Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

2 November - 3 November 2011, Omni Austin Hotel Downtown, Austin, Texas, United States

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Hotel Reservations | Conference Program

How optical nanostructures and materials improve the efficiency of solar cells and solar concentrator systems.

The scope of the meeting covers all aspects of optical nanostructures for photovoltaic applications including:

- textured surfaces
- diffraction gratings
- plasmonic enhancement,
- spectrally split multiple cells
- spectral flux management in multijunction solar cells

This event is part of the Renewable Energy and the Environment Congress, allowing attendees to access to all meetings within the Congress for the price of one and to collaborate on topics of mutual interest.

Dynamic Program

- **8 Plenary Speakers**
  - **New** - Pathways to Ultra-Efficient Solid-State Lighting
    Mary H. Crawford, Sandia National Laboratories, USA
  - Applying Systems Analysis to Innovation: Solar Energy
    Kevin DeGroat, Program Director, Antares Group, Inc., USA
    Joe Morabito, Director, Alcatel-Lucent, USA
  - Theory and Practice for Nanophotonic Light Trapping
    Shanhui Fan, Stanford University, USA
  - Sustainable Energy & Optical Methods for Monitoring Air Pollution *Matthew Fraser, Global Institute of Sustainability, Arizona State Univ., USA*
  - Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology

Sarah Kurtz, Interim NCPV Director, Reliability Group Manager, NREL, USA

- Army S&T Development: Selected Energy Solutions
  Ed Shaffer, Chief, Energy & Power Division, Army Research Laboratory, USA
- Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications
  E. Fred Schubert and Jaehee Cho, Rensselaer Polytechnic Institute, USA

- **13 Expert invited speakers from academia, industry and government**
- **16 Oral presentations on cutting edge research in the field**
- **Poster presentations**
- **Postdeadline paper sessions**

Chairs

Thomas Krauss, *Univ. of St. Andrews, UK,* **General Chair**
Ralf Wehrspohn[1,2], *[1]Fraunhofer Inst. for Mechanics of Materials, Germany, [2]Martin-Luther-Univ. Halle- Wittenberg, Germany,* **Program Chair**

Papers are Published in Optics InfoBase. Here Are the Top 5 Downloaded 2010 PV Meeting InfoBase Papers:

- Absorption Enhancement in an Amorphous Si Solar…
- Plasmonic Anti-Reflection Coating for Thin Film…
- Increasing Polymer Solar Cell Efficiency with…
- All-Oxide Embedded-Nanowire Solar Cell
- Grating Mirror Based High Efficiency Optical…

Go to Optics InfoBase for a listing of all meeting paper archives.

View the 2010 Meeting Archive containing the final program (pdf).

Sponsor:

OSA

Renewable Energy and the Environment

November 2-3, 2011, Omni Austin Hotel Downtown, Austin, TX, USA

Four Collocated Meetings Cover Optics and Photonics in Energy Generation and Conservation

NEW! Optical Instrumentation for Energy & Environmental Applications (E2)

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

Optics for Solar Energy (SOLAR)

Solid State and Organic Lighting (SOLED)

***Register for one meeting and attend any session in the Congress.**

Wide Spectrum of Topics Present Optical Solutions for Renewable Energy

- Utilization of optical technologies to develop energy generation equipment
- Optical design and analysis of optics for solar and LED applications
- Instrumentation and optical sensors for energy management
- Methods to measure the impact on the environment
- Optical nanostructures and materials to improve efficiency of solar cells and solar concentrator systems
- Advances in solid state lighting in materials, devices and light management

Latest Advances in Solar and Solid-State Lighting

- **8 Plenary Speakers**
  - **New** - Pathways to Ultra-Efficient Solid-State Lighting
    Mary H. Crawford, Sandia National Laboratories, USA
  - Applying Systems Analysis to Innovation: Solar Energy

Kevin DeGroat, Program Director, Antares Group, Inc., USA
Joe Morabito, Director, Alcatel-Lucent, USA

- Theory and Practice for Nanophotonic Light Trapping
  Shanhui Fan, Stanford University, USA
- Sustainable Energy & Optical Methods for Monitoring Air Pollution
  Matthew Fraser, Global Institute of Sustainability, Arizona State Univ., USA
- Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology
  Sarah Kurtz, Interim NCPV Director, Reliability Group Manager, NREL, USA
- Army S&T Development: Selected Energy Solutions
  Ed Shaffer, Chief, Energy & Power Division, Army Research Laboratory, USA
- Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications
  E. Fred Schubert and Jaehee Cho, Rensselaer Polytechnic Institute, USA

- **48 expert invited speakers from academia, industry and government**
- **49 oral presentations on cutting edge research in the field**
- **24 poster presentations**
- **Postdeadline paper sessions**

Sponsor:

OSA

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

2 November - 3 November 2011, Omni Austin Hotel Downtown, Austin, Texas, United States

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Program

Agenda of Sessions, Abstracts and Key to Authors
Searchable Online Conference Program
Overview of Program
Conference at a Glance (pdf)
Invited Speakers At-a-Glance

Program Overview

PV solar electricity is an important technology being developed to help reduce the world's reliance on fossil fuels. Research into developing higher efficiency cells is aimed at making photovoltaics economically competitive. Optical nanostructures appear to offer advantages that can lead to improved efficiency by increasing the absorption of incident light, especially for thin-film applications. Solar concentrator systems, organic solar cells and dye-sensitized cells also stand to benefit from nano-photonic engineering schemes.

How optical nanostructures and materials improve the efficiency of solar cells and solar concentrator systems.

The scope of the meeting covers all aspects of photovoltaic efficiency improvement techniques including:

- Nano-textured surfaces of various types
- Nanostructures for solar concentrators
- Nanostructures for dye-sensitized solar cells
- Nanostructures for thin-film organic solar cells
- Tandem cells
- Spectral flux management in multijunction solar cells
- Gratings and diffractive optics used with/on solar cells
- Resonance and plasmonic enhancement of optical absorption
- Spectral flux management
- Novel solar cell geometries

Online Conference Program

Searchable Conference Program Available Online!

- Browse speakers and the agenda of sessions.
- Browse sessions by type or day.
- Use Advanced Search to search the program by author, title, OCIS code and more.
- Plan and print your personal itinerary before coming to the conference.

You may search the program without creating an account; however, you will not be able to create or save a personal itinerary without first creating an account. We strongly recommend that you create a user account first.

Abstracts, Agenda of Sessions and Key to Authors

- Agenda of Sessions (pdf)
- Abstracts (pdf)
- Key to Authors and Presiders (pdf)

Special Events

Welcome Reception
Plenary Sessions
Poster Session
Post Deadline Sessions

2011 OSA OPTICS & PHOTONICS CONGRESS

CONFERENCE PROGRAM

Renewable Energy and the Environment

Optical Instrumentation for Energy & Environmental Applications (E2)

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

Optics for Solar Energy (SOLAR)

Solid State and Organic Lighting (SOLED)

2–3 November 2011

Omni Austin Hotel Downtown
Austin, Texas, USA

OSA®

Optical Instrumentation for Energy & Environmental Applications (E2)
Optical Nanostructures and Advanced Materials for Photovoltaics (PV)
Optics for Solar Energy (SOLAR)
Solid State and Organic Lighting (SOLED)

2 & 3 November 2011

Omni Hotel Austin Downtown, Austin, Texas, USA

Welcome to the Optical Society of America's 2011 Renewable Energy and the Environment Optics and Photonics Congress (OPC) in Austin, Texas. This is the second year of this OPC, with the first being in Karlsruhe, Germany in 2010, but this year two meetings have joined the OPC. The four meetings being held at this Congress are:

- Solid State and Organic Lighting (SOLED; at Karlsruhe in 2010),
- Optics for Solar Energy (SOLAR; in Tucson in 2010),
- Optical Nanostructures and Advanced Materials for Photovoltaics (PV; at Karlsruhe in 2010), and
- Optical Instrumentation for Energy and Environmental Applications (E2; new meeting).

Though the primary focus of this meeting is renewable energy, especially solar, the topics are broadened to include solid-state and organic light sources and the connection between energy and the environment. In the solar arena the PV meeting presents how materials and nanostructures are being used to increase the efficiency of solar energy systems, while the SOLAR meeting addresses the optical design aspects of concentrators and similar optics for the generation of energy. SOLED tackles the source side of the efficient use of energy, including the materials, the optical design, and metrology of solid state and organic LEDs. Finally, E2 takes a look at how energy and environmental issues are intertwined, especially measurement methods, energy management, and the development of instrumentation.

The challenges for all energy optics fields are similar in a number of cases, so there are two joint plenary sessions with a total of seven speakers:

- ***Applying Systems Analysis to Innovation: Solar Energy*** – Kevin DeGroat, Program Director, Antares Group, Inc., USA and Joe Morabito, Director, Alcatel-Lucent, USA;
- ***Theory and Practice for Nanophotonic Light Trapping*** – Shanhui Fan, Stanford University, USA;
- ***Sustainable Energy and Optical Methods for Monitoring Air Pollution*** – Matthew Fraser, Global Institute of Sustainability, Arizona State Univ., USA;
- ***Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology*** – Sarah Kurtz, Interim NCPV Director, Reliability Group Manager, NREL, USA;
- ***Energy & Power Science and Technology: An Army Perspective*** – Ed Shaffer, Chief, Energy and Power Division, Army Research Laboratory, USA; and
- ***Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications*** – E. Fred Schubert and Jaehee Cho, Rensselaer Polytechnic Institute, USA .

As can be seen, these speakers range from industry to academia to government, which gives an excellent overview of the burgeoning energy in optics field. These plenary sessions bring together all attendees of the OPC to present the current challenges for given topic areas, while also encouraging cross-development in other fields. In addition there are 48 invited speakers and 49 contributed papers. In the joint poster session there will be 24 presentations. Finally, postdeadline paper sessions are planned, for which the details will be provided in your registration packets.

We are already planning the 2012 through 2014 Renewable Energy and the Environment OPCs. In 2012 we will be meeting in Eindhoven, The Netherlands. If you are interested in assisting or have ideas for this OPC, please contact the meeting chairs, program committees, OSA staff or me.

Personally, I thank the chairs of the four collocated meetings (see below for a listing), their program committees, and the OSA staff. It could not have been done without your tireless efforts. A final thank you to you, the attendees – this conference is for you – I know that you will enjoy your stay to Austin, Texas.

Regards,

R. John Koshel
OSA Board of Meetings, Chair Elect
jkoshel@optics.arizona.edu

E2

John Koshel, *Photon Engineering and Univ. of Arizona, USA,* ***General Chair***
Joseph A. Shaw, *Montana State Univ., USA,* ***General Chair***

PV

Thomas Krauss, *Univ. of St. Andrews, UK*, ***General Chair***
Ralf Wehrspohn, *Fraunhofer Inst. for Mechanics of Materials and Martin-Luther-Univ. Halle- Wittenberg, Germany,* ***Program Chair***

SOLAR

Joseph Ford, *Univ. of California at San Diego, USA,* ***General Chair***
Alan Kost, *Univ. of Arizona, USA,* ***General Chair***
Raymond Kostuk, *Univ. of Arizona, USA,* ***General Chair***

SOLED

Bernard Kippelen, *Georgia Tech, USA,* ***General Chair***
Jiangeng Xue, *Univ. of Florida, USA,* ***General Chair***
Ulrich Lemmer, *Univ. Karlsruhe, Germany,* ***Program Chair***
Joachim Wagner, *Fraunhofer Inst. for Applied Solid State Physics IAF, Germany,* ***Program Chair***
Dongxue (Michael) Wang, *OSRAM, USA,* ***Program Chair***

Renewable Energy and the Environment Program Committee

Optical Instrumentation for Energy and Environmental Applications (E2)

General Chairs

John Koshel, *Photon Engineering and Univ. of Arizona, USA*
Joseph A. Shaw, *Montana State Univ., USA*

Committee Members

Ian Ashdown, *ByHearts Consulting, Canada*
Zuguang Guan, *ALOMAR Observatory, Andoya Rocket Range AS, Norway*
Mark Phillips, *Pacific Northwest Natl. Lab, USA*
R. Sai Santosh, *Center for Nano Science and Technology, Italy*
Greg Smestad, *Sol Ideas, USA*
Jeffrey R. Taylor, *National Ecological Observatory Network (NEON), USA*
Blair Unger, *BLU Optics, USA*
Michael Wojcik, *Energy Dynamics Lab, USA*
Gerard Wysocki, *Princeton Univ., USA*

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

General Chair

Thomas Krauss, *Univ. of St. Andrews, UK*

Program Chair

Ralf Wehrspohn, *Fraunhofer Inst. for Mechanics of Materials and Martin-Luther-Univ. Halle- Wittenberg, Germany*

Committee Members

Lucio Claudio Andreani, *Univ. degli Studi di Pavia, Italy*
Kylie Catchpole, *Australian Natl. Univ., Australia*
Ihab El-Kady, *Sandia Natl. Labs, USA*
Falk Lederer, *Friedrich-Schiller-Univ. Jena, Germany*
Joachim Loos, *Univ. of Glasgow, UK*
Albert Polman, *FOM Inst. AMOLF, Netherlands*
Johannes Upping, *Martin Luther Univ., Germany (Chair Helper)*

Optics for Solar Energy (SOLAR)

General Chairs

Joseph Ford, *Univ. of California at San Diego, USA*
Alan Kost, *Univ. of Arizona, USA*
Raymond Kostuk, *Univ. of Arizona, USA*

Committee Members

Allen Barnett, *Univ. of Delaware, USA*
Kylie Catchpole, *The Australian Natl. Univ., Australia*
Martha Symko Davies, *Natl. Renewable Energy Lab, USA*
César Domínguez, *Univ. Politécnica de Madrid, Spain*
Jesse Frantz, *US Naval Res. Lab, USA*
Mark George, *General Plasma Inc., USA*
Swee Hoe Lim, *Arizona State Univ., USA*
Nasser Karam, *USA*
Jun Ke, *Univ. of Hong Kong, Hong Kong*
John Koshel, *Photon Engineering and Univ. of Arizona, USA*
Fred Leonberger, *MIT, USA*
Patrick Meada, *Palo Alto Res. Ctr., USA*
Anastasios Melis, *Univ. of California at Berkeley, USA*
Ugur Ortabasi, *United Innovations, USA*
Ioannis Papakonstantinou, *CERN-European Organization for Nuclear Res., Switzerland*
Peter Peumans, *Stanford Univ., USA*
Greg P. Smestad, *Solar Energy Materials and Solar Cells, USA*
Georgios Veronis, *Louisiana State Univ., USA*
Roland Winston, *Univ. of California at Merced, USA*
Yong Hang Zhang, *Arizona State Univ., USA*

Solid State and Organic Lighting (SOLED)

General Chairs

Bernard Kippelen, *Georgia Tech, USA*
Jiangeng Xue, *Univ. of Florida, USA*

Program Chairs

Ulrich Lemmer, *Univ. Karlsruhe, Germany*
Joachim Wagner, *Fraunhofer Inst. for Applied Solid State Physics IAF, Germany*
Dongxue (Michael) Wang, *OSRAM, USA*

Committee Members - OLED

Chihaya Adachi, *Kyushu Univ., Japan*
Klaus Bonrad, *Merck KGaA, Germany*
Brian d'Andrade, *Exponent, USA*
Anil Duggal, *GE, USA*
Russell Holmes, *Univ. of Minnesota, USA*
Ioannis (John) Kymissis, *Columbia Univ., USA*
John de Mello, *Imperial College London, UK*
Hideyuki Murata, *Japan Advanced Inst. of Science and Technology (JAIST), Japan*
Franky So, *Univ. of Florida, USA*

Committee Members - LED

Hiroshi Amano, *Nagoya Univ., Japan*
Norbert Linder, *OSRAM/Siemens, China*
Yongio Park, *Samsung LED, South Korea*
U. T. Schwarz, *Univ. Regensburg / Fraunhofer IAF, Germany*
Seth Coe Sullivan, *QD Vision, USA*
C.C. Yang, *National Taiwan Univ., Taiwan*

Committee Members - Lighting Systems

Mike Lu, *Acuity Brands Lighting, USA*

Special Events

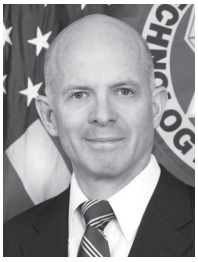
Opening Plenary Session

Wednesday, 2 November 2011, 08:00-10:00
Capital Ballroom A

Army S&T Development: Selected Energy Solutions

Future forces need alternatives and efficient conversion for resilient operations. Alternative energy, energy storage, and conversion technologies provide higher efficiency, higher density solutions adaptable to military requirements.

Ed Shaffer, *Chief, Energy & Power Division, Army Research Laboratory, USA*



Dr. Edward Shaffer is currently Director for the Sensors & Electronic Devices Directorate, Army Research Lab, overseeing development efforts in power and energy, electronics, and sensor technologies. Dr. Shaffer received the B.S. degree from the US Military Academy; the M.S. and E.E. degrees from the Massachusetts Institute of Technology; and the Ph.D. in Electrical Engineering from Auburn University. He served in a variety of technical and leadership positions as a US Army officer, including tours in Germany, Korea and the United Kingdom, and as an Associate Professor in the Department of Electrical Engineering & Computer Science at the US Military Academy.

Dr. Shaffer was also a Senior Design Engineer with Solectria Corporation in Woburn, MA. As Chief of the Energy & Power Division at ARL, he supervised efforts in high energy batteries, fuel cells, and continuous and pulsed wideband gap power electronic materials and devices. He is currently Lead of the US Army RDECOM Power and Energy Technology Focus Team, serves as senior Army representative on the OSD Energy and Power Community of Interest, and is Chair of the Interagency Power Group Steering Committee. His awards include the Legion of Merit; he is a Senior Member of IEEE and is a licensed Professional Engineer.

Pathways to Ultra-Efficient Solid-State Lighting

In this presentation, we review materials and device roadblocks to achieving ultra-efficient lighting based on inorganic LEDs. We present emerging research approaches for overcoming these roadblocks and enabling new functionality in lighting.

Mary H. Crawford, *Sandia National Laboratories, USA*

Mary Crawford is a Senior Scientist in the Semiconductor Material and Device Sciences Department at Sandia National Laboratories in Albuquerque, NM. She received a Ph.D. degree in physics from Brown University with a focus on excitonic effects and gain in ZnSe-based quantum wells and laser diodes. She joined Sandia National Laboratories in 1993 and worked on the development of novel vertical-cavity surface-emitting lasers (VCSELs), including AlInGaP red VCSELs and intracavity frequency-doubled VCSELs, and wide-bandgap nitride materials for UV LEDs.

In 2000, Dr. Crawford embarked on a two-year entrepreneurial leave and worked as Senior Scientist and Director of Research and Development at Uniroyal Optoelectronics in Tampa, FL. There she was involved in epitaxial growth and characterization of InGaN-based near-UV, blue, and green LEDs and led R&D to support new LED products. She returned to Sandia in 2002 and has continued research and development of nitride-based materials and optoelectronic devices. Her most recent studies involve AlGaN deep UV (< 340 nm) LEDs and laser diodes for applications including bioagent sensing and water purification, and spectroscopic studies of radiative and nonradiative processes in blue/green InGaN materials for solid-state lighting. She is presently on the senior leadership council of Sandia's Energy Frontier Research Center on Solid-State Lighting Science and has co-authored more than 100 publications.

Special Events continued

Applying Systems Analysis to Innovation: Solar Energy

A Systems Analysis for photovoltaics identifies positive reinforcements for solar development (global solar value creation). There are three high leverage points: photovoltaics and smart grids, photovoltaic industry supply chains, and pressure for sustainable development.

Joe Morabito, *Director, Alcatel-Lucent, USA*

Joe Morabito received his training in Materials/Engineering Science at Notre Dame with honors (B.S. 1963) and his Ph.D. from the University of Pennsylvania (1967). He then went, as a postdoctoral fellow, to the University of California at Berkeley (1968) and as a visiting scientist (1969) to the Philips Research Laboratories, Eindhoven, The Netherlands. He joined Bell Laboratories in 1970 and is the author of 81 publications and six patents covering a broad range of technology development for advanced telecommunications systems, business development, environmental sciences, and renewable energy. He received the Bell Labs Fellow Award in June, 2005. He has served on the editorial boards of Thin Solid Films and the Journal of Surface and Interface Science. He has also been active as a consultant to the National Science Foundation, the Electrical Power Research Institute (EPRI) and the Department of Energy in the area of solar energy, a member of the Industrial Advisory Council at Penn State, a member of the Advisory Committee of the EPA National Pollution Prevention Center at the University of Michigan, and the Advisory Committee on Environmental Health and Safety issues at the Oak Ridge National Laboratory and on the internal research programs at the National Renewable Energy Laboratory (NREL), the Board of Directors of the Research and Development Council of New Jersey, the Selection Committee for Industrial Ecology Grants by the AT&T Foundation and on the Advisory Board of the Multi-Lifecycle Engineering Research Center at the New Jersey Institute of Technology (NJIT). He is currently Senior Director of Integrated Robust Design and Compliance Engineering Center for Alcatel-Lucent - Bell Laboratories. He recently served as 2008 Chairman of the DOE Solar Energy Program.

Kevin DeGroat, *Program Director, Antares Group, Inc., USA*

Kevin DeGroat is Program Director for the Antares Group, Inc., a clean energy engineering firm in business since 1992. Mr. DeGroat has been a consultant on clean energy and environmental policy and research programs since 1985. His primary clients have been in the US Department of Energy Office of Energy Efficiency and Renewable Energy and the Office of Electricity Delivery and Energy Reliability, including the Solar Energy Technology Program, the Federal Energy Management Program, the Geothermal Technology Program, the Building Technologies Program and the Biomass Program. He has also worked with Sandia National Laboratory, the National Renewable Energy Laboratory and the California Energy Commission with a focus on research and development program planning and budgeting, research peer review, renewable energy market analysis, and technology roadmapping. His educational background includes graduate work at the University of Minnesota HHH Institute of Public Affairs focused on public policy with an energy and environmental technology core, and undergraduate study in Public Administration at Hamline University.

Special Events continued

Tutorial Session

Wednesday, 2 November 2011, 10:30-12:15
Austin South

Introduction to Energy and Environmental Optics

10:30-11:15
Overview of Optical Remote Sensing Systems for Environmental Studies

Joseph A. Shaw, *Electrical and Computer Engineering Department, Montana State University, USA.*

Joseph Shaw is the Director of the Optical Technology Center, Professor of Electrical and Computer Engineering, and Affiliate Professor of Physics at Montana State University (MSU) in Bozeman, Montana. Previously he worked at the National Oceanic and Atmospheric Administration (NOAA) Environmental Research Labs in Boulder, Colorado. He earned a Bachelor of Science degree in electrical engineering from the University of Alaska – Fairbanks, a Master of Science degree in electrical engineering from the University of Utah, and a Master of Science and Ph.D. in Optical Sciences from the University of Arizona.

Dr. Shaw conducts research developing optical remote sensing systems and using them to study climate, weather, and atmospheric optical effects. His current research focuses on polarimetric and radiometric spectral imaging and lidar measurements of the natural Earth environment. He enjoys photographing natural optical phenomena and using his photos to understand and teach about optics and nature. Recognition for his work includes the *Presidential Early Career Award for Scientists and Engineers* and the *Vaisala Award* from the World Meteorological Organization. Dr. Shaw is a Fellow of both the Optical Society of America (OSA) and SPIE.

11:15 -12:15
Applied Photometry, Radiometry, and Measurements of Optical Losses: Systems, Methods, Techniques for Energy and Environmental Applications

Part 1, Direct Approaches 11:15-11:45
Part 2, Remote Studies 11:45-12:15

Michael A. Bukshtab, *Michael A Bukshtab Consulting, USA.*

Michael A Bukshtab received M.S. and Ph.D. degrees in Optical Design and Spectroscopy and in Physical Optics from The Technical University of Fine Mechanics & Optics and from Vavilov' State Optical Institute, and had post-doctoral tenure analyzing high-purity silica glasses & specialty fibers in The Institute of Silicate Chemistry, Academy of Sciences - all in St. Petersburg (Leningrad), Russia. His M.S thesis received Best-Diploma award among nearly 30 Leningrad's technical universities and was published in "Measurement Techniques" in 1978. Michael's monograph "The Low Loss Measurement Techniques", was published in 1988 by Energoatomizdat, Moscow-Leningrad. Another book: M.A. Bukshtab, A. S. Doynikov, and V. N. Koromislichenko, "Photometry and Radiometry for Engineers" (editors M. A. Bukshtab and A. A. Wolkenstein) by Polytechnika, Leningrad (St. Petersburg), 1991, was announced for publication, proofs were printed, but manuscript was left unpublished, as Michael immigrated to the USA. Michael was elected by employees the Board Chairman of Leningrad Institute of Telecommunications, where he served from 1989 until immigrating in 1991. In USA Michael worked on design, development, and fabrication of optical systems and components for such companies as Sandoz, Corning, Pirelli, Kodak, CIENA, Lucent, and GE Advanced Materials. Michael latest experience via Michael A Bukshtab Consulting includes investigation of various optical properties: detection of color-shifting, polarization-dependent, backreflection, backscattering and other low-loss related phenomena, designing all-optical wavelength-switching and cross-connect systems and OADM networks, working on terabit optical routers and fiber backplanes, investigating EUV lithography systems, interferometric and diffraction-based positioning sensors, improving fiber-laser and EDFA-based air-to-ground ranging lidars. Michael has either authored or co-authored more than 30 Patents or Invention Certificates and participated in more than 70 Scientific Publications and Conference Presentations: book Applied Photometry, Radiometry, and Measurements of Optical Losses is being published in Springer Series in Optical Sciences.

Special Events continued

Joint Poster Session with refreshments

Wednesday, 2 November 2011, 18:00-19:00
Capital Ballroom B

Conference Reception —
Texas BBQ at the Six Lounge

Wednesday, 2 November 2011, 19:15-20:30
117 W. 4th St., Austin, TX
http://www.sixlounge.com/2.0/#/about2/

Joint Plenary Session

Thursday, 3 November 2011, 08:00-10:00
Capital Ballroom A

08:00
Theory and Practice for Nanophotonic Light Trapping

Shanhui Fan; *Stanford University, USA.*

Shanhui Fan is an Associate Professor of Electrical Engineering at the Stanford University. He received his Ph. D in 1997 in theoretical condensed matter physics from the Massachusetts Institute of Technology (MIT), and was a research scientist at the Research Laboratory of Electronics at MIT prior to his appointment at Stanford. His research interests are in computational and theoretical studies of solid state and photonic structures and devices, especially photonic crystals, plasmonics, and meta-materials. He has published over 220 refereed journal articles that were cited over 13,000 times, has given over 170 invited talks, and was granted 39 US patents. Prof. Fan received a National Science Foundation Career Award (2002), a David and Lucile Packard Fellowship in Science and Engineering (2003), the National Academy of Sciences Award for Initiative in Research (2007), and the Adolph Lomb Medal from the Optical Society of America (2007). Dr. Fan is a Fellow of the American Physical Society, the Optical Society of America, the SPIE, and the IEEE.

08:30
Sustainable Energy & Optical Methods for Monitoring Air Pollution

Matthew Fraser; *Global Institute of Sustainability, Arizona State University, USA.*

Prof. Matt Fraser is the Director of Research Development in the Global Institute of Sustainability (GIOS) at Arizona State University (ASU) as well as an Associate Professor in the School of Sustainability (SOS) at ASU.

In leading the research development team at GIOS, Dr. Fraser is directly involved in initiating and promoting interdisciplinary research projects across ASU and building teams of researchers to respond to the grand challenges of global sustainability. The research portfolio at GIOS is valued at approximately $10M per year and spans renewable energy and energy efficiency, water sustainability and climate, urban ecology and ecosystem services and international development and social sustainability.

As a faculty member, Dr. Fraser directs his own research projects on urban air quality. Dr. Fraser's research focuses on using organic speciation and receptor modeling to apportion ambient pollutants to their original source. To tackle this complex problem, Dr. Fraser's research group has been involved in field monitoring programs, source characterization studies, emission inventory preparation, and analytical method and instrument development projects.

Recently, Prof. Fraser has worked to initiate a series of research grants on the sustainability of energy systems, including:

Energize Phoenix – a $25M collaborative effort between the City of Phoenix, Arizona State University and Arizona Public Service to catalyze an energy efficient culture in central Phoenix (funded by US Dept. of Energy)

The Green Apple Study investigating the indoor air quality and health outcomes of energy efficiency retrofits with the specific goal of quantifying how sealing a building envelope impacts indoor air pollution and associated health effects (funded by US Dept. of Housing and Urban Development)

Dr. Fraser received his Bachelors of Science (with University Honors) in Chemical Engineering from Carnegie Mellon University and his Masters and Ph.D. in Environmental Engineering Science from Caltech. Prior to joining the School of Sustainability at ASU, Prof. Fraser was on the faculty of Rice University in the Department of Civil and Environmental Engineering.

Special Events continued

09:00
Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology

Sarah Kurtz; *Interim NCPV Director, Reliability Group Manager, NREL, USA.*

Sarah Kurtz obtained her PhD in 1985 from Harvard University and has worked since then at the National Renewable Energy Laboratory, in Golden, CO. She is best known for her contributions to developing multijunction, GaInP/GaAs solar cells and for supporting the Concentrator Photovoltaic (PV) industry. Currently, she is managing the Reliability Group at NREL and working to facilitate the growth of the PV industry through improved performance of PV in the field.

09:30
Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications

E. Fred Schubert; *Rensselaer Polytechnic Institute, USA.*

E. Fred Schubert is the Wellfleet Senior Constellation Professor at Rensselaer Polytechnic Institute. He made pioneering contributions to the field of compound semiconductor materials and devices, particularly to the doping of compound semiconductors and to the development and understanding of light-emitting diodes. He authored the books *Doping in III–V Semiconductors* (1992), *Delta Doping of Semiconductors* (1996), and *Light-Emitting Diodes* (1st edition 2003 and 2nd edition 2006). He is co-inventor of more than 30 US patents and co-authored more than 300 publications. He is a Fellow of the APS, IEEE, OSA, and SPIE and has received several awards.

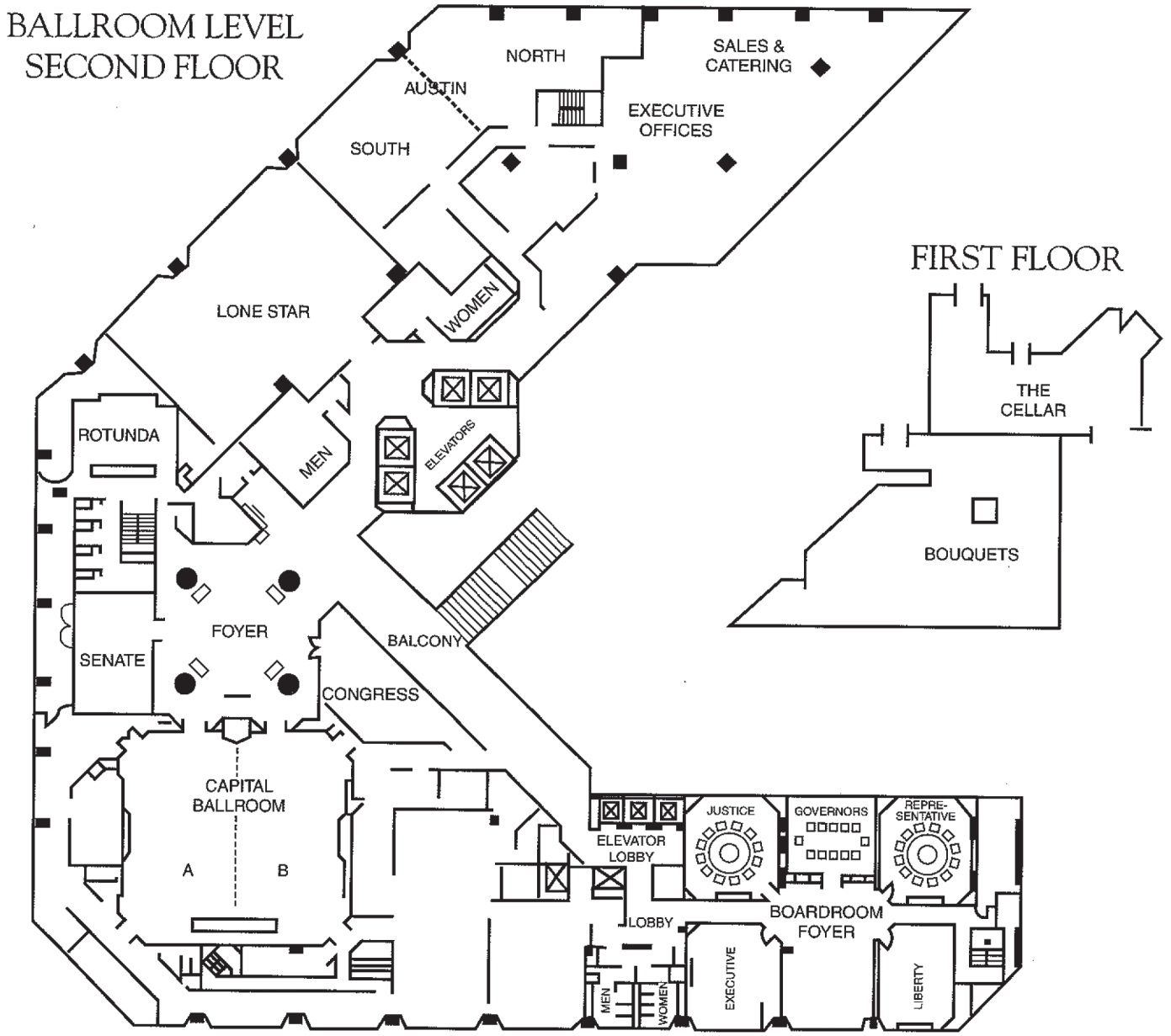
Postdeadline Papers Presentations

The committees of E2, SOLAR and SOLED accepted postdeadline papers for presentation. The purpose of postdeadline session is to give participants the opportunity to hear new and significant materials in rapidly advancing areas. Only those papers judged to be truly excellent and compelling in their timelines were accepted.

For more information, including the schedule and locations see the Update Sheet with copies of the Postdeadline papers attached.

Joint Postdeadline Paper Session
Wednesday, 17:00-18:00
Senate Room

OMNI AUSTIN HOTEL



Agenda of Sessions — Wednesday, 2 November

	Senate	Austin North	Capital Ballroom A	Austin South
	SOLAR	**SOLED**	**PV**	**E2**
07:00–18:00	**Registration Open**			
08:00–10:00	**JWA • Renewable Energy Plenary Session,** *Capital Ballroom A* Esther Hoffman Beller Award Presentation			
10:00–10:30	**Coffee Break,** *Capital Ballroom Foyer*			
10:30–12:30	**SRWB • CPV Systems** (Ends at 12:00)	**SDWB • Novel OLED Materials**	**PWB • Photon Management in Solar Cells: Dielectric Nanostructures I**	**EWB • Introduction to Energy and Environmental Optics TUTORIAL** (Ends at 12:15)
12:30–14:00	**Lunch** *(on your own)*			
14:00–16:00	**SRWC • CPV Design and Components**	**SDWC • OLED Device Physics**	**PWC • Photon Management in Solar Cells: Dielectric Nanostructures II**	**EWC • Sensors for Atmospheric Trace Gases and Aerosols**
16:00–16:30	**Coffee Break,** *Capital Ballroom Foyer*			
16:30–18:00	**Joint Postdeadline Paper Session** (Starts at 17:00)	**SDWD • Quantum Dot LED's** (Ends at 17:30)	**PWD • Photon Management in Solar Cells: Plasmonic Nanostructrures**	
18:00–19:00	**JWE • Joint Poster Session,** *Capital Ballroom B*			
19:15–20:30	**Conference Reception,** *Six Lounge*			

Key to Conference Abbreviations

E2 Optical Instrumentation for Energy & Environmental Applications
PV Optical Nanostructures and Advanced Materials for Photovoltaics
SOLAR Optics for Solar Energy
SOLED Solid State and Organic Lighting

Agenda of Sessions — Thursday, 3 November

	Senate	Austin North	Capital Ballroom A	Austin South
	SOLAR	**SOLED**	**PV**	**E2**
07:00–17:00	**Registration Open,** *Capital Ballroom Foyer*			
8:00–10:00	**JThA • Joint Congress Plenary Session,** *Capital Ballroom A*			
10:00–10:30	**Coffee Break,** *Capital Ballroom Foyer*			
10:30–12:30	**SRThB • Planar Optical Concentrators and High Efficiency Concepts**	**SDThB • LED Materials and Devices**	**PThB • Nanostructured Materials with Enhanced Efficiency**	**EThB • Optical Design of Components and Subsystems for Energy and Environment** (Ends at 12:15)
12:30–14:00	**Lunch** *(on your own)*			
14:00–16:00	**See Joint PV/Solar Capital Ballroom A**	**SDThC • Novel Devices and Lighting Systems** (Ends at 15:30)	**JThC • Joint PV/Solar Concepts of Light Trapping and Photon Transport**	**EThC • Laser Systems for Trace Gas Sensing and Combustion Diagnostics** (Ends at 16:15)
16:00–16:30	**Coffee Break,** *Capital Ballroom Foyer*			
16:30–18:30			**PThD • Photon Management in Organic Solar Cells**	**EThD • Testing and Development of Solar Energy Systems and Materials**

Key to Conference Abbreviations

E2 Optical Instrumentation for Energy & Environmental Applications
PV Optical Nanostructures and Advanced Materials for Photovoltaics
SOLAR Optics for Solar Energy
SOLED Solid State and Organic Lighting

07:00–18:00 Registration Open

08:00–10:00 JWA • Renewable Energy Plenary Session, Esther Hoffman Beller Award Presentation, *Capital Ballroom A*

10:00–10:30 Coffee Break, *Capital Ballroom Foyer*

Senate

Optics for Solar Energy

10:30–12:00
SRWB • CPV Systems
Ioannis Papakonstantinou; *University College, London, England, Presider*

SRWB1 • 10:30 Invited
Amonix Concentration Photovoltaic Power Plants, *Geoffrey S. Kinsey[1]; [1]Aminox, USA.* Energy modeling has been used to increase both the rated power and energy yield. Solar power generators deployed in 2011 exceed previous performance by more than 10%.

SRWB2 • 11:00 Invited
Luminescent Solar Concentrators: Applications and Advances, *Amanda Chatten[1]; [1]Imperial College, UK.* The luminescent solar concentrator provides unique design flexibility and the opportunity to concentrate both diffuse and direct sunlight. We will review recent advances and applications ranging from power generating windows to portable charging cloth.

Austin North

Solid State and Organic Lighting

10:30–12:30
SDWB • Novel OLED Materials
Jiangeng Xue; *University of Florida, United States, Co-Presider*
Jian Li, *Arizona State University, United States, Co-Presider*

SDWB1 • 10:30 Invited
High Efficiency White Organic Light Emitting Device Using A Single Emitter, Jian Li[1]; *[1]University of Arizona, USA.* The white organic light emitting diodes (WOLEDs) with high power efficiency (>100 lm/W) are considered as strong candidates for next generation illumination devices. Especially, WOLEDs use environmentally benign organic materials and their fabrication cost can be significantly reduced with potential roll-to-roll processing technology. To date, however, the white electroluminescent (EL) spectrum is generated using multiple emitters embedded in a comparably complex device structure. In this presentation, we will discuss some of our efforts towards the development of efficient WOLEDs using a single emitter, which include our progress on 1) excimer-based WOLEDs, and 2) the design and the synthesis of broadband phosphorescent emitters for lighting applications.

SDWB2 • 11:00 Invited
Rational Design of Host/Charge Transport Molecules for Blue OLEDs, *Asanga Padmaperma[1]; [1]Pacific Northwest National Laboratory, USA.* Charge balance and exciton confinement are key factors in achieving high EQE in OLEDs. We demonstrate that a combination of HTL, ETL and host with appropriate energy levels can provide high EQE.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

10:30–12:30
PWB • Photon Management in Solar Cells: Dielectric Nanostructures I
Ralf Wehrspohn; *Fraunhofer IWM Halle, Germany, Presider*

PWB1 • 10:30 Invited
Light Trapping in Nano-textured Silicon Thin Film Solar Cells, *Rahul Dewan[1], Vladislav Jovanov[1], Dietmar Knipp[1]; [1] Jacobs University Bremen, Germany.* The optics of thin-film microcrystalline silicon solar cells with integrated 3-D pyramid-like surface texture was investigated. The influence of the dimensions of the surface texture on the quantum efficiency and short circuit current was evaluated.

PWB2 • 11:00 Invited
Optical Properties of Quantum Dot Intermediate Band Solar Cells; *Elisa Antolin, Antonio Martí and Antonio Luque; Instituto de Energía Sola, Universidad Politécnica de Madrid, Spain.* Simple quantum calculations have permitted to model the quantum efficiency in quantum dot intermediate band solar cells in agreement with measurements. Furthermore, far and near field structures have been studied to assess possible absorption improvement.

Austin South

Optical Instrumentation for Energy & Environmental Applications

10:30–12:15
EWB • Introduction to Energy and Environmental Optics
John Koshel, *University of Arizona and Photon Engineering, United States, Presider*

EWB1 • 10:30 Tutorial
Overview of Optical Remote Sensing Systems for Environmental Studies, *Joseph A. Shaw[1]; [1]Electrical and Computer Engineering Department, Montana State University, USA.* This presentation will review some of the fundamental principles employed in active and passive environmental remote sensing systems, ranging from passive radiometric imaging to active range-gated laser scattering measurements. The principles will be illustrated with examples of real sensor systems.

EWB2 • 11:15 Tutorial
Applied Photometry, Radiometry, and Measurements of Optical Losses: Systems, Methods, Techniques for Energy and Environmental Applications - Part 1, Direct Approaches, *Michael A. Bukshtab[1]; [1]Michael A Bukshtab Consulting, USA.* Methodologies and measurement systems for combustion diagnostics, remote sensing, pollution detection ringdown, pulsed, resonator, calorimetric, interferometric, acoustooptic, polarization, active and passive - are analyzed versus direct techniques.

Senate

Optics for Solar Energy

SRWB • CPV Systems—Continued

SRWB3 • 11:30 Invited

High Efficiency Solar Cells at Solar Junction, *Homan Yuen[1]; [1]Solar Junction, USA.* Solar Junction has adopted the lattice matched dilute nitride material system to overcome today's multi-junction technology limitations. Advantages of this technology to CPV systems and the achievement of 43.5% efficiency will be discussed.

Austin North

Solid State and Organic Lighting

SDWB • Novel OLED Materials—Continued

SDWB3 • 11:30 Invited

Tandem OLEDs based on Organic Semiconductor Heterojunction as Charge Generation Layer, *Dongge Ma[1]; [1]Changchun Institute of Applied Chemistry, Chinese Academy of Science, China.* Abstract not available.

SDWB4 • 12:00

Environmentally Stable Al-doped ZnO Transparent Electrode for Organic Optoelectronic Devices, *Dhriti S. Ghosh[1], Tong L. Chen[1], Danny Krautz[1], Stephanie Cheylan[1], Valerio Pruneri[1,2]; [1]Optoelectronics, ICFO-The Institue of Photonic Sciences, Spain; [2]ICREA- Institució Catalana de Recerca i Estudis Avançats, Spain.* Al-doped ZnO (AZO) transparent electrodes capped with oxidized ultrathin Ni are proposed. The novel structure show enhanced stability in damp heat and also leads to OLED efficiencies as high as those of similar ITO-based devices.

SDWB5 • 12:15

Transparent Organic Light-Emitting Diodes with LiF:Al Composite Cathodes, *Bo Qu[1], Zhijian Chen[1], Lixin Xiao[1], Qihuang Gong[1]; [1]Peking University, China.* A transparent and electrical conductive layer comprising LiF and Al was designed and obtained successfully. The TOLED with LiFAl composite cathode showed acceptable electroluminescent behavior of both top and bottom emission.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

PWB • Photon Management in Solar Cells: Dielectric Nanostructures I—Continued

PWB3 • 11:30 Invited

Use of PLD-grown Moth-eye ZnO Nanostructures as Templates for MOVPE Growth of InGaN-Based Photovoltaics, *Dave Rogers[1], V. E. Sandana[1,2], F. Hosseini Teherani[1], S. Gautier[4], G. Orsal[4], T. Moudakir[5], M. Molinari[6], M. Troyon[6], M. Peres[7], M. J. Soares[7], A. J. Neves[7], T. Monteiro[7], D. McGrouther[8], J. N. Chapman[8], H. J. Drouhin[3], M. Razeghi[2], A. Ougazzaden[9]; [1]Nanovation, France; [2]Center for Quantum Devices, Northwestern University, USA; [3]LSI, Ecole Polytechnique, France; [4]LMOPS, University de Metz & Supelec, France; [5]Supelec/UMI 2958, Georgiatech-CNRS, France; [6]LMEN, University de Reims Champagne Ardennes, France; [7]Departamento De Fisicia/13N, Universidade de Aveiro, Portugal; [8]Department of Physics & Astronomy, University of Glasgow, United Kingdom; [9]Georgia Institute of Technology, Georgia Tch-CNRS, France.* ZnO based thin films and nanostructures are used in many photovoltaic devices. This talk will overview these and present the potential of moth-eye ZnO nanostructures for use as buffer layers in novel InGaN-based photovoltaics.

PWB4 • 12:00

3D Photonic Crystal as Intermediate Reflector Layers in Micromorph Tandem Cells, *Ralf B. Wehrspohn[1,2], Johannes Üpping[1], Andreas Bielawny[1]; [1]Institute of Physics, University of Halle, Germany; [2]Fraunhofer Institute for Mechanics of Materials, Germany.* Unbalanced currents in serial-connected tandem solar cells are a mayor limitation of their performance. We will show that an embedded 3D photonic crystal acting as an intermediate reflector can balance the currents.

PWB5 • 12:15

Performance of Large Period Engineered Grating for Solar Cell Applications, *Emiliano R. Martins[1], Juntao Li[1], Yikun Liu[2,1], Jianying Zhou[2], Thomas Krauss[1]; [1]Physics and Astronomy, University of St. Andrews, United Kingdom; [2]State Key Laboratory of Optoelectronic Materials and Technologies, SunYat-sen University, China.* We study engineered large period gratings for thin-film silicon solar cells. Numerical calculations indicate that such gratings outperform conventional gratings over a wide range of wavelengths, incident angles and for both polarizations.

Austin South

Optical Instrumentation for Energy & Environmental Applications

EWB • Introduction to Energy and Environmental Optics—Continued

EWB3 • 11:45 Tutorial

Applied Photometry, Radiometry, and Measurements of Optical Losses: Systems, Methods, Techniques for Energy and Environmental Applications - Part 2, Remote Studies, *Michael A. Bukshtab[1]; [1]Michael A Bukshtab Consulting, USA.* Methodologies and measurement systems for combustion diagnostics, remote sensing, pollution detection ringdown, pulsed, resonator, calorimetric, interferometric, acoustooptic, polarization, active and passive - are reviewed and compared.

12:30–14:00 Lunch *(on your own)*

Senate

Optics for Solar Energy

14:00–16:00
SRWC • CPV Design and Components
Raymond Kostuk; *University of Arizona, United States, Presider*

SRWC1 • 14:00 Invited
A CPV Thesis, David Schultz[1]; [1]*Banyan Energy, Inc., USA.* The viability of a concentrator technology is determined by five interrelated factors economic benefit, cell performance under concentration, thermal management, optical performance and manufacturability.

SRWC2 • 14:30
Lenticulated Köhler Integrator for a Utility-Scale CPV System, *Brian Wheelwright[1]; [1]College of Optical Sciences, University of Arizona, USA.* LPI LLC's XR-Kohler design is adapted to the modular scale proposed by REhnu LLC. The limitations of the CAP metric are discussed in the context of CPV systems with arrayed multi-junction receiver cells.

SRWC3 • 14:45
Design, Optimization and Characterization of Secondary Optics for a Dish-Based 1000x HCPV System, I; *Guillaume Butel[1], Tom Connors[2], Blake Coughenour[1], and Roger Angel[2]; [1]College of Optical Sciences, University of Arizona, USA; [2]Steward Observatory, University of Arizona, USA.* This paper presents a novel design of a solar secondary optics used in a dish-based HCPV system at 1000x. Different optimizations were conducted as well as experiments to determine its optimum configuration.

SRWC4 • 15:00 Invited
Materials for Fresnel Lenses in Concentrating Photovoltaics, *Ralf Leutz[1]; [1]Concentrator Optics, GMBH, Germany.* Abstract Fresnel lenses for CPV are made of PMMA or silicone-on-glass (SOG). We discuss these optical materials in terms of spectral transmissivity, refractive index, longevity, bankability and cost. Thermal expansion is most critical.

Austin North

Solid State and Organic Lighting

14:00–16:00
SDWC • OLED Device Physics
Bernard Kippelen; *Georgia Tech, United States, Presider*

SDWC1 • 14:00 Invited
Organic Electronics: A World of Interfaces, *Antoine Kahn[1]; [1]Princeton University, USA.* This talk gives an overview of the definition and measurement of molecular energy levels that are central to carrier injection into, and transport through, organic-based devices. [1] J. Hwang et al. Materials Science and Engineering, R 64, 1-31 (2009)

SDWC2 • 14:30
Multiperiod Gratings in a High Refractive Index Material for Enhanced OLED Outcoupling, Arfat Pradana[1]; [1]*Integrated Systems and Photonics, Christian-Albrechts-Universität zu Kiel, Germany.* We produce multiperiod gratings in Ta2O5 using nanoimprint lithography in combination with RIE. The photoluminescence spectrum of an emitter layer on a multiperiod grating is demonstrated to exhibit multiple peaks of enhanced emission.

SDWC3 • 14:45
Highly Efficient Blue Electrophosphorescent Device Using a Weak Electron Transporting Material, Lixin Xiao[1], Boyuan Qi[1], Xing Xing[1], Zhijian Chen[1], Bo Qu[1], Qihuang Gong[1]; [1]*Peking University, China.* Over 20% of external quantum efficiency of blue electrophosphorescence is achieved by employing a weak electron transporting material. It shows an alternative way to design materials for blue electrophosphorescent devices.

SDWC4 • 15:00 Invited
Conductive Low-Index Layer: A New Opportunity For Outcoupling Enhancement In OLEDs, SeungHyup Yoo[1]; [1]*Electrical Engineering, Korea Advanced Institute of Science and Technology, Republic of Korea.* A novel electrode structure utilizing low-index properties of conductive polymers is explored for outcoupling enhancement in OLEDs.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

14:00–16:00
PWC • Photon Management in Solar Cells: Dielectric Nanostructures II
Thomas Krauss; *University of St. Andrews, United Kingdom, Presider*

PWC1 • 14:00
Light Trapping in Thin Film Silicon Solar Cells with Mono and Bidimensional Photonic Patterns, *Angelo Bozzola[1], Marco Liscidini[1], Lucio C. Andreani[1]; [1]University of Pavia, Italy.* We investigate light trapping in thin film silicon solar cells with 1D and 2D photonic patterns. Absorbance and short-circuit current density are calculated with scattering matrix formalism and compared with Lambertian limits.

PWC2 • 14:15
Optimization of Silicon Solar Cells using Backside Diffraction Gratings, *Markus Wellenzohn[1], Rainer Hainberger[1]; [1]Health & Environment Department, Nano Systems, AIT Austrian Institute of Technology GmbH, Austria.* This numerical study investigates the influence of backside diffraction gratings on the efficiency of silicon solar cells. In particular, the dependence of the optimum grating period and modulation depth on the silicon thickness is determined.

PWC3 • 14:30 Invited
Decreasing the Thickness of Crystalline-Silicon Solar Cells below 40 µm and Increasing their Light Absorption with Surface Nanostructures, *Valérie Depauw[1], Ounsi El Daif[1], Dries Van Gestel[1], Kris Van Nieuwenhuysen[1], Christos Trompoukis[1], Frederic Dross[1], Ivan Gordon[1], Jef Poortmans[1]; [1]IMEC, Belgium.* Three methods for fabricating crystalline-silicon solar cells thinner than 40 µm down to 1 µm are presented, together with the integration of three nanostructuring schemes - texturing, photonic crystals, plasmons - to boost their light absorption.

PWC4 • 15:00
Combining Front and Back Grating Structures for Broadband Absorption Enhancement in Thin-Film Silicon Solar Cells, *Aimi Abass[1], Khai Q. Le[2,3], Peter Bienstman[3], Andrea Alu[2], Bjorn Maes[3,4], Marc Burgelman[1]; [1]Department of Electronics and Information Systems, Ghent University, Belgium; [2]Department of Electrical and Computer Engineering, The University of Texas at Austin, USA; [3]Department of Information Technology, Ghent University-imec, Belgium; [4]Department of Physics, University of Mons, Belgium.* We investigate the possibilities of enhancing absorption in thin-film silicon solar cells with grating structures on the front ITO and back Ag contacts simultaneously. Broadband enhancement from complementary effects of each grating is demonstrated.

Austin South

Optical Instrumentation for Energy & Environmental Applications

14:00–16:00
EWC • Sensors for Atmospheric Trace Gases and Aerosols
Joseph Shaw; *Montana State University, United States, Presider*

EWC1 • 14:00
Chirped Laser Dispersion Spectroscopy for Remote Sensing of Trace-gases, *Gerard Wysocki[1], Michal Nikodem[1]; [1]Electrical Engineering, Princeton University, USA.* A chirped laser dispersion spectroscopy system configured for remote sensing of chemicals is presented. Using a 4.52µm quantum cascade laser and 100m optical pathlength an N2O detection limit of <1ppbv/Hz1/2 has been achieved.

EWC2 • 14:15
Dynamic Aerosol In-Situ Imager (DAISI), *Alan Marchant[1], Jed Simmons[1], Thomas Apedaile[1]; [1]Energy Dynamics lab, Utah State University Research Foundation, USA.* Transverse confocal imaging with pulsed laser illumination enables real-time multi-parameter characterization of individual aerosol particles. Independent values for size, shape, dynamics, and cross-section enable enhanced PM speciation.

EWC3 • 14:30 Invited
Spectroscopic Instruments for Airborne Measurements of Atmospheric Trace Gases, *Alan Fried[1], Dirk Richter[1], Petter Weibring[1], James Walega[1], Scott Spuler[1], Matthew Taubman[2]; [1]National Center for Atmospheric Research, USA; [2]Applied Physics Group, National Security Division, Pacific Northwest National Laboratory, USA.* Investigators at the National Center for Atmospheric Research have developed and deployed a state-of-the-art instrument based upon difference frequency generation absorption spectroscopy to carry out such investigations on various airborne platforms.

EWC4 • 15:00
Atmospheric Vertical Profiling of Multiple Chemicals with an External Cavity Quantum Cascade Laser Heterodyne Radiometer, *Tracy Tsai[1], Damien Weidmann[2], Neil Macleod[2], Rebecca Rose[2], Gerard Wysocki[1]; [1]Electrical Engineering, Princeton University, USA; [2]Space Science and Technology, STFC Rutherford Appleton Laboratory, United Kingdom.* We present a 60 MHz resolution ground-based EC-QCL heterodyne radiometer capable of spectroscopic sensing of five molecules. High spectral resolution allows for retrieval of vertical atmospheric concentration profiles from transition lineshapes.

Senate

Optics for Solar Energy

SRWC • CPV Design and Components—Continued

SRWC5 • 15:30
Defining System Conversion Efficiency for Dish-Based Solar Concentrator PV, *Blake Coughenour[1], Guillaume Butel[1], Roger Angel[2,1]; [1]College of Optical Sciences, The University of Arizona, USA; [2]Steward Observatory, The University of Arizona, USA.* Concentrator system conversion efficiency may be characterized by using measurements of the optical components. Techniques of characterizing radiometric throughput via geometric ray shadowing, optical efficiency, and cell efficiency are presented.

SRWC6 • 15:45
Concentrating Photovoltaic Systems Using Micro-Optics, *William Sweatt[1], Greg Nielson[1], Marat Okandan[1]; [1]Sandia National Lab, USA.* Molded plastic micro-optics with 100X solar gain are described. A ±40 acceptance cone is allowed so the lens arrays can be mounted on one-axis heliostats and give achromatic, stationary images on photo-voltaic cells.

Austin North

Solid State and Organic Lighting

SDWC • OLED Device Physics—Continued

SDWC5 • 15:30
Efficient Green and Blue Electrophosphorescent Light-Emitting Diodes using a Combination of Solution and Vacuum-Processed Materials, Wojciech Haske[1,3], Sung-Jin Kim[1,3], Denke Cai[1,3], Ehsan M. Najafabadi[1,3], Canek Fuentes-Hernandez[1,3], Bernard Kippelen[1,3], Julie Leroy[2,3], Carlos Zuniga[2,3], Yadong Zhang[2,3], Annabelle Scarpaci[2,3], Huifang Li[2,3], Lingyun Zhu[2,3], John S. Sears[2,3], Stephen Barlow[2,3], Jean-Luc Bredas[2,3], Seth R. Marder[2,3]; *[1]School of Electrical and Computer engineering, Georgia Institute of Technology, USA; [2]School of Chemistry and Biochemistry, GA Institute of Technology, USA; [3]Center for Organic Photonics and Electronics, GA Institute of Technology, USA.* The performance of organic light-emitting diode devices with a spin-coated hole-transporting layer and a thermally deposited emissive layer consisting of a bis-sulfone small molecule, as a host for the blue phosphorescent emitter will be presented.

SDWC6 • 15:45
High Efficiency White Organic Light-Emitting Devices, Sang-Hyun Eom[1], Edward Wrzesniewski[1], Jaewon Lee[1], Neetu Chopra[1], Debasis Bera[1], Paul Holloway[1], Franky So[1], Jiangeng Xue[1]; *[1]Materials Science and Engineering, University of Florida, USA.* We report two efficient white OLED structures with efficacy up to 100 lm/W. One structure involves using three different emitters in the same emitting layers, while the other integrates a blue-emitting OLED with down-conversion phosphors.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

PWC • Photon Management in Solar Cells: Dielectric Nanostructures II—Continued

PWC5 • 15:15
A Full Scalar Scattering Model for Nano-Textured Interfaces, *Klaus Jäger[1], René van Swaaij[1], Miro Zeman[1]; [1]Photvoltaic Devices and Materials, Delft University of Technology, Netherlands.* We present a full scattering model for nano-textured interfaces as they are present in thin film silicon solar cells. The model is based on the scalar scattering theory and predicts measured scattering parameters well.

PWC6 • 15:30 Invited
Advanced Nanostructured Materials for Pushing Light Trapping Towards the Yablonovitch Limit, *Corsin Battaglia[1], L. Barraud[1], A. Billet[1], M. Boccard[1], G. Bugnon1, M. Charriere1, P. Cuony1, Matthieu Despeisse[1], S. De Wolf[1], L. Ding[1], L. Erni[1], J. Escarre[1], S. Hanni[1], Franz-Josef Haug[1], L. Lofgren[1], F. Meillaud[1], S. Nicolay[1], G. Parascandolo[1], K. Soderstrom[1], M. Stuckelberger[1], Christophe Ballif[1]; [1]EPFL STI IMT-NE PV-LAB, Institute of Microengineering IMT, Switzerland.* We give an overview on recent progress in the synthesis, fabrication and integration of advanced nanostructured materials for efficient light trapping in high-efficiency thin-film silicon solar cells.

Austin South

Optical Instrumentation for Energy & Environmental Applications

EWC • Sensors for Atmospheric Trace Gases and Aerosols—Continued

EWC5 • 15:15
Environmental Ammonia Monitoring for Urban and Rural Areas of Texas using an EC-QCL based Sensor Platform, *Rafal Lewicki[1], Longwen Gong[2], Robert Griffin[2], Timothy Day[3], Frank K. Tittel[1]; [1]Electrical and Computer Engineering, Rice University, USA; [2]Civil and Environmental Engineering, Rice University, USA; [3]Daylight Solutions Inc., USA.* Results of continuous, recent, long-term atmospheric ammonia measurements obtained in Houston and a rural area of Dallas/Fort Worth with a 10.4 μm EC-QCL based amplitude modulated photo-acoustic spectroscopy sensor platform, will be reported.

EWC6 • 15:30 Invited
Measuring Atmospheric Carbon Dioxide from Space: The GOSAT and OCO-2 Missions, *David Crisp[1]; [1]Jet Propulsion Laboratory, California Institute of Technology, USA.* The Japanese Greenhouse gases Observing Satellite is providing new insight into atmospheric carbon dioxide trends. The NASA Orbiting Carbon Observatory-2 Mission will build on this record with increased sensitivity, resolution and coverage.

16:00–16:30 Coffee Break, *Capital Ballroom Foyer*

Austin North

Solid State and Organic Lighting

16:30–17:30
SDWD • Quantum Dot LEDs
SeungHyup Yoo; *Korea Advanced Institute of Science and Technology, South Korea, Presider*

SDWD1 • 16:30 Invited

Steady Progress of Colloidal Quantum Dot LED (QLED) Technologies, *Vladimir Bulovic[1]; [1]Electrical Engineering and Computer Science, M.I.T., USA.* State of the art colloidal quantum dot LED structures are advancing both the QLED efficiencies and the operating lifetimes. The talk will contrast advantages of DC-driven and AC-driven QLED structures.

SDWD2 • 17:00 Invited

Quantum Dot Based Light-Emitting Diodes, *Changhee Lee[1]; [1]Seoul National University, Democratic People's Republic of Korea.* Quantum-dots (QDs) have attractive properties for full-color displays and solid-state lightings. Here, we present several approaches for improving the performance of QD-LEDs. In addition, we present a versatile QD patterning method that can allow well-defined ?m-scale patterns, leading to the realization of high-resolution, full-color QD displays.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

16:30-18:00
PWD • Photon Management in Solar Cells: Plasmonic Nanostructures
Thomas Krauss; *University of St. Andrews, UK, Presider*

PWD1 • 16:30 Invited

Plasmonic and High Dielectric Constant Nanostructures for Light Trapping, *Mark Brongersma[1]; [1]Stanford University, USA.* Nanometallic and high index dielectric nanostructures have gained significant interest for their ability to boost the energy conversion efficiency of photovoltaic cells. I will discuss recent progress in the development of such structures.

PWD2 • 17:00

A Polarization-Independent Wavelength-Tuned Metamaterial for Solar Energy Applications, *Eli Lansey[1], Jonah Gollub[2], Thomas L. James[2], David T. Crouse[3]; [1]Physics, GC and CCNY, City University of New York, USA; [2]Phoebus Optoelectronics, USA; [3]Electrical Engineering, The City College of New York, USA.* We present simulations of a polarization-independent, L-shaped cavity metamaterial using finite element techniques. These structures concentrate light in the cavities and have applications in high-efficiency solar energy devices.

PWD3 • 17:15

Absorption Enhancement in Guided-Mode-Resonant Hydrogenated Amorphous Silicon Thin-Film Solar Cells, *Tanzina Khaleque[1], Jaewoong Yoon[1], Wenhua Wu[1], Robert Magnusson[1]; [1]Electrical Engineering, University of Texas at Arlington, USA.* We present measured absorption characteristics of GMR hydrogenated amorphous silicon (a-SiH) thin-film solar cells. About 22% integrated absorption enhancement compared to planar reference solar cell is observed for 450-730nm wavelength range.

PWD4 • 17:30 Invited

Role of Nanostructures on the Performance of a-Si:H Solar Cells, *Jeehwan Kim[1]; [1]IBM T.J. Watson Research Center, USA.* This paper represents a method to enhance efficiency of a-SiH solar cells by using nanostructures. The role of plasmonic nanoparticles as well as nanotemplates on the performance of a-SiH solar cell will be discussed.

17:00–18:00 JWD • Joint E2/SOLAR/SOLED Postdeadline Session, *Senate (see page 25)*

Capital Ballroom B

Joint Poster Session

18:00–19:00
JWE • Joint Poster Session

JWE1

Solar Energy Concentrators and their Optimization and Analysis with the OptisWorks Solar Package, *Günther Hasna[1]; [1]OPTIS, France.* Optis has developed tools put together in the OptisWorks Solar Package which can change the sun position by macros calculating and optimizing the efficiency of such concentrators based on reflective or refractive materials.

JWE2

LED Phosphor Modeling and Color Optimization in OptisWorks, *Günther Hasna[1]; [1]OPTIS, France.* OPTIS has developed in OptisWorks an editor for LED phosphor dyes which take into account physics based measureable spectra information as well as the volume scattering by the Hyenyey-Greenstein equations.

JWE3

Design Method of High-Efficient LED Freeform Optical System for Aeronautical Ground Light, *Shang Wang[1], Fei Chen[1], Quan Chen[1], Zhili Zhao[1], Zong Qin[1], Sheng Liu[1]; [1]Wuhan National Laboratory for Optoelectronics, School of Optoelectronic Science and Engineering, Huazhong University of Science and Technology, China.* We propose an optimization method of optical design in brief. A high-efficient LED chip array packaging (LCAP) based freeform optical system of runway center line light which can fully comply with the ICAO regulation has been design.

JWE4

Process Development for Carbothermal Reduction and Nitridation Synthesis of alpha-SiAlON Phosphor, *Shyan-Lung Chung[1], Shu Chi Huang[1]; [1]Chemical Engineering, National Cheng Kung University, Taiwan.* When doping with Eu2+ as an activator,optical adsorption from 420 to 650nm was observed. By useing a light at 380 nm as an excitation source ,a luminescent radiation from 220 to 500nm.

JWE5

13,6-N-sulfinylacetamidopentacene based Fully Encapsulated Low Voltage Vertical Short Channel OFET, *Munish Puri[1], Sanjukta Bhanja; [1]EE, USF,FL, USA.* 13,6-N-sulfinylacetamidopentacene based low cost fully encapsulated OFET is designed. High output current of 5mA is achieved under 1volt for better OLED brightness in novel device geometry with channel length of 350nm.

JWE6

Broadband Absorption Enhancement in Vertical Silicon Nanowire Arrays with Random Position for Photovoltaic Applications, *Qing Guo Du[1], Chanhin Kam[1], Xiaowei Sun[1]; [1]Nanyang Technological University Singapore.* The optical properties of ordered and position random silicon nanowire arrays are investigated using finite-difference time-domain method. Position randomization with filling ratio larger than 36% renders better absorptance than regular structures.

JWE7

Surface Passivation of Black Silicon by Thermal ALD Deposited Aluminum Oxide, *Martin Otto[1], Matthias Kroll[2], Thomas Käsebier[2], Marco Ernst[3], Roland Salzer[4], Ralf B. Wehrspohn[1,4]; [1]*µMD group - Institute of Physics, Martin Luther University Halle-Wittenberg, Germany; *[2]Institute of Applied Physics, Friedrich Schiller University Jena, Germany; [3]Institut für Solarenergieforschung Hameln ISFH, Germany; [4]Fraunhofer Institute for Mechanics of Materials IWM, Germany.* Black silicon (bSi) surfaces can be effectively passivated by thermal ALD. The nanosturcures with aspect ratios up to 10 show excellent anti-reflection and light-trapping properties with absorption in the visible spectrum of over 97%.

JWE8

Scattering Loss Reduction in Sub-wave Length Gratings for Solar Cell Applications, *Emiliano R. Martins[1], Juntao Li[1], Abdul Shakoor[1], Thomas Krauss[1]; [1]Physics and Astronomy, University of St. Andrews, United Kingdom.* We propose a simple post-fabrication treatment aiming at scattering loss reduction in silicon sub-wave length gratings. The gratings lines are smoothened by the treatment and the measured resonances indicate a reduction in the scattering losses.

JWE9

Optimization of Broadband Absorption in Semiconductor Nanowire Arrays for Photovoltaic Applications, *Ningfeng Huang[1], Chenxi Lin[1], Michelle L. Povinelli[1]; [1]Ming Hsieh Department of Electrical Engineering, University of Southern California, USA.* We study broadband absorption in semiconductor nanowire arrays made of several common photovoltaic materials. We optimize the structural parameters to determine how the maximum achievable efficiency depends on nanowire height.

JWE • Joint Poster Session—Continued

JWE10
Infrared-to-Visible Upconversion by Yb3+-Er3+ Energy Transfer in Oxyfluoride Glass-Ceramics, *A-Young Moon[1], Mi-Yeon Yoo[1], Dae-Young Lee[1], Woon-Young Lee[1], Ki-Soo Lim[1], P. Babu[2]; [1]Physics Department, Chungbuk National University, Republic of Korea; [2]Govt. Degree and P.G. College, India.* Oxyfluoride glass-ceramics containing CaF2 nanocrystals doped with 1 mol % Er and 2 mol% Yb ions have been prepared and characterized. Upconverted visible emissions under 980 nm excitation are found to be enhanced due to CaF2 nanocrystals.

JWE11
Plasmonic Enhanced Light Absorption of Solar Cells with Metal Nanoparticles, *Fang Liu[1], Di Qu[1], Qi Xu[1], Wanlu Xie[1], Yidong Huang[1]; [1]Tsinghua University, China.* The plasmonic enhanced absorption for solar cell with metal nanoparticles deposited on top and inside of the active layer of solar cells has been simulated and investigated experimentally.

JWE12
3D-FDTD Analysis of Absorption Enhancement in Nanostructured Thin Film Solar Cells, *Jerónimo Buencuerpo[1], Maria Luisa Dotor[1], Luis Enrique Munioz-Camuniez[1], Pablo A. Postigo[1]; [1]MBE, IMM-CNM-CSIC, Spain.* We investigate 1D-2D photonic crystals for light absorption enhancement on thin film photovoltaics (Si, GaAs an InP) by FDTD. A comparison with RCWA and TMM is presented. The absorption is increased substantially for these systems.

JWE13
Near Field Radiative Heat Transfer Measurement, *Ning Gu[1], Karthik Sasihithlu[2], Arvind Narayanaswamy[2]; [1]Dept of Electrical Engineering, Columbia University, USA; [2]Dept of Mechanical Engineering, Columbia University, USA.* Using an improved experimental setup, we measured near field radiative heat transfer that may benefit TPV up to a value as small as 0.5 nW/K. The experimental data is compared with modified proximity approximation prediction.

JWE14
Observations of Human-made Debris in Earth Orbit, *Heather Cowardin[1]; [1]NASA-JSC\ESCG-JACOBS, USA.* Pollution is generally considered contaminants of Earth's surface, hydrosphere and atmosphere, but there is another problem overhead, everyday space debris. This paper discusses observational methods used to characterize the growing debris population.

JWE15
Characterization of a Quantum Cascade Laser Based Emissivity Monitor for CORSAIR, *Maung Lwin[1,2], Michael Wojcik[2], Harri Latvakoski[2], Martin Mlynczak[3]; [1]Princeton University, USA; [2]Energy Dynamics Laboratory, USA; [3]NASA Langley Research Center, USA.* The QCL based emissivity monitor which was designed to obtain emissivity uncertainty goal of ±0.00015 (3σ) for the CORSAIR blackbody has been characterized. The laser power stability and temperature distribution of the system are analyzed.

JWE16
The National Ecological Observatory Network's Fundamental Instrument Unit: The Challenges of Managing Thousands of Environmental Sensors, *Jeffrey R. Taylor[1,2], Ed. Ayres[1,2], Hongyan Luo[1,2], Henry W. Loescher[1,2]; [1]Fundamental Instrument Unit, National Ecological Observatory Network, USA; [2]Institute of Arctic and Alpine Research, University of Colorado, USA.* NEON's Fundamental Instrument Unit must implement >45,000 environmental sensors at 60 instrument sites across the US. The observation strategy for managing these sensors, as well as the preliminary plan for automated quality control, is presented.

JWE17
A Tele-Operated Gas Analyzer, *Libing Ren[1], Haoyun Wei[1], Yan Li[1]; [1]Precision Instruments, Tsinghua university, China.* A remote operable gas analyzer was designed and depicted in this paper. There's no geographical restriction on using it and it's easy to maintain. It's especially suitable for long-term and large-scale detection of polluted gases.

JWE18
Silicon Photonic Interrogation System for Wavelength Encoded Optical Sensors, *German Vargas[1], Roberto R. Panepucci[2]; [1]FIU, USA; [2]Centro de Tecnologia da Informação Renato Archer, Brazil.* A wavelength interrogation system using a micro-ring resonator device and based on a time interval between peaks method is presented experimentally using a tunable laser source. A simulation is also presented which agrees with experimental results.

JWE19
Wireless Sensor Networks for Monitoring of Atmospheric Chemicals, *Wen Wang[1], Clinton Smith[1], Stephen So[2], Elie Bou-Zeid[3], Gerard Wysocki[1]; [1]Electrical Engineering, Princeton University, USA; [2]Sentinel Photonics Inc., USA; [3]Environmental Engineering, Princeton University, USA.* To study the transport of trace gases in the atmosphere, a wireless sensor network (WSN) of chemical sensor nodes can be implemented. In this work we present a basic three-node WSN for atmospheric CO2 monitoring.

JWE20
Efficiency of Wide-Angle Lens as a Virtual Tracking System, *Sébastien Bouchard[1], Simon Thibault[1]; [1]COPL, Universite Laval, Canada.* We simulated a wide-angle lens to act as a "virtual" tracker and a lens having a very narrow field of view to obtain boundaries for the efficiency of an arbitrary optical tracker.

JWE21
Trap-states Influence on Transient Electroluminescence of CBP:Ir(ppy)3-based Organic Light Emitting Diodes, *Kenichi Kasahara[1], Takashi Saitoh[1], Akira Yamazaki[1]; [1]Ritsumeikan University, Japan.* The overshoot of CBP:Ir(ppy)3-based phosphorescent organic light emitting diodes was large under a negative bias voltage, different from previously reported results. This was probably caused by trap states formed in carrier-injecting organic layers.

JWE22
Cu, CuO, and Cu2O Nanoparticle Plasmons for Enhanced Scattering in Solar Cells, *Jagmeet S. Sekhon[1]; [1]Physics, SLIET Longowal, India.* Copper oxide (s) nanosphere compete with Cu for better scattering response under some parametric conditions viz. size, embedding medium, and localized surface plasmon resonance wavelength region for plasmonic solar cells.

JWE23
Transfer-Matrix Method for Optical Multilayer Systems: Application to Solar Cells, *Nikolai I. Petrov[1], Victor Danilov[2], Boris Usievich[2], Vladimir Popov[3]; [1]Russia R&D Lab, LG Electronics, Russian Federation; [2]General Physics Institute, Russian Federation; [3]Physics Faculty, Moscow State University, Russian Federation.* Electromagnetic simulations of multilayer structure are carried out using the transfer-matrix method. Reflectance, quantum efficiency and short-circuit current density for periodical and random boundary surfaces are calculated.

JWE24
Spectroscopic Investigation of Nd3+-doped ZBLAN Glass for Solar Pumped Lasers, *Takenobu Suzuki[1], Hiroyuki Kawai[1], Hiroyuki Nasu[1], Shintaro Mizuno[2], Hiroshi Ito[2], Kazuo Hasegawa[2], Yasutake Ohishi[1]; [1]Toyota Technological Institute, Japan; [2]Toyota Central R&D Labs. Inc., Japan.* We clarified that Nd3+-doped ZBLAN glass would be a promising material for solar pumped laser applications due to its high quantum efficiency for sunlight, large stimulated emission cross-section, long emission lifetime and broad absorption bands.

19:15–20:30 Conference Reception, *Six Lounge*

07:00–17:00 Registration Open, *Capital Ballroom Foyer*

Senate

Joint Congress Plenary Session

08:00-10:00
JThA • Joint Plenary Session
Bernard Kippelen; *Georgia Tech, United States, Presider*

JThA1 • 08:00 Invited
Theory and Practice for Nanophotonic Light Trapping, *Shanhui Fan[1]; [1]Stanford University, USA.* We present studies of light management in solar cells from a rigorous electromagnetic perspective. We discuss the statistical temporal couple theory formalism, and the practical considerations to achieve simultaneously light trapping and anti-reflection.

JThA2 • 08:30 Invited
Sustainable Energy & Optical Methods for Monitoring Air Pollution, *Matthew Fraser[1]; [1]Global Institute of Sustainability, Arizona State University, USA.* Development of optical sensors capable of rapid quantification of pollutants that today are measured through slow responding instruments will be discussed.

JThA3 • 09:00 Invited
Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology, *Sarah Kurtz[1]; [1]Interim NCPV Director, Reliability Group Manager, NREL, USA.* The photovoltaic industry has grown dramatically; concentrating photovoltaic products are generating interest, but would benefit from optical techniques developed for other industries. This talk will give an overview and highlight the opportunities.

JThA4 • 09:30 Invited
Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications, *E. Fred Schubert[1], Jaehee Cho[1]; [1]Rensselaer Polytechnic Institute, USA.* This presentation will discuss one of the formidable challenges of LED technology We will discuss the origin of the efficiency droop as well as ways to reduce the droop.

10:00–10:30 Coffee Break, *Capital Ballroom Foyer*

Senate

Optics for Solar Energy

10:30–12:30
SRThB • Planar Optical Concentrators and High Efficiency Concepts
Raymond Kostuk; *University of Arizona, United States, Presider*

SRThB1 • 10:30 Invited
A Review of Photovoltaic Cavity Converter Optics and Its Impact on Multi-junction and Multi-bandgap Systems, *Ugur Ortabasi[1]; [1]United Innovations, Inc., USA.* PVCC is a novel HCPV receiver that re-cycles reflected photons trapped within the cavity. Thus, cell series resistance can be lowered while effective shadowing-loss is minimized. The paper focuses on optical issues and achievable efficiencies.

Austin North

Solid State and Organic Lighting

10:30–12:30
SDThB • LED Materials and Devices
Dong-Xue (Michael) Wang; *OSRAM Sylvania, United States, Co-Presider*
Chih-Chung (C.C.) Yang; *Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan, Co-Presider*

SDThB1 • 10:30 Invited
Argonne National Laboratory and Science Education, *Deon Ettinger[1]; [1]Argonne National Labs, USA.* Argonne National Lab is one of the Department of Energy's laboratories for energy and environment research. Argonne has science education programs for middle-school to post-doctoral students. We will present a discussion of the science education.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

10:30–12:30
PThB • Nanostructured Materials with Enhanced Efficiency
Dietmar Knipp; *University of Bremen Germany, Presider*

PThB1 • 10:30
A Relation Between a Filling Ratio and a Length of Silicon Nano Wires on their Solar Cell Performances, *Jin-Young Jung[1], Keya Zhou[1], Han-Don Um[1], Sang-Won Jee[1], Kwang-Tae Park[1], Yoon-Ho Nam[1], Sun-Mi Shin[1], Jung-Ho Lee[1]; [1]Chemical Engineering, Hanyang University, Republic of Korea.* The relation between filling ratio and length of Si nano wires is investigated via characterizing the optical and electrical performances of solar cells. To enhance photovoltaic performances, we suggest the optimal parameters in nano wired solar cell.

PThB2 • 10:45
Optimal Design of Aperiodic, Vertical Silicon Nanowire Structures for Photovoltaics, *Chenxi Lin[1], Michelle L. Povinelli[1]; [1]Ming Hsieh Department of Electrical Engineering, University of Southern California, USA.* We use electromagnetic simulations to design an aperiodic, vertically-aligned silicon nano wire array that maximizes solar absorption. We achieved a 2.35 times enhancement in ultimate efficiency compared to a periodic array.

Austin South

Optical Instrumentation for Energy & Environmental Applications

10:30–12:30
EThB: Optical Design of Components and Subsystems for Energy and Environment
Jeffrey Taylor; *National Ecological Observatory Network, United States, Presider*

EThB1 • 10:30
Identification and Quantification of Methane Emissions in an Urban Setting, *Eric Crosson[1], Nathan Phillips[2], Jocelyn Turnbull[3]; [1]CTO, Picarro, USA; [2]Department of Geography and Environment, Boston University, USA; [3]ESRL, NOAA/GMD, USA.* To identify and quantify major methane sources in Boston and Indianapolis, measurements of CH4 concentrations were made using a vehicle mounted cavity ringdown analyzer with Global Positioning Device capabilities along with plume transport models.

EThB2 • 10:45
Real-Time Sensing of Fluorocarbons Using an External Cavity Quantum Cascade Laser, *Mark C. Phillips[1], Bruce E. Bernacki[1], Matthew S. Taubman[1], B. D. Cannon[1], J. T. Schiffern[1], T. L. Myers[1]; [1]Pacific Northwest National Laboratory, USA.* We present results demonstrating real-time sensing of fluorocarbons at ppb-levels using an external cavity quantum cascade laser.

Senate

Optics for Solar Energy

SRThB • Planar Optical Concentrators and High Efficiency Concepts—Continued

SRThB2 • 11:00
Reactive Self-Tracking Solar Concentration, *Katherine Baker[1], Jason Karp[1], Justin Hallas[1], Joseph Ford[1]; [1]UC San Diego, USA.* We present a design for a reactive self-tracking solar concentrator. Using a cladding material with a non-linear optical response in a planar micro-optic solar concentrator allows for wide-angle acceptance without violating étendue.

SRThB3 • 11:15
Thermal Effects of Holographic Planar Concentrator Regions in Photovoltaic Modules, *Jose E. Castillo[1], Juan M. Russo[2], Glenn Rosenberg[1], Raymond Kostuk[2]; [1]Prism Solar Technologies, Inc., USA; [2]Electrical and Computing Engineering, University of Arizona, USA.* Experimental and modeled data of the thermal properties of holographic planar concentrator photovoltaic modules is presented. The low concentration and increased area of the panel configuration produces a net decrease in panel operating temperature.

SRThB4 • 11:30
Common-plane Spectrum-splitting Concentrating Photovoltaic Module Design and Development, *Tian Gu[1], Michael W. Haney[1]; [1]Electrical and Computer Engineering, University of Delaware, USA.* A novel tiled micro-optical CPV concept is described. Within each unit cell, spectrally selective elements are laterally displaced on a common plane to enhance conversion efficiency and reduce packaging costs in high-performance PV modules.

SRThB5 • 11:45
Spectral Characterization of the Temperature Performance of Silicon Solar Cells, *Juan M. Russo[1], Deming Zhang[1], Shelby D. Vorndran[1], Ostin Zarse[1], Raymond Kostuk[1]; [1]Electrical and Computing Engineering, University of Arizona, USA.* The solar spectrum illuminating silicon photovoltaic cells is modified to eliminate ultraviolet and infrared spectral bands. The effect of modifying the spectrum on cell temperature and electrical performance is evaluated.

Austin North

Solid State and Organic Lighting

SDThB • LED Materials and Devices—Continued

SDThB2 • 11:00 Invited
Surface Plasmon Coupled Light-Emitting Diodes, *Yang Kuo[1], Che-Wei Huang[1], Shao-Ying Ting[1], Chieh Hsieh[1], Che-Hao Liao[1], Chih-Yen Chen[1], Jeng-Jie Huang[1], Yen-Cheng Lu[1], Cheng-Yen Chen[1], Kun-Ching Shen[1], Chih-Feng Lu[1], Dong-Ming Yeh[1], Jyh-Yang Wang[1], Wen-Hung Chuang[1], Yean-Woei Kiang[1], Chih-Chung (C. C.) Yang[1]; [1]Institute of Photonics and Optoelectronics, National Taiwan University, Taiwan.* The results of light-emitting diode fabrication with surface plasmon coupling with the dipoles in its quantum wells are reviewed, including internal quantum efficiency enhancement, reducing the droop effect, and producing partially polarized output.

SDThB3 • 11:30
Process Development for Synthesis of High-Performance Oxynitride Phosphor, *Shyan-Lung Chung[1], Shu Chi Huang[2,1]; [1]Chemical Engineering, National Cheng Kung University, Taiwan; [2]Chemical Engineering, National Cheng Kung University, Taiwan.* We report the development of a new method for the synthesis of a yellow oxynitride phosphor (i.e.,Ca-α-SiAlONEu2+) based on SHS reactions. The synthesized product emists in 400-670nm centered at 555nm upon excitation at 380nm.

SDThB4 • 11:45
Optical Thin Film Filters for UV and Blue LEDs, *Dong-Xue (Michael) Wang[1]; [1]Central Research Labs, OSRAM Sylvania, USA.* A model to design and simulate thin film filter for LED and solid state lighting was developed, where a quarter -wave stack was used as a building block to design Distributed Bragg Reflector (DBR).

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

PThB • Nanostructured Materials with Enhanced Efficiency—Continued

PThB3 • 11:00 Invited
Efficient Light-Trapping in Periodic Nanostructured Thin Crystalline Silicon Solar Cells, *Gang Chen[1]; [1]MIT, USA.* We theoretically and experimentally show that simple periodic pyramid structures on the order of the wavelength can greatly enhance absorption for solar cell applications and potentially reduce silicon mass up to two orders of magnitude.

PThB4 • 11:30 Invited
Achieving the Yablonovitch Limit in Thin-Film Solar Cells with Tailored Randomly Textured Interfaces, *Sämi Wiesendanger[1], Stephan Fahr[1], Thomas Kirchartz[2], Carsten Rockstuhl[1], Falk Lederer[1]; [1]Friedrich-Schiller-Universität Jena, Institut für Festkörpertheorie und -optik, Germany; [2]Blackett Laboratory of Physics, Imperial College London, United Kingdom.* In this contribution we show how the Yablonovitch limit can be reached and eventually exceeded in thin-film solar cells by incorporating randomly textured surfaces with a critical dimension in the order of hundred nanometers.

Austin South

Optical Instrumentation for Energy & Environmental Applications

EThB • Optical Design of Components and Subsystems for Energy and Environment—Continued

EThB3 • 11:00
Development of Compact, Economical and Sensitive Instruments based on IR LED and Laser Spectroscopy for the Detection of Pollutant Gases in the Atmosphere, *Alok J. Verma[1]; [1]Optoelectronics, SAMEER, India.* VCSELs and LEDs at near and mid Infra-red wavelengths are very useful for trace gas sensing. We have developed methane gas sensor with IR LED at 3.38 µm and developing multi-gas sensing by tuning laser diode for detecting traces of pollutant gases.

EThB4 • 11:15
Whole-Facility Particulate Emissions Measurement of a Process Water Treatment Facility using Aglite: A 3-Wavelength Elastic Lidar, *Michael Wojcik[1]; [1]Energy Dynamics Laboratory, USA.* Aglite, an elastic lidar system is used to measure the particulate emissions from a fracture mining petroleum process water treatment facility. Particulate emissions were found to be low for the two kinds of water treatment studied.

EThB5 • 11:30
Quantum Cascade Laser-based CO2 Isotope Sensors for Carbon Sequestration and Environmental Monitoring, *Matthew Escarra[1,2], Stephen So[2], David Thomazy[2], Loan Le[1], Richard Cendejas[1], Igor Trofimov[1,3], Claire Gmachl[1]; [1]Electrical Engineering, Princeton University, USA; [2]Sentinel Photonics, USA; [3]PTAC, Inc., USA.* We report a quantum cascade (QC) laser for detecting 12CO2, 13CO2, and 18OCO in carbon sequestration leak and environmental monitoring. The parallel development of a compact and efficient QC laser-based isotopic ratiometer will also be discussed.

EThB6 • 11:45
A Field-Deployable Multi-Spectral Imaging System for Indirect CO2 Leak Detection through Vegetation Imaging, *Joseph A. Shaw[1]; [1]Electrical Engineering, Montana State University, USA.* To reduce human influence on the global environment, carbon capture and sequestration <CCS) is proposed as a means of collecting CO2 generated through industrial and consumer processes and sequestering it to prevent atmospheric emission.

Senate

Optics for Solar Energy

SRThB • Planar Optical Concentrators and High Efficiency Concepts—Continued

SRThB6 • 12:00 Invited

Luminescent and Non-Luminescent Solar Concentrators: Challenges and Progress, *Dick de Boer[1,2]; Philips Research; [2]Eindhoven University of Technology, The Netherlands.* Luminescent concentrators allows for high concentration if losses by reabsorption and escape could be minimized. New phosphors and filters facilitate this. Another type of lightguide-based concentrators, diffraction-based, is discussed as well.

Austin North

Solid State and Organic Lighting

SDThB • LED Materials and Devices—Continued

SDThB5 • 12:00

A Novel LED Light Extraction Technique Based on Evanescent Wave Coupling , *Xue-Lun Wang[1], Guo-Dong Hao[1], Tokio Takahashi[1]; [1]Nanosystem Research Institute, National Institute of Advanced Industrial Science and Technology (AIST), Japan.* A novel light extraction technique based on coupling of evanescent waves in a ridge structure is reported. This technique can extract directly light outside the escape cone, which cannot be achieved with the conventional techniques.

SDThB6 • 12:15

Energy-Saving Bottom-Lit LED Backlight with Angle-Control Freeform Lens, *Zong Qin[1,2], Kai Wang[1,3], Shang Wang[1,3], Sheng Liu[1,2]; [1]Division of MOEMS, Wuhan National Laboratory for Optoelectronics, China; [2]School of Mechanical Science and Engineering, Huazhong University of Science & Technology, China; [3]School of Optoelectronics Science and Engineering, Huazhong University of Science & Technology, China.* In this paper, relation of transmittance of prism sheets used in bottom-lit LED backlight on the direction of incident light was studied. Freeform lens was utilized to enhance the efficiency to make displays more energy-saving.

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

PThB • Nanostructured Materials with Enhanced Efficiency—Continued

PThB5 • 12:00

Absorption of Silicon Nanowire Arrays on Silicon and Silica Substrates, *Björn C. Sturmberg[1], Kokou B. Dossou[2], Lindsay C. Botten[2], Ara A. Asatryan[2], Christopher G. Poulton[2], C. Martijn de Sterke[1], Ross C. McPhedran[1]; [1]CUDOS and IPOS, School of Pysics, University of Sydney, Australia; [2]CUDOS and School of Mathematical Science, University of Technology Sydney, Australia.* We analyse the absorption mechanism of silicon nanowire arrays on various substrates using a semi-analytic modal method. Independent of the substrate, we find a few well coupled, well concentrated, resonant modes to dominate the absorption.

PThB6 • 12:15

Fluorescent Borate Glasses as Potential Substrates for CdTe Thin Film Solar Cells, *Franziska Steudel[1], Marcel Dyrba[2,1], Stefan Schweizer[1,2]; [1]Fraunhofer Center for Silicon Photovoltaics CSP, Germany; [2]Centre for Innovation Competence SiLi-nano, University of Halle-Wittenberg, Germany.* Sm3+-doped barium borate glasses are investigated for their potential as superstrate for CdTe solar cells. A 3.2 mm thick, 1 mol% Sm3+-doped glass superstrate enables an increase in the external quantum efficiency of approximately 2%.

Austin South

Optical Instrumentation for Energy & Environmental Applications

EThB: Optical Design of Components and Subsystems for Energy and Environment—Continued

EThB7 • 12:00

Compact Raman Spectrometer for Analysis of the Nitrification in the Gulf of Mexico due to Extensive Nutrient Loading, *Manfred Fink[1], Philip Varghese[1]; [1]Physics, The University of Texas at Austin, USA.* A novel, Analytic Non Dispersive Raman analyzer (ANDRaS®) capable of detection of traces of organic compounds with isotopic specificity will be presented. ANDRaS® was designed to measure the rate of nitrification in the Gulf of Mexico.

12:30–14:00 Lunch *(on your own)*

NOTES

Austin North

Solid State and Organic Lighting

14:00–15:30
SDThC • Novel Devices and Lighting Systems

Dongxue Wang; *OSRAM, United States, Co-Presider*
Jiangeng Xue, *Univ. of Florida, United States Co-Presider*

SDThC1 • 14:00 Invited

New Approaches for Cost-Effective Organic Luminescence-Based Lighting, *Max Shtein[1]; [1]Materials Science and Engineering, University of Michigan, USA.* This talk will describe a versatile, cost-effective lighting device architecture based on efficient organic emitters, enabling diffuse and color-tunable light output, as well as minimal waste heat generation.

SDThC2 • 14:30 Invited

Organic Light-emitting Transistor Technology, Michele Muccini[1,2]; *[1]CNR Bologna, Italy; [2]E.T.C s.r.l., Bologna, Italy.* The emerging organic light-emitting transistor (OLET) technology will be introduced and its characteristics and stage of development analyzed and discussed.

SDThC3 • 15:00 Invited

Efficient LED Design, *Dung (pronounced Young) Duong[1], Darren McCosky[1]; [1]Illumitex, USA.* LED Lighting systems are making their way into all aspects of illumination. Efficiently manipulating the intensity distribution of these systems remains a challenge as the industry transitions from using traditional sources to LEDs. LEDs offer the possibility for high lumens per watt, but more importantly, they offer the ability to precisely control the intensity distribution. Ultimately, this improved optical beam control leads to more lumens at the task plane. While high lumens per watt at the LED package level has been the primary LED efficiency metric in the emerging SSL market, the ratings of LED component efficiency should not take precedence over those of total system performance.

Capital Ballroom A

Joint Optical Nanostructures and Advanced Materials for Photovoltaics/ Optics for Solar Energy

14:00–16:00
JThC • Concepts of Light Trapping and Photon Transport

Raymond Kostuk; *University of Arizona, United States, Presider*

JThC1 • 14:00 Invited

All new: New Photonic Materials and Devices for Solar Energy Conversion, *Harry A. Atwater[1]; [1]Resnick Institute and [2]Kavli Nanoscience Institute, California Institute of Technology, USA.* I will describe approaches to control of light-matter interactions leading to enhanced light-trapping and absorption, as well as increased open circuit voltage and enhanced quantum efficiency in low-cost flexible thin film photovoltaic structures.

JThC2 • 14:30 Invited

Plasmonic Photovoltaics: Linking Nanophotonics with Carrier Transport Considerations, *Stefan Maier[1]; [1]Imperial College London, United Kingdom.* The direct linking of electrodynamic with carrier transport modeling in three dimensions enables prediction of the properties of plasmonic solar cells. Examples for both the III/V and the Si materials system will be presented.

JThC3 • 15:00 Invited

Light Trapping and Quantum Semiconductor Structures for High-Efficiency Photovoltaics, *Edward T. Yu[1], Claiborne O. McPheeters[1], Xiaohan Li[1], Daniel M. Schaadt[2], Dongzhi Hu[2]; [1]Microelectronics Research Center, University of Texas at Austin, USA; [2]Institut für Angewandte Physik/DFG-Center for Functional Nanostructures, Karlsruhe Institute of Technology, Germany.* Plasmonics and light trapping provide new avenues for increasing photocurrent in photovoltaics. We discuss current approaches and applications to quantum-well/dot solar cells with potential for high efficiency under varying illumination conditions.

JThC4 • 15:30

Photon Transport in Luminescent Solar Concentrators based on Semiconductor Nanoparticles, *Derya Sahin[1], Boaz Ilan[1], David F. Kelley; [1]UC Merced, USA.* Photon transport in luminescent solar concentrators using semiconductor nanoparticles is modeled by Monte Carlo simulations. Using quantum dots proves to be highly efficient, while using aligned nanorods reduces the escape of light significantly.

JThC5 • 15:45

Near-field Light Focusing by Wavelength-sized Dielectric Spheroids for Photovoltaic Applications, *Manuel J. Mendes[1], Ignacio Tobías[1], Antonio Martí[1], Antonio Luque[1]; [1]E.T.S.I. Telecomunicacion, Instituto de Energia Solar, Universidad Politecnica de Madrid, Spain.* We explore the near-field concentration properties of dielectric spheroidal scatterers with wavelength sizes, using a separation-of-variables method. Such "mesoscopic lenses" are optimized for maximum light enhancement in photovoltaic applications.

Austin South

Optical Instrumentation for Energy & Environmental Applications

14:00–16:15
EThC • Laser Systems for Trace Gas Sensing and Combustion Diagnostics

Gerard Wysocki; *Princeton University, United States, Presider*

EThC1 • 14:00

Broadband Femtosecond Sources for Greenhouse Gas Spectroscopy and Trace-Gas Sensing, *Tyler W. Neely[1], Todd Johnson[1], Lora Nugent-Glandorf[1], Florian Adler[1], Scott Diddams[1]; [1]NIST Boulder, USA.* We describe several approaches for producing broadband femtosecond sources in the mid-infrared for applications in atmospheric spectroscopy. Using a 3.3 µm source, measurements of CH4 and H2O concentrations in atmospheric conditions are described.

EThC2 • 14:15 Invited

Compact Quantum Cascade Laser Instrument for High Precision Trace Gas Measurements, *John B. McManus[1], Mark Zahniser[1], David D. Nelson[1], Ryan M. McGovern[1], Mike Agnese[1], William F. Brown[1]; [1]Aerodyne Research, Inc., USA.* Results from a new generation of mid-infrared quantum cascade laser based trace gas instrument are reported. The 1 s noise for ambient N2O is 6 parts per trillion, corresponding to an absorption noise of 3x10-6.

EThC3 • 14:45

A 243 mJ, Eye-Safe, Frequency Agile, Optical Parametric Oscillator-Based DIAL Transmitter, *Robert Foltynowicz[1]; [1]USURF, USA.* We demonstrate and characterize an OPO-based, NIR-DIAL source that produces 243 mJ per pulse with a spectral linewidth of 157 MHz FWHM and has a frequency switching rate of 2 Hz.

EThC4 • 15:00

Kilohertz-Rate, One-Dimensional Thermometry in Reacting Flows Using Femtosecond-CARS Line Imaging, *Waruna D. Kulatilaka[1], Hans U. Stauffer[1], Sukesh Roy[1], James R. Gord[2]; [1]Spectral Energies, LLC, USA; [2]Air Force Research Laboratory, USA.* We report 1D thermometry at 1 kHz using fs coherent anti-Stokes Raman scattering (fs-CARS) line imaging. Collision-free single-shot measurements are reported in combustion temperatures >2000K demonstrating the technique in chemically reacting flows.

EThC5 • 15:15 Invited

Beyond FTIR - Using Broadly Tunable QC Lasers to Extend Spectroscopic Monitoring Capabilities in Energy and Environmental Applications, *Miles Weida[1], Peter R. Buerki[1], Brandon Yee[1]; [1]Daylight Solutions, USA.* The extension of FTIR performance by broadly tunable quantum cascade lasers (QCLs) is discussed, including the practical effects of reduced tuning ranges. One application enabled by QCL spectrometers (SOx monitoring) is considered.

EThC6 • 15:45 Invited

Laser Spectroscopy and Optical Diagnostics of Combustion Processes, *Ronald K. Hanson[1]; [1]Mechanical Engineering, Stanford University, USA.* Tunable diode laser absorption spectroscopy of temperature and species (NO,H2O,CO,CO2,UHC) with applications in coal fired powerplants, gasifiers and IC engines. Wavelength modulation strategies for dealing with high pressures/ particulate scattering.

16:00–16:30 Coffee Break, *Capital Ballroom Foyer*

Capital Ballroom A

Optical Nanostructures and Advanced Materials for Photovoltaics

16:30–18:30
PThD • Photon Management in Organic Solar Cells
Mark Brongersma; *Stanford University, United States, Presider*

PThD1 • 16:30 Invited

Constructing Precise Morphology for High Performance Printable Polymer Solar Cells, *Xiaoniu Yang[1]; [1]Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, China.* Hereby we present a few approaches to construct precise morphology towards high-performance device for printable polymer solar cells based mainly on P3HT/PCBM composite, which could be potentially produced by using roll-to-roll technique.

PThD2 • 17:00 Invited

Morphology and Performance of Polymer-Based Solar Cells, *Michael E. Mackay[1]; [1]University of Delaware, USA.* Excitons in polymer-based solar cells are short lived placing great emphasis on construction of a nanoscale morphology of electron donor and acceptor. Here we discuss how processing affects the morphology and subsequent performance.

PThD3 • 17:30

Using Localized Plasmon Resonances to Enhance Absorption Efficiency in Thin-film Organic Solar Cells, *Khai Q. Le[1,2], Aimi Abass[2], Bjorn Maes[3], Peter Bienstman[2], Andrea Alu[1]; [1]Electrical and Computer Engineering, The University of Texas at Austin, USA; [2]Ghent University, Belgium; [3]University of Mons, Belgium.* We propose the use of localized surface plasmon modes excited by square metallic gratings to enhance the optical absorption of thin-film organic solar cells. Broadband absorption enhancement of up to 29% is theoretically demonstrated.

PThD4 • 17:45

Simulation and Optimization of Fluorescent Dyes and 3D Microtextures for Luminescent Solar Concentrators, *Günther Hasna[1]; [1]OTPIS, France.* Development of a simulation software taking into account the fluorescent dyes and the shape of the light guide applying 3D virtual textures to reduce reflection.

PThD5 • 18:00

Metal Nanoparticle Enhanced Organic Solar Cells: A Numerical Study of Structure Property Relationships, *Michael Salvador[1], David S. Ginger[1], Yong Zhang[2], Kung-Shih Chen[2], Hin-Lap Yip[2], Alex K-Y.* Jen[2]; *[1]Chemistry, University of Washington, USA; [2]Materials Science & Engineering, University of Washington, USA.* We conduct systematic FDTD calculations for assessing the impact of size and shape of metal nanoparticles as well as the influence of spectral overlap for given particle/semiconductor pairs in nanoparticle enhanced organic solar cells.

PThD6 • 18:15

Improved Performances in Annealed P3HT-Based Dye Sensitized Solar Cells (DSSC): A Detailed Morphological and Spectroscopic Investigation, *Sai Santosh Kumar Raavi[1], Giulia Granchini[2,3], Agnese Abruzzi[3], Henry Snaith[3]; [1]Center for Nano Science and Technology of IIT@PoliMi, Italy; [2]Dipartimento di Fisica, Politecnico di Milano, Italy; [3]Oxford University, Department of Physics, Clarendon Laboratory, United Kingdom.* We employ femtosecond transient absorption spectroscopy and atomic force microscopy on operating hybrid solid-state DSSC with P3HT as the hole transporter, to probe the effect of annealing on charge transfer dynamics and nanoscale morphology.

Austin South

Optical Instrumentation for Energy & Environmental Applications

16:30–18:30
EThD • Testing and Development of Solar Energy Systems and Materials
Ralf Leutz; *Concentrator Optics, GMBH Germany, Presider*

EThD1 • 16:30 Invited

Spectroscopic Techniques to Probe the Charge Generation and Recombination in Solid-State Dye Sensitized Solar Cells, *Sai Santosh Kumar Raavi[1]; [1]Istituto Italiano di Tecnologia, Italy.* We elucidate the use of various spectroscopic tools from femtosecond to quasi-cw regime for complete characterization of charge generation and recombination dynamics in polymer based solid-state dye sensitized solar cells for good device optimization.

EThD2 • 17:00 Invited

Using Sunlight for Affordable Indoor Illumination, *Lorne Whitehead[1]; [1]University of British Columbia, Canada.* Emerging technologies make it practical to affordably deliver sunlight deep into buildings to deliver energy-efficient, high quality natural illumination whenever the sun shines.

EThD3 • 17:30 Invited

Rapid and Nondestructive Testing of Solar Cells for Manufacturing Environment, *Richard K. Ahrenkiel[1]; [1]National Renewable Energy Laboratory, NREL, USA.* The carrier recombination lifetime is a critical parameter in photovoltaic performance. A description of current nondestructive, laboratory techniques, and the potential adoption for the production line will the focus of this presentation.

EThD4 • 18:00 Invited

Testing of Solar Thermal Systems, *Saranpal "Sunny" Rai[1]; [1]Intertek, USA.* A description of standards & certifications available for Solar Thermal products and a detailed examination of the Solar Rating & Certification Corporation (SRCC) certification, which is currently the most recognized standard in the US.

Key to Authors and Presiders

(**Bold** denotes Presider or Presenting Author)

Postdeadline Session

Senate

Joint Optical Instrumentation for Energy & Environmental Applications/Optics for Solar Energy/Solid State and Organic Lighting

Wednesday, 2 November, 17:00–18:00

JWD • E2/SOLAR/SOLED
Postdeadline Session

Joseph Ford; *Univ. of California at San Diego, United States, Presider*

JWD1 • 17:00
Numerical Simulation of Micro-optical Structures for Enhancing Efficiency of Solar Panels, *R. Dey[1], E.V. Bordatchev[1], M. Tauhiduzzaman[1], [1]H. Reshef; [1]Centre for Automotive Materials and Manufacturing, National Research Council of Canada, Canada.* Four types of elongated planar arrays of micro-optical structures (triangular, rectangular, concave and convex) are numerically simulated. The results allow comprehensive understanding how the photovoltaic performance of solar panels can be improved.

JWD2 • 17:15
AGILE: Axially Graded Index LEns as a non-tracking solar concentrator, *O. Solgaard[1], R. Dauskardt[2]; [1]Electrical Engineering, Stanford Univ., USA, Material Science and Engineering, Stanford Univ., USA.* The Axially Graded Index Lens (AGILE) explicitly takes advantage of the fact that the density of electromagnetic radiation modes is proportional to the square of the Refractive Index to create non-tracking solar concentrators.

JWD3 • 17:30
An Airborne Spectrometer and Retrieval Development Project for Air Quality Measurements, *J. Leitch[1], T. Valle[1], C. Hardesty[1], T. Delker[1], B. Baker[1], J. Eskin[1], K. Chance[1], X. Liu[2]; S. Janz, K[3]. Pickering[3]; J. Wang[4] ; [1]Ball Aerospace, USA; [2]Smithsonian Institution/ Smithsonian Astrophysical Observatory, USA; [3]NASA/Goddard Space Flight Center, USA ; [4]University of Nebraska, USA.* The NASA-funded GeoTASO Instrument Incubator project will develop an airborne spectrometer, participate in field campaigns, and test trace gas and aerosol retrieval performance in support of a proposed space-based air quality sensor in orbit.

JWD4 • 17:45
Efficiency Improvement in Top-Emitting Organic Light Emitting Diodes Using Color Conversion Layer, *[1]T. Schwab, [1]S. Hofmann, [1]M. Thomschke, [1]K. Leo, [1]B. Lüssem; [1]TU Dresden, Institut für Angwandte Photophysik, Germany.* We present top-emitting organic light emitting diodes (OLEDs) using internal color conversion layers (CCL). It is shown that pure conversion is realized with CCLs inside the electron transport layer of the OLED providing enhanced efficiency.

(Note: pdp papers are located on the Technical Digest CD Rom)

Postdeadline Key to Authors and Presiders

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