

PROGRAM

The 2019 U.S. WORKSHOP on the PHYSICS and CHEMISTRY of II-VI MATERIALS

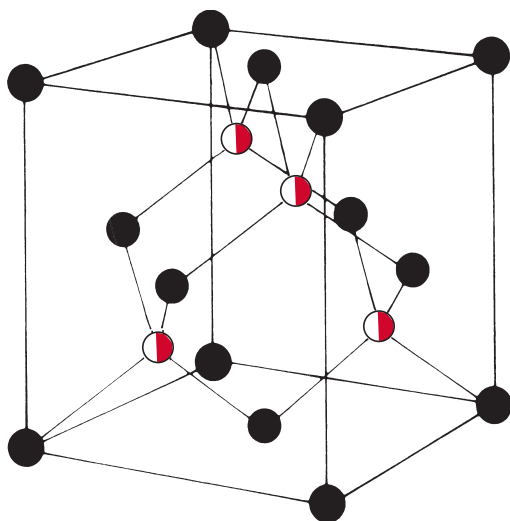
**Embassy Suites Chicago, Downtown Lakefront
Chicago, Illinois, USA
November 18–21, 2019**

II-VI Detector Materials

- IR
- UV
- Gamma-Ray
- X-Ray
- Photovoltaic
- CdZnTe
- HgCdTe
- ZnO
- ZnS
- History of IR Detectors

Special Sessions

- Superlattices: II-VI and III-As/Sb
- II-VI Based Solar Cells
- Alternatives to CdZnTe Substrates
- HgCdTe Avalanche Photodiodes
- X-Ray and Gamma-Ray Detectors
- Surfaces and Interfaces
- ZnO Materials and Devices
- Defects and Doping
- Surface Passivation



Participating Organizations

*U.S. Army RDECOM CERDEC Night Vision & Electronic
Sensors Directorate*

U.S. Army Research Laboratory

U.S. Army SMDC

U.S. Navy Electro-Optics Center

Penn State University

Office of Naval Research

Air Force Research Laboratory

Army Research Office

The Minerals, Metals & Materials Society

Endorsed by

The American Physical Society

University of Illinois at Chicago

Promotional Partners

The 2019 II-VI Workshop would like to express sincere thanks to our supporting organizations and for the contributions from our very generous corporate partners.

Gold Partners



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Tabletop Exhibitors

Eurofins EAG Laboratories

JX Nippon Mining & Metals USA

Pulse Instruments

2019 II-VI WORKSHOP

In the 38 years since the first MCT Workshop was held in 1981, the technology of HgCdTe and related devices has significantly matured and broadened. The Workshop plays a vital role in this technological evolution. It provides the principal open forum for the exchange of information relative to theory and experiment, synthesis, and analysis. It brings together university, governmental, and industrial research in a highly interactive manner.

- To encourage in-depth discussion and audience participation, the Workshop combines conventional oral and poster presentations with sufficient time allocated for questions and answers.
- To broaden exposure without sacrificing depth, invited speakers offer insight into areas relevant to II-VI materials.
- To ensure dissemination of results, submitted peer-reviewed full-length papers will appear in the *Journal of Electronic Materials*.

The Workshop will focus on fundamental research on the major scientific problems in II-VI materials. Its primary goal is to promote an understanding of the relationship among the physical and chemical properties and to leverage this understanding into manufacturing and performance improvements.

Informal discussions among participants are strongly encouraged and ample time for paper discussion and individual interactions has been scheduled. To foster these interactions, lunch will be provided on all three days of the Workshop, while a wine and cheese reception has been scheduled for Tuesday evening.

The 2019 II-VI Workshop Brings Together Industrial Leaders!

We are excited to announce this year's invited speakers:

Keynote Speakers:

Philip Perconti, *Army Research Laboratory*

“Foundational Research Towards Army Modernization”

Michael Eismann, *Air Force Research Laboratory*

“The Air Force Science and Technology 2030 Strategy and Infrared Technology Research”

Invited Speakers:

Oğuz Altun, *ASELSAN Inc.*

“Infrared Detector Technology Development at ASELSAN”

Fikri Aqariden, *Leonardo DRS*

“Overview of HgCdTe Molecular Beam Epitaxial Growth for High Density Vertically Integrated Photodiode (HDVIP) Technology”

Brett Breazeale, *Leonardo DRS*

“Progress in HgCdTe IR Imaging Devices at Leonardo DRS”

Michael Carmody, *Teledyne Imaging Sensors*

“Keeping HgCdTe Detector Technology Alive and Healthy: A Manufacturing and Technologies Perspective”

Debashis Chanda, *University of Central Florida*

“Dirac Plasmon-Assisted Asymmetric Hot Carrier Generation for Room-Temperature Infrared Detection”

Christoph Grein, *University of Illinois at Chicago*

“Guiding MBE Growth with Atomistic Simulations”

Pierre Jenouvrier, *LYNRED*

“More than 50 Years of Infrared Technologies Excellence Joined Now in LYNRED”

Philip Klipstein, *Semiconductor Devices*

“Performance Limits of III-V Barrier Detectors”

David Rhiger, *Raytheon Visions Systems*

“Absorption Characteristics near the Infrared Cutoff in III-V Superlattice Materials”

David Ting, *NASA Jet Propulsion Laboratory*

“Theoretical Aspects of the InAs/InAsSb Type-II Strained Layer Superlattice”

Jason Zeibel, *US Army CCDC CSISR NVESD*

“Enabling Technologies Needed: The Future of Army High-Performance Imaging”

Yong-Hang Zhang, *Arizona State University*

“A Liftoff Technology Using a Water-Soluble MgTe Sacrificial Layer, and CdTe/MgCdTe Double-Heterostructure Devices Based on InSb Substrates”

Tutorials:

William Radford, *Infrared Focal Plane Array Technologist*
“Observations on Excess Noise Measurements and
Mechanisms in Infrared Focal Plane Arrays”

Chad Fulk, *Raytheon Vision Systems*
“Noise in Photovoltaic HgCdTe”

WORKSHOP CO-CHAIRS

Sivalingam Sivananthan, *University of Illinois at Chicago*
(*Proceedings Editor*)

Pradip Mitra, *Leonardo DRS, Electro-Optical and Infrared
Systems (EOIS)*

PROGRAM COMMITTEE

Tony Almeida, *Army NVESD*

Jose M. Arias, *CACI / U.S. Army RDECOM CERDEC*
(*NVESD*)

Enrico Bellotti, *Boston University*

Ishwara Bhat, *Rensselaer Polytechnic Institute*

Arnold Burger, *Fisk University*

Joseph Burns, *Air Force Research Laboratory*

William Clark, *Army Research Office*

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Nibir Dhar, *DARPA/MTO (Proceedings Co-Editor and Web
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Ralph James, *Brookhaven National Laboratory*

Scott Johnson, *Raytheon Vision Systems*

Pradip Mitra, *Leonardo DRS*

Thomas Myers, *Texas State University – San Marcos*

Joe Pellegrino, *Army NVESD*

Eric Piquette, *Teledyne Imaging Sensors*

Marion Reine, *Consultant, Infrared Detectors*

Herbert Pollehn, *Army Research Laboratory*

Priyalal Wijewarnasuriya, *Army Research Laboratory*

WORKSHOP COORDINATOR

Samantha Tola
Palisades Convention Management, Inc.
Phone: (813) 284-0634
Fax: (212) 460-5460
E-mail: stola@pcm411.com

SPECIAL ISSUE EDITORIAL COORDINATOR

Paola Caicedo
Sivananthan Laboratories, Inc.
590 Territorial Drive
Bolingbrook, IL 60440
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WORKSHOP PARTICIPATING ORGANIZATIONS

*U.S. Army RDECOM CERDEC Night Vision & Electronic
Sensors Directorate*

U.S. Army Research Laboratory

U.S. Army SMDC

U.S. Navy Electro-Optics Center

Penn State University

Office of Naval Research

Air Force Research Laboratory

Army Research Office

The Minerals, Metals & Materials Society

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*The American Physical Society
University of Illinois at Chicago*

WORKSHOP PARTICULARS

LOCATION AND DATE

The 2019 II-VI Workshop will be held from November 18–21 at the Embassy Suites Chicago, Downtown Lakefront, Chicago, Illinois.

TRAVEL ARRANGEMENTS

FROM THE AIRPORT

Chicago-O'Hare International Airport

Directions:

Take I-190 to I-90 East to Downtown. Exit Ohio Street. Hotel is on left corner of State and Ohio. Airport shuttle service is operated by Airport Express from each terminal.

Distance from Hotel: 17 mi.

Limousine	\$70.00 USD	Subway/Rail	\$7.50 USD
Taxi	\$50.00 USD	Various other	\$30.00 USD

Chicago Midway Airport

Directions:

Cicero Ave. to I-55 North. I-55 North to I-90/94 West (Dan Ryan Expy). Exit Ohio Street. Hotel is on left corner of State and Ohio. Airport shuttle service is operated by Airport Express from each terminal.

Distance from Hotel: 11 mi.

Limousine	\$60.00 USD	Subway/Rail	\$2.50 USD
Taxi	\$40.00 USD	Various other	\$25.00 USD

For additional map and direction information visit:

[http:// embassysuites3.hilton.com/en/hotels/illinois/embassy-suites-chicago-downtown-magnificent-mile-CHIREES/maps-directions/index.html](http://embassysuites3.hilton.com/en/hotels/illinois/embassy-suites-chicago-downtown-magnificent-mile-CHIREES/maps-directions/index.html)

WORKSHOP CHECK-IN

Attendees arriving on Monday, November 18, will be able to pick up their Workshop material at the II-VI Registration Desk located in the Lobby between 4:00 and 8:00 pm.

Please see the registration hours below for pick-up of Workshop Materials at the II-VI Registration Desk throughout the week:

Tuesday, November 19:	7:30 am–6:00 pm
Wednesday, November 20:	7:45 am–5:00 pm
Thursday, November 21:	8:00 am–3:00 pm

LUNCHES

Lunches will be served in a section of the hotel on all three days of the Workshop. To keep the Workshop on schedule, attendees are encouraged to participate.

WINE AND CHEESE/TABLETOP DISPLAYS

Following the presentations on Tuesday afternoon, a wine and cheese reception has been scheduled to help promote informal discussion and attendee interaction. The reception will be accompanied by several tabletop displays from commercial vendors showing products of interest to the II-VI community. The tabletops will be on view during the Tuesday evening reception as well as during the day on Wednesday and Thursday in the Chicago River Ballroom Foyer. The poster session will also take place at the same time of the reception in a section of the Ballroom adjacent to the foyer.

WORKSHOP MEETING ROOMS

The Workshop presentations as well as the Poster Session on Tuesday will be held in the Chicago River Ballroom. The wine and cheese reception, tabletop displays, and refreshment breaks will all take place in the Chicago River Ballroom Foyer.

BOOK OF EXTENDED ABSTRACTS

A copy of the *Book of Extended Abstracts* will be distributed to all attendees at the Workshop. The *Extended Abstracts* will contain summaries of all oral and poster papers presented at the Workshop.

WORKSHOP PROCEEDINGS

The II-VI Workshop papers will be published in a special issue of the *Journal of Electronic Materials*. The proceedings will contain full-length refereed versions of papers presented at the Workshop. A copy of the Workshop proceedings (printed soft-cover and electronic versions available) is included with registration fees.

INSTRUCTIONS TO AUTHORS PLANNING TO SUBMIT FULL-LENGTH MANUSCRIPTS

We are asking all authors to submit their manuscripts to II-VI workshop for online peer review using the link provided by the *Journal of Electronic Materials (JEM)* at <http://www.editorial-manager.com/jems/>. Please click on “submit manuscript” at the top of the page. Online manuscript submissions will close on January 10, 2020.

II-VI Paper Submission

- Authors (both oral and poster) who presented their work at the Workshop can submit their manuscripts either by going to the JEM’s editorial web page at <http://www.editorial-manager.com/jems/> or via II-VI workshop’s website, <http://www.ii-viworkshop.org/>. The link to the manuscript submission can be accessed by clicking on the Author’s information link located under the “Particulars” link on the navigation banner on top of the II-VI Workshop’s website. Submissions via e-mail will not be accepted.

- New users will need to create an account. During the submission process, authors will be asked to enter additional information.
- The type of paper is “Special Issue” and the category is “2019 U.S. II-VI Workshop”.
- All submissions require an abstract of 200 words or less, a keywords line, a transfer of copyright form, and an electronic file. Papers are reviewed by two qualified referees to determine suitability. The editors’ decision to accept or reject a paper, based on referees’ comments, is final. Please employ the following guidelines when submitting a paper for review:
- Manuscripts, written in English, should be in a single column and formatted to fit on a 22 × 28-cm sheet. Should manuscripts contain too many grammatical errors or awkward passages, the papers will be returned without review. Assistance from a professional proofreader (such as www.journalexperts.com) or a qualified native speaker of English is recommended under these circumstances and may not only accelerate the review process but also allow for an early publication date.
- The title of the article and abstract should be separate from the text. References, figure captions, and tables should also be on separate pages.
- The work’s significance and its relation to the work of others should be detailed in the Introduction. Major assumptions should be stated and procedures adequately outlined.
- References should be cited by Arabic numbers as superscripts. Include the names of all authors, standard abbreviated name of journal (see, for example, <http://library.caltech.edu/reference/abbreviations/>) the volume number, initial page number, and year of publication in parenthesis. For books, include city of publication and publisher.
- Measurements should be given in metric units, including common abbreviations for time such as h, min, and s.
- Figures may be published online in color at no charge, but color figures in the print version of the *Journal* carry a mandatory fee.

To avoid delays, please:

1. Define all acronyms upon first use, including in the abstract, in this style: scanning electron microscopy (SEM).
2. All micrographs must have scale markers. All plots must have both axes labeled with the variable name (units).
3. Contact author e-mail address and keywords must be included on the abstract page.

For detailed guidelines on artwork and the copyright issue please visit:

<http://www.springer.com/materials/optical+%26+electronic+materials/journal/11664#>

PROGRAM

MONDAY, NOVEMBER 18, 2019

- 4:00– 8:00 pm Workshop Pre-Registration
5:00– 7:45 pm Tutorials

TUESDAY, NOVEMBER 19, 2019

- 7:30– 6:00 pm Registration
7:30– 9:30 am Continental Breakfast
8:15– 8:30 am Welcoming Remarks
8:30– 9:00 am Keynote Address: **Dr. Philip Perconti**
9:00–10:00 am 1: Industrial Overview I
10:00–10:15 am **BREAK**
10:15–12:00 pm 2: Devices I
12:00– 1:15 pm **LUNCH**
1:15– 3:15 pm 3: Heteroepitaxy and Solar Cells
3:15– 3:30 pm **BREAK**
3:30– 5:15 pm 4: Materials I
5:30– 7:30 pm **TABLETOPS / WINE & CHEESE
RECEPTION / POSTERS**

WEDNESDAY, NOVEMBER 20, 2019

- 7:45– 5:00 pm Registration
7:45– 9:30 am Continental Breakfast
8:30– 9:00 am Keynote Address: **Dr. Michael Eismann**
9:00–10:15 am 5: Industrial Overview II
10:15–10:30 am **BREAK**
10:30–12:00 pm 6: Superlattice & Barrier Devices
12:00– 1:15 pm **LUNCH**
1:15– 3:00 pm 7: Devices II
3:00– 3:15 pm **BREAK**
3:15– 5:00 pm 8: Materials II

THURSDAY, NOVEMBER 21, 2019

- 8:00– 3:00 pm Registration
8:00– 9:30 am Continental Breakfast
8:45– 9:00 am Welcome Remarks and Future Conference
Updates
9:00– 9:45 am 10: Industrial Overview III
9:45–10:00 am **BREAK**
10:00–12:00 pm 11: Devices III
12:00– 1:15 pm **LUNCH**
1:15– 3:15 pm 12: Materials III
3:15– 3:30 pm **WILLIAM E. SPICER AND
THOMAS N. CASSELMAN**
3:30– 3:45 pm Closing Remarks & Adjourn

MONDAY, NOVEMBER 18, 2019

Chicago River Ballroom

(4:00 – 8:00 pm)

Workshop Pre-Registration (4:00–8:00)

Tutorials (5:00–7:45)

“Observations on Excess Noise Measurements and Mechanisms in Infrared Focal Plane Arrays” (5:00–6:15)

William Radford

William Radford Consulting

Infrared Focal Plane Array Technologist

Santa Barbara, CA, USA

This presentation will review techniques and challenges of using FPA-level testing to evaluate infrared detector performance characteristics and their limiting mechanisms. In particular, it will focus on identifying and analyzing pixels that manifest non-gaussian, excess noise. The presentation will review statistical, temporal and spectral signatures of pixels that exhibit excess noise levels. The presentation will also review some of the key models and physical mechanisms for low-frequency noise in infrared detectors.

BREAK (6:15–6:30)

“Noise in Photovoltaic HgCdTe” (6:30–7:45)

Chad Fulk

Raytheon

Goleta, CA, USA

This review defines and describes fundamentals of HgCdTe infrared focal plane noise with an emphasis on assumptions and unknowns. We will cover both noise theory and some examples of noise measurement. The lecture’s goal is for the audience to take away a better understanding of detector noise performance and advance our communities’ knowledge base. It will help both the manufacturer analyze results and guide government customers in questioning data.

TUESDAY, NOVEMBER 19, 2019

Chicago River Ballroom

(7:30 am – 7:30 pm)

Registration (7:30–6:00)

Continental Breakfast (7:30–9:30)

Welcome Remarks (7:30–8:30)

Dr. Sivalingam Sivananthan, II-VI Workshop Co-Chair
University of Illinois at Chicago, Chicago, IL, USA

Dr. Pradip Mitra, II-VI Workshop Co-Chair
Leonardo DRS, Dallas, TX, USA

Congressman Raja Krishnamoorthi
U.S. House of Representatives, IL, USA

KEYNOTE ADDRESS

8:30 – 9:00 am

Dr. Philip Perconti
Army Research Laboratory

***“Foundational Research Towards Army
Modernization”***

Dr. Perconti will present the overall mission of the Army Research Laboratory and elaborate on the recently established Center for Semiconductor Materials and Devices (CSM). He will describe the unique capabilities that the CSM has to offer as well as some of its ongoing projects that support Army Modernization.

Session 1: Industry Overview I

(9:00–10:00 am)

Chair: Sivalingam Sivananthan
University of Illinois at Chicago, Chicago, IL, USA

1.1

***Invited Paper:* More than 50 Years of Infrared Technologies Excellence Joined Now in LYNRED** (9:00)

P. Jenouvrier, L. Rubaldo, A. Brunner, N. Péré-Laperne, J. Berthoz, N. Jamin, V. Destefanis, L. Martineau, N. Ricard
LYNRED, Veurey-Voroize, France
O. Gravrand
CEA-LETI, Grenoble, France

1.2

***Invited Paper:* Performance Limits of III-V Barrier Detectors** (9:30)

P. C. Klipstein, Y. Benny, Y. Cohen, N. Fraenkel, S. Gliksman, A. Glozman, I. Hirsh, O. Klin, L. Langof, I. Lukomsky, I. Marderfeld, Y. Nechemya, M. Nitzani, D. Rakhmilevich, L. Shkedy, N. Snapi, I. Shtrichman, E. Weiss, B. Milgrom
Semiconductor Devices, Haifa, Israel

BREAK (10:00–10:15)

Session 2: Devices I

(10:15 am–12:00 pm)

Chair: Nibir Dhar
NVESD, Fort Belvoir, VA, USA

2.1

RTS Noise Studies in HOT 15 μm Pitch HgCdTe Focal Plane Array (10:15)

Maxence Guénin

*ONERA/DOTA – Chemin de la Vauve aux Granges,
Palaiseau, France*

and

Université Paris-Sud, Orsay, France

*Sophie Derelle, Marcel Caes, Isabelle Ribet-Mohamed
ONERA/DOTA – Chemin de la Vauve aux Granges,
Palaiseau, France*

Laurent Rubaldo

LYNRED, Palaiseau, France

2.2

Law 19 – The Ultimate Photodiode Performance Metric (10:30)

D. Lee

Don L. Lee IR Consulting, Thousand Oaks, CA, USA

P. Dreiske, J. Ellsworth, R. Cottier, A. Chen,

S. Tallarico, A. Yulius, M. Carmody, E. Piquette,

M. Zandian, S. Douglas

Teledyne Imaging Sensors, Camarillo, CA, USA

2.3

High Energy Neutron Irradiation Effects on Molecular Beam Epitaxy HgCdTe-Based Focal Plane Arrays and Cameras (10:45)

Y. Chang, S. Velicu

EPIR, Inc., Bolingbrook, IL, USA

2.4

Broadband Metasurface Polarizers for Mid-Wave Infrared Radiation (11:00)

*Kai Zheng, Peihong Man, Christoph Grein,
Sivalingam Sivananthan*

University of Illinois at Chicago, Chicago, IL, USA

Srini Krishnamurthy

Sivananthan Laboratories, Bolingbrook, IL, USA

2.5

Design Criteria for High Quantum Efficiency (QE > 99%) SWIR HgCdTe Detectors (11:15)

*ND Akhavan, GA Umana-Membreno, R Gu,
J Antoszewski, L. Faraone*

University of Western Australia, Crawley, Australia

2.6

Modelling of Proton Irradiation Induced Luminescence of CdZnTe Substrate in HgCdTe Detectors (11:30)

*T. Pichon, S. Mouzali, O. Boulade, O. Limousin
Commissariat à l'Energie Atomique, Gif-sur-Yvette,
France*

*G. Badano, A. Ferron, O. Gravrand
Commissariat à l'Energie Atomique, LETI, Grenoble,
France*

2.8

Polarization-Sensitive Infrared Detection with Colloidal Quantum Dots (11:45)

*Xin Tang, Matthew M. Ackerman,
Philippe Guyot-Sionnest*

University of Chicago, Chicago, IL, USA

LUNCH

(12:00–1:15)

Session 3: Heteroepitaxy and Solar Cells (1:15–3:15 pm)

Chair: Timothy Gessert
*Gessert Consulting, LLC, Conifer, CO,
USA*

3.1

Invited Paper: A Liftoff Technology Using a Water-Soluble MgTe Sacrificial Layer, and CdTe/MgCdTe Double-Heterostructure Devices Based on InSb Substrates (1:15)

*Yong-Hang Zhang
Arizona State University, Tempe, AZ, USA*

3.2

Development of HgCdTe Infrared Detectors by Heterogeneous Processing (1:45)

*T. Mella, J. Abergel, L. Di Cioccio, S. Gout,
J.-L. Santailler, S. Renet
Univ. Grenoble Alpes, CEA-LETI, Grenoble, France*

3.3

A Study of the Effect of CdZnTe/CdTe Dislocation Filters on the MBE-Grown CdTe Buffers on Lattice Mismatched GaSb (211)B Substrates (2:00)

*W. W. Pan, R. J. Gu, Z. K. Zhang, J. L. Liu, W. Lei,
L. Faraone
University of Western Australia, Crawley, Australia*

3.4

Defect Properties of Group-V Doped Cadmium Telluride Single Crystal for High Open-Circuit Voltage (2:15)

*Akira Nagaoka, Kensuke Nishioka, Kenji Yoshino
University of Miyazaki, Miyazaki, Japan
Darius Kuciauskas
National Renewable Energy Laboratory, Golden, CO,
USA*

*Michael A. Scarpulla
University of Utah, Salt Lake City, UT, USA*

3.5

Selenium and Tellurium Diffusion in Polycrystalline $\text{CdSe}_x\text{Te}_{1-x}$ Films for Photovoltaics (2:30)

*Eric Colegrove, Craig Perkins, Tursun Ablekim,
David Albin, Joel N. Duenow, John Moseley,
Matt Young, Steve Harvey, Helio Moutinho,
Steve Johnson, Wyatt K. Metzger*
*National Renewable Energy Laboratory, Golden, CO,
USA*

Xin Zheng
University of Illinois at Chicago, Chicago, IL, USA

3.6

Progress Towards Fabrication of Poly-Crystalline $\text{Cd}_{(1-x)}\text{-Zn}_x\text{-Te}$ Top Cell for Multi-Junction Solar Cell (2:45)

*Tushar Shimpi, Carey Reich, Ramesh Pandey,
Anna Kindvall, Kurt Barth, Walajabad Sampath*
Colorado State University, Fort Collins, CO, USA
Ali Abbas, John Walls
Loughborough University, Leicestershire, UK

3.7

Synthesis of $\text{CdSe}_x\text{Te}_{1-x}$ Thin Film for CdSeTe/CdTe Gradient Solar Cell Application (3:00)

Xin Zheng
*National Renewable Energy Laboratory, Golden, CO,
USA*
and
University of Illinois at Chicago, Chicago, IL, USA
Eric Colegrove, Wyatt K. Metzger
*National Renewable Energy Laboratory, Golden, CO,
USA*
Siva Sivananthan
University of Illinois at Chicago, Chicago, IL, USA

BREAK (3:15–3:30)

Session 4: Materials I

(3:30–5:15 pm)

Chair: **Joseph Burns**

*Air Force Research Laboratory –
AFRL/RXAN, Wright-Patterson AFB, OH,
USA*

4.1

Electron Beam Induced Current (EBIC) (3:30) Analysis of HgCdTe/CdZnTe Defects

*J. D. Benson, L. O. Bubulac, R. N. Jacobs, J. M. Arias,
L. A. Almeida, A. Stoltz*

U.S. Army RDECOM, Fort Belvoir, VA, USA

*M. Reddy, J. Peterson, S. M. Johnson, J. Bangs,
D. D. Lofgreen*

Raytheon Vision Systems, Goleta, CA, USA

4.2

Developing a High-Resolution EBIC System (3:45) for Scanning Transmission Electron Microscopy of Advanced Infrared Semiconductor Devices

Robert F. Klie, Silviu Velicu

EPIR, Inc., Bolingbrook, IL, USA

4.3

Properties of Iodine-Doped CdTe Layers on (4:00) (211) Si Grown at High Substrate Temperatures by MOVPE

*M. Niraula, K. Yasuda, R. Torii, Y. Higashira,
R. Tamura, B. S. Chaudhari, T. Kobayashi, H. Goto,
S. Fujii, Y. Agata*

Nagoya Institute of Technology, Nagoya, Japan

4.4

Low-Threshold II-VI Lattice-Matched (4:15) SWS-FETs for Multi-Valued Low-Power Logic

F. Jain, R. Gudlavalleti, R. Mays, J. Chandy

University of Connecticut, Storrs, CT, USA

B. Saman

*University of Connecticut, Storrs, CT, USA
and*

Taif University, Saudi Arabia

E. Heller

Synopsys Inc., Ossining, NY, USA

4.5

Compressive Sensing Enhanced Hyperspectral Infrared Imaging for Earth Observing Systems (4:30)

*C. Buurma, A. Stevens, D. Wijewarnusuriya,
N. Browning*

Sivananthan Laboratories, Bolingbrook, IL, USA

4.6

HgCdTe HDVIP Focal Plane Arrays with In-situ Passivation Grown by Molecular Beam Epitaxy (4:45)

*Christopher Schaake, Justin Wilks, Marc Conner,
Sameer Ajmera*

Leonardo DRS, Dallas, TX, USA

Jun Zhao, Fikri Aqariden

Leonardo DRS, Bolingbrook, IL, USA

4.7

Development of Atomic Layer Deposited Passivation Layers for HgCdTe IRFPA Detectors (5:00)

Sushant Sonde, Yong Chang, Silviu Velicu

EPIR, Inc., Bolingbrook, IL, USA

RECEPTION/TABLETOPS

(5:30–7:30)

Poster Sessions (5:30–7:30 pm)

P.1

Modeling CuS–CdSe Solar Cell S-Shaped I-V Characteristics

Oleg Olikh, Dmytro Krasko

Taras Shevchenko National University of Kyiv, Kyiv, Ukraine

P.2

Wet Process of ZnO Films in Argon Atmosphere

Kenji Yoshino, Kohki Kamimizutaru, Yuuki Narita

University of Miyazaki, Miyazaki, Japan

Takashi Minemoto

Ritsumeikan University, Shiga, Japan

Satoshi Iikubo

Kyushu Institute of Technology, Kitakyushu, Japan

Qing Shen, Shuzi Hayase

University of Electro-Communications, Tokyo, Japan

P.3

Temperature Hysteresis of Electrical Conductivity Caused by Ultrasound in CdZnTe:Cl

Ya. M. Olikh, M. D. Tymochko

*V.Ye. Lashkaryov Institute of Semiconductor Physics
NAS of Ukraine, Kyiv, Ukraine*

O. Ya Olikh

Taras Shevchenko National University, Kyiv, Ukraine

P.4

Inclusion of Dislocation Pinning Interactions in a Model for Plastic Flow in II-VI Semiconductors

T. Kujofsa, J. E. Ayers

University of Connecticut, Storrs, CT, USA

P.5

Dislocation Sidewall Gettering in II-VI Semiconductors and the Effect of Pinning Interactions

T. Kujofsa, J. E. Ayers

University of Connecticut, Storrs, CT, USA

P.6

Development of HgCdTe Infrared Detectors by Heterogeneous Processing

T. Mella, J. Abergel, L. Di Cioccio, S. Gout,

J.-L. Sentailler, S. Renet

Univ. Grenoble Alpes, CEA-LETI, Grenoble, France

P.7

Development of a Cryogenic Test Bench for Spectral MTF Measurement on Midwave Infrared Focal Plane Arrays

*E. Huard, J. Jaeck, S. Derelle, J. Primot
ONERA, Palaiseau, France*

P.8

RTS Noise Studies in HOT 15 μm Pitch HgCdTe Focal Plane Array

Maxence Guénin

*ONERA/DOTA – Chemin de la Vauve aux Granges,
Palaiseau, France*

and

Université Paris-Sud, Orsay, France

*Sophie Derelle, Marcel Caes, Isabelle Ribet-Mohamed
ONERA/DOTA – Chemin de la Vauve aux Granges,
Palaiseau, France*

Laurent Rubaldo

LYNRED, Palaiseau, France

P.9

HgTe Colloidal Quantum Dot Short- and Mid-Wave Infrared Photodiodes

Matthew M. Ackerman, Xin Tang,

Philippe Guyot-Sionnest

University of Chicago, Chicago, IL, USA

P.10

Auger Suppression in Midwave Infrared Quantum Dots

Christopher Melnychuk, Philippe Guyot-Sionnest

University of Chicago, Chicago, IL, USA

P.11

Modelling of Proton Irradiation Induced Luminescence of CdZnTe Substrate in HgCdTe Detectors

T. Pichon, S. Mouzali, O. Boulade, O. Limousin

*Commissariat à l'Energie Atomique, Gif-sur-Yvette,
France*

G. Badano, A. Ferron, O. Gravrand

*Commissariat à l'Energie Atomique, LETI, Grenoble,
France*

RECEPTION/TABLETOPS

(5:30–7:30)

WEDNESDAY, NOVEMBER 20, 2019

Chicago River Ballroom

(7:45 am–5:00 pm)

Registration (7:45–5:00)

Continental Breakfast (7:45–9:30)

KEYNOTE ADDRESS

8:30 – 9:00 am

Dr. Michael Eismann

*Air Force Research Laboratory, Wright Patterson AFB,
OH, USA*

***“Air Force Science and Technology 2030 Strategy and
Infrared Technology Research”***

This presentation provides an overview of the primary objectives outlined in the Air Force Science and Technology 2030 (ST2030) that was released in 2019 in response to the National Defense Strategy. Using the ST2030 framework of transformational strategic capabilities, research priorities of future infrared systems and related technology development within AFRL are outlined and several of the approaches being pursued to address these challenges are described.

Session 5: Industrial Overview II

(9:00–10:15 am)

Chair: Pradip Mitra

Leonardo DRS, EOIS, Dallas, TX, USA

5.1

***Invited Paper:* Keeping HgCdTe Detector Technology Alive and Healthy: A Manufacturing and Technologies Perspective** (9:00)

M. Carmody

Teledyne Imaging Sensors, Camarillo, CA, USA

5.2

***Invited Paper:* Infrared Detector Technology Development at ASELSAN** (9:30)

Oğuz Altun

ASELSAN, Inc., Akyurt, Turkey

5.3

Higher Operating Temperature IR Detectors of the MOCVD Grown MCT Heterostructures (10:00)

P. Madejczyk, P. Martyniuk, A. Rogalski

Military University of Technology, Warsaw, Poland

W. Gawron, A. Kęblowski, D. Stępień, J. Piotrowski

Vigo System S.A., Ozarów Mazowiecki, Poland

BREAK

(10:15–10:30)

Session 6: Superlattice & Barrier Devices (10:30–12:00 pm)

Chair: Jill Nolde
Naval Research Laboratory, USA

6.1

Invited Paper: Theoretical Aspects of the InAs/InAsSb Type-II Strained Layer Superlattice (10:30)

David Z. Ting
California Institute of Technology, Pasadena, CA, USA

6.2

DFT Calculations of the Formation Energy and Valence Band Edge on Sb Disordered and Clustered LWIR InAs / InAsSb Type-II Superlattices (11:00)

C. Buurma, A. Ciani, C. Grein
Sivananthan Laboratories, Bolingbrook, IL, USA

6.3

Invited Paper: Absorption Characteristics Near the Infrared Cutoff in III-V Superlattice Materials (11:15)

David R. Rhiger
Raytheon Vision Systems, Goleta, CA, USA

6.4

Influence of Valence Band Offsets on the Performance Metrics of MWIR InAs/InAsSb Type II Strained Layer Superlattice nBn Detectors (11:45)

Jonathan Schuster
U.S. Army CCDC Army Research Laboratory, Adelphi, MD, USA
and
Boston University, Boston, MA, USA

Roger E. DeWames
Manufacturing Techniques, Lorton, VA, USA

LUNCH (12:00–1:15)

Session 7: Devices II

(1:15–3:00 pm)

Chair: Eric Piquette
Teledyne, Camarillo, CA, USA

7.1

Invited Paper: Enabling Technologies Needed: (1:15)
The Future of Army High Performance Imaging

J. G. Zeibel

*U.S. Army Night Vision and Electronic Sensors
Directorate (NVESD) Science & Technology
Division, Fort Belvoir, VA, USA*

7.2

GHz Single Photon Detection with HgCdTe APD Detectors (1:45)

*Johan Rothman, Salvatore Pes, Pierre Bleuet,
Julie Abergel, Sylvain Gout, Jean-Alain Nicolas,
Jean-Pierre Rostaing, Sebastien Renet, Lydie Mathieu,
Jérôme Le Perchec
CEA-LETI, Grenoble, France*

7.3

MTF Characterization of Small Pixel Pitch IR Cooled Photodiodes Using EBIC (2:00)

*A. Yèche, O. Gravrand, F. Boulard, S. Bisotto,
F. Rochette, J. Abergel, A. Ferron
CEA-LETI, Grenoble, France*

7.4

Reducing Dark Counts in HgCdTe Linear-Mode Photon-Counting e-APDs at Leonardo DRS (2:15)

*P. Duke Anderson, Jeffrey D. Beck, Mark Skokan,
William Sullivan III, Pradip Mitra
Leonardo DRS - EOIS, Dallas, TX, USA*

7.5

Characterization of SAPHIRA HgCdTe Avalanche Photodiodes for Space Lidar Applications (2:30)

Guangning Yang, Xiaoli Sun

*NASA Goddard Space Flight Center, Greenbelt MD,
USA*

Sachidadanda R. Babu

*NASA Earth Science Technology Office, Washington
DC, USA*

7.6

Development of a Cryogenic Test Bench for Spectral MTF Measurement on Midwave Infrared Focal Plane Arrays (2:45)

*E. Huard, J. Jaeck, S. Derelle, J. Primot
ONERA, Palaiseau, France*

BREAK (3:00–3:15)

Session 8: Materials II

(3:15–5:00 pm)

Chair: **Scott Johnson**

Raytheon Vision Systems, Goleta, CA, USA

8.1

Carrier Transport Models for HgTe Colloidal Quantum Dots (3:15)

Anthony J. Ciani, Srini Krishnamurthi,

Thomas Mlynarski, Richard E. Pimpinella

Sivananthan Laboratories, Bolingbrook, IL, USA

Christoph H. Grein

University of Illinois at Chicago, Chicago, IL, USA

Zhi-Gang Yu

Washington State University, Pullman, WA, USA

8.2

Full Electronic Band Structure Analysis of Cd Doped ZnO Thinfilms Deposited by Sol-Gel Spin Coating Method (3:30)

*Praveen Saxena, R. Trigunayat, Pankaj Srivastava,
Md. Zain*

Tech Next Lab Pvt Ltd, Lucknow, India

*Anchal Srivastava, R. K. Shukla, Nishant Kumar,
Shivendra Tripathi*

University of Lucknow, Lucknow, India

8.3

PbS Quantum-Dot Photodiodes Performance (3:45)

A. I. D'Souza, E. Robinson, A. Bakulin, C. Li

DRS Network & Imaging Systems, Cypress, CA, USA

D. S. Temple

RTI International, Research Triangle Park, NC, USA

E. Klem, A. Hilton, C. Gregory

*SWIR Vision Systems, Research Triangle Park, NC,
USA*

K. K. Choi, G. T. Dang, P. Wijewarnasuriya

US Army Research Laboratory, Adelphi, MD, USA

8.4

CdZnTe Substrate Production at RVS (4:00)

K. A. Jones, A. Hampp, J. M. Peterson, A. Andreatta,

R. W. McCord, G. Venzor, M. Bowers, F. Mach,

K. Gleissner, B. T. Fennell, P. Goetz, N. Juanko,

T. Vang, J. Hogan, S. M. Johnson

Raytheon Vision Systems, Goleta, CA, USA

8.5

Growth of CdZnTe for IR Substrate Applications Using the Travelling Heater Method — Current State of the Art (4:15)

J. MacKenzie, F. J. Kumar, L. Burgess

Redlen Technologies, Saanichton, BC, Canada

T. Sheahan, M. D. Cooper

Galaxy Compound Semiconductor Inc. (IQE Group Company), Spokane, WA, USA

M. Furlong

IQE IR, Cardiff, UK

8.6

Surface Preparation and Characterization of IR Specification Cadmium Zinc Telluride Substrates (4:30)

T. Sheahan, M. D. Cooper, B. Martinez

Galaxy Compound Semiconductors Inc. (IQE Group Company), Spokane, WA, USA

J. Mackenzie, L. Burgess, F. J. Kumar

Redlen Technologies Ltd., Saanichton, BC, Canada

8.7

Bragg Diffraction Imaging of CdZnTe Single Crystals (4:45)

P. Ballet, C. Yildirim, E. Gout, A. Pagot, D. Brellier

Univ. Grenoble Alpes, Grenoble, France

T. N. Tran Thi Caliste, J. Baruchel

ESRF, Grenoble, France

THURSDAY, NOVEMBER 21, 2019

Chicago River Ballroom

(8:00 am–3:00 pm)

Registration (8:00–3:00)

Continental Breakfast (8:00–9:30)

**WELCOME REMARKS AND FUTURE
CONFERENCE UPDATES**

8:45 am

Dr. Sivalingam Sivananthan, *II-VI Workshop Co-Chair*
University of Illinois at Chicago, Chicago, IL, USA

Dr. Pradip Mitra, *II-VI Workshop Co-Chair*
Leonardo DRS, Dallas, TX, USA

Session 10: Industrial Overview III
(9:00–9:45 am)

Chair: **Jose Arias**
CACI / NVESD, Fort Belvoir, VA, USA

10.1

***Invited Paper:* Progress in HgCdTe IR Imaging Devices at Leonardo DRS (9:00)**

Brett Breazeale
DRS, Arlington, VA, USA

10.3

Space Application Requirement Breakdown and Sensor Concept Implementation for MCT-Based VIS-SWIR Through VLWIR 2D High Performance Focal Plane Detector Arrays at AIM (9:30)

S. Hanna, A. Bauer, H. Bitterlich, D. Eich, M. Finck, H. Figgemeier, W. Gross, K.-M. Mahlein
AIM Infrarot-Module GmbH, Heilbronn, Germany

BREAK (9:45–10:00)

Session 11: Devices III

(10:00–12:00 pm)

Chair: Enrico Bellotti
Boston University, Boston, MA, USA

11.1

Invited Paper: Dirac Plasmon-Assisted Asymmetric Hot Carrier Generation for Room-Temperature Infrared Detection (10:00)

Debashis Chanda

University of Central Florida, Orlando, FL, USA

11.2

Development of High-Performance Graphene-HgCdTe Detector Technology for Mid-Wave Infrared Applications (10:30)

Samiran Ganguly, Sheikh Z. Ahmed, Avik W. Ghosh

University of Virginia, Charlottesville, VA, USA

Ashok K. Sood, John W. Zeller

Magnolia Optical Technologies, Woburn, MA, USA

Parminster Ghuman, Sachidananda Babu

NASA Earth Science Technology Office, Greenbelt, MD, USA

Nibir K. Dhar

U.S. Army Night Vision & Electronic Sensors

Directorate, Fort Belvoir, VA, USA

11.3

Performance of MWIR and LWIR Fully-Depleted HgCdTe FPAs (10:45)

D. Lee

Donald L. Lee IR Consulting, Thousand Oaks, CA, USA

P. Dreiske, J. Ellsworth, R. Cottier, A. Chen,

S. Tallarico, H. Barr, H. Tcheou, A. Yulius,

M. Carmody, E. Piquette, M. Zandian, S. Douglas

Teledyne Imaging Sensors, Camarillo, CA, USA

11.4

HgTe Colloidal Quantum Dot Short- and Mid-Wave Infrared Photodiodes (11:00)

Matthew M. Ackerman, Xin Tang,

Philippe Guyot-Sionnest

University of Chicago, Chicago, IL, USA

11.5

Auger Suppression in Midwave Infrared Quantum Dots (11:15)

*Christopher Melnychuk, Philippe Guyot-Sionnest
University of Chicago, Chicago, IL, USA*

11.6

Novel Spectroscopic Detection Using the Quantum-Confined Stark Effect in HgTe Colloidal Quantum Dot Infrared Detectors (11:30)

*Richard E. Pimpinella, Thomas Mlynarski
Sivananthan Laboratories, Bolingbrook, IL, USA*

*Christoph H. Grein
University of Illinois at Chicago, Chicago, IL, USA*

11.7

Two-Color NBN Infrared Detectors Based on Type-III Superlattices (11:45)

*Peihong Man, Christoph H. Grein
University of Illinois at Chicago, Chicago, IL, USA*

*Srini Kishnamurthy, Sivalingam Sivananthan
University of Illinois at Chicago, Chicago, IL, USA
and
Sivananthan Laboratories, Bolingbrook, IL, USA*

LUNCH (12:00–1:15)

Session 12: Materials III

(1:15–3:15 pm)

Chair: Tony Almeida
NVESD, Fort Belvoir, VA, USA

12.1

Invited Paper: Overview of HgCdTe Molecular Beam Epitaxial Growth for High Density Vertically Integrated Photodiode (HDVIP) Technology (1:15)

Fikri Aqariden

Leonardo DRS, Bolingbrook, IL, USA

12.2

MBE Growth of Strained HgZnTe on (001)CdTe (1:45)

J. Papin

*Univ. Grenoble Alpes, Grenoble, France
and*

Institut Néel, C.N.R.S. and Université Grenoble Alpes, Grenoble, France

P.-H. Jouneau, J.L. Rouvières, P. Noël, L. Vila,

J.-P. Attané, P. Ballet

Univ. Grenoble Alpes, Grenoble, France

T. Meunier

Institut Néel, C.N.R.S. and Université Grenoble Alpes, Grenoble, France

12.3

Molecular Simulations of Dislocation Line Energies and Mobility in CdTe, HgTe and ZnTe (2:00)

N. Hew, D. Spagnoli, W. Lei, J. Antoszewski, L. Faraone

University of Western Australia, Crawley, Australia

12.4

Conformal Passivation of HgCdTe Surfaces with CdTe Thin Film Using Novel Low-Temperature Atomic Layer Deposition (2:15)

Harish Bhandari, Steven Rose, Oleg Maksimov

Radiation Monitoring Devices, Inc., Watertown, MA, USA

Adam Hock, Michael Foody

Illinois Institute of Technology, Chicago, IL, USA

Ishwara Bhat, Rajendra Dahal

Rensselaer Polytechnic Institute, Troy, NY, USA

Andrew Stotlz

Night Vision and Electronic Sensors Directorate, Fort Belvoir, VA, USA

12.5

Ternary Lead Chalcogenide Tunable Mid-Infrared Detectors via Physical Vapor Deposition (2:30)

*Peter Su, Kazumi Wada, Lionel C. Kimerling,
Anu Agarwal*

*Massachusetts Institute of Technology, Cambridge,
MA, USA*

*Pijush Bhattacharya, Oleg Maksimov, Harish Bhandari
Radiation Monitoring Devices, Inc., Watertown, MA,
USA*

12.6

***Invited Paper:* Guiding MBE Growth with Atomistic Simulations** (2:45)

C. H. Grein

University of Illinois at Chicago, Chicago, IL, USA

A. Ciani

Sivananthan Laboratories, Bolingbrook, IL, USA

**WILLIAM E. SPICER
and**

**THOMAS N. CASSELMAN AWARDS
(3:15–3:30 pm)**

CLOSING REMARKS (3:30–3:45)

NOTES
