0A	
Ladret, Romain G., 08	
Lelevkin, V. M., 0B	
Minin, I. V., 0G	
Minin, O. V., 0G	
Moldosanov, K. A., 0B	
Owda, Amani Y., 02	
Paoletti, R., 04	
Paolucci, F., 04	
Peichl, Markus, 03	
Postnikov, A. V., 0B	
Pronin, A. A., 0G	
Qiu, Jing-Hui, 05	
Razanoelina, Manjakavahoaka, 09	
Şahin, A. B., 06	
Salmon, Neil A., 02, 0D	
Serebryannikov, Sergej S., 0I	
Serebryannikov, Sergej V., 0I	
Smirnov, Sergey A., 0E	
Stiaccini, L., 04	
Strolov, Valery V., 0E	
Tonouchi, Masayoshi, 09	
Trofimov, Vyacheslav A., 05	
Varentsova, Svetlana A., 05	
Wang, Nan-Nan, 05	

Conference Committee

Symposium Chairs

Ric Schleijpen, TNO Defence, Security and Safety (Netherlands)
Karin U. Stein, Fraunhofer-Institut für Optronik, Systemtechnik und
Bildauswertung (Germany)

Symposium Co-chair

Catherine Barrat, HGH Systèmes Infrarouges (France)

Conference Chairs

Neil A. Salmon, MMW Sensors Ltd. (United Kingdom)
Frank Gumbmann, Rohde & Schwarz GmbH & Company KG
(Germany)

Conference Programme Committee

Amir Abramovich, Ariel University (Israel)
Sherif Sayed Ahmed, Rohde & Schwarz GmbH & Company KG
(Germany)
Hakan Altan, Middle East Technical University (Turkey)
Nicholas J. Bowring, University of Huddersfield (United Kingdom)
Stephan Dill, Deutsches Zentrum für Luft- und Raumfahrt e.V.
(Germany)
Charmaine Cisneros Franck, NASA Langley Research Center
(United States)
Marcin Kowalski, Military University of Technology (Poland)
Wojciech Knap, Université Montpellier 2 (France)
Steven R. Murrill, U.S. Army Research Laboratory (United States)
Markus Peichl, Deutsches Zentrum für Luft- und Raumfahrt e.V.
(Germany)
Douglas T. Petkie, Wright State University (United States)
Christopher A. Schuetz, Phase Sensitive Innovations, Inc.
(United States)
Vyacheslav A. Trofimov, Lomonosov Moscow State University
(Russian Federation)
Vincent P. Wallace, The University of Western Australia (Australia)

Session Chairs

- 1 MMW & THz Radiometric and Radar Imagers and Sensors I
Neil A. Salmon, MMW Sensors Ltd. (United Kingdom)
- 2 Enabling Technology
Frank Gumbmann, Rohde & Schwarz GmbH & Company KG
(Germany)
- 3 MMW & THz Radiometric and Radar Imagers and Sensors II
Neil A. Salmon, MMW Sensors Ltd. (United Kingdom)

Introduction

This year's conference on Millimetre Wave and Terahertz Sensors and Technology XII featured a range of technology and techniques for passive and active sensing in the field of security and defence and related fields. A model and results which illustrate the performance of sensors over the band 10 GHz to 1000 GHz in adverse weather conditions kicked off the presentations. Also presented was a system that screens packages and parcels over the band 100 GHz to 500 GHz. The use of tracking algorithms to process passive millimetre wave imagers for the purpose of tracking drones was discussed.

A presentation was given on the concepts and measurements from near-field scanning microscopes with flexible sapphire fibers for imaging human tissue in the range 200 GHz to 600 GHz. Measurements at 80 GHz, which indicate how the radiometric emissivity of the human body increases due to physical exercise and a new angle on signatures for sensing that impacts the medical field was featured. Also, discussed, were measurements and models from full polarimetric radar for extraction of the Huynen target parameters for a range of targets including the human body. A novel method for measuring dielectric properties of materials was also presented.

A range of novel sources, detectors, and mixers for the THz range was explored, and the use of gold nanobars as a means for generating THz photons by accessing energy imparted to phonons was investigated. The structure as a means to up-conversion of THz radiation to the infrared band was then presented. Glow discharge sources were explored for their mixer up-conversion capabilities as well as how an infrared CMOS camera can be used to form the millimetre wave image. This approach can offer cost-efficient detection of THz signals. Investigations into how millimetre wave radiation can modulate the intensity of visible light from the glow discharge were featured. The case for high temperature superconductors acting as antenna coupled terahertz mixers and detectors was discussed. Finally, a novel large area thermal source using liquid nitrogen was featured and cited as a means to increase the contrast of indoor passive millimetre wave imagers for security screening of personnel.

Neil A. Salmon
Frank Gumbmann