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 Wehrspohn¹,², ¹Fraunhofer Inst. for Mechanics of Materials, Germany, ²Martin-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
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
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- Army S&T Development: Selected Energy Solutions
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- 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

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.
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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
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
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

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

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
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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

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

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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

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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
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.
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.
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. Koromilichenko, ”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
Agenda of Sessions — Wednesday, 2 November

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<td>SOLAR</td>
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<td>08:00–10:00</td>
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<td>JWA • Renewable Energy Plenary Session, Capital Ballroom A</td>
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<td>10:00–10:30</td>
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<tr>
<td>10:30–12:30</td>
<td>SRWB • CPV Systems (Ends at 12:00)</td>
<td>SDWB • Novel OLED Materials</td>
<td>PWB • Photon Management in Solar Cells: Dielectric Nanostructures I</td>
<td>EWB • Introduction to Energy and Environmental Optics TUTORIAL (Ends at 12:15)</td>
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<tr>
<td>14:00–16:00</td>
<td>SRWC • CPV Design and Components</td>
<td>SDWC • OLED Device Physics</td>
<td>PWC • Photon Management in Solar Cells: Dielectric Nanostructures II</td>
<td>EWC • Sensors for Atmospheric Trace Gases and Aerosols</td>
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<td>16:30–18:00</td>
<td>Joint Postdeadline Paper Session (Starts at 17:00)</td>
<td>SDWD • Quantum Dot LED’s (Ends at 17:30)</td>
<td>PWD • Photon Management in Solar Cells: Plasmonic Nanostructures</td>
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<td>19:15–20:30</td>
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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

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<tr>
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<tr>
<td>10:30–12:30</td>
<td>SRThB • Planar Optical Concentrators and High Efficiency Concepts</td>
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<td>SDThB • LED Materials and Devices</td>
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<td>PThB • Nanostructured Materials with Enhanced Efficiency</td>
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<td></td>
<td>EThB • Optical Design of Components and Subsystems for Energy and Environment (Ends at 12:15)</td>
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<td>12:30–14:00</td>
<td>Lunch (on your own)</td>
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<tr>
<td>14:00–16:00</td>
<td>See Joint PV/Solar Capital Ballroom A</td>
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<td>SDThC • Novel Devices and Lighting Systems (Ends at 15:30)</td>
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<td>JThC • Joint PV/Solar Concepts of Light Trapping and Photon Transport</td>
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<td>ETHC • Laser Systems for Trace Gas Sensing and Combustion Diagnostics (Ends at 16:15)</td>
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<td>16:30–18:30</td>
<td>PThD • Photon Management in Organic Solar Cells</td>
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<td>ETHD • Testing and Development of Solar Energy Systems and Materials</td>
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## 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
Renewable Energy and the Environment • 2–3 November 2011
Advantages of this material system to overcome today’s multi-junction has adopted the lattice matched dilute nitride. SRWB3 • 11:30 Invited

High Efficiency Solar Cells at Solar Junction, Human Yue1, 2; 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.

SRWB • CPV Systems—Continued

SDWB3 • 11:30 Invited

Tandem OLEDs based on Organic Semiconductor Heterojunction as Charge Generation Layer. Dongge Ma1, 2; Changzhou Institute of Applied Chemistry, Chinese Academy of Science, China. Abstract not available.

SDWB • Novel OLED Materials—Continued

SDWB4 • 12:00

Environmentally Stable Al-doped ZnO Transparent Electrode for Organic Optoelectronic Devices, Dhirit S. Ghosh1, 2; Tong L. Chen1, Danny Krautz1, Stephanie Chaylan1, Valerio Praneri1, 2; ‘Optoelectronics, ICFO-The Institute of Photonic Sciences, Spain; 1ICREA- 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 Qu1, Zhijian Chen1, Lixin Xiao1, Qiuhang Gong2; ‘Peking University, China. A transparent and electrical conductive layer comprising LiF and Al was designed and obtained successfully. The TOLED with LiF:Al composite cathode showed acceptable electroluminescent behavior of both top and bottom emission.

PWB3 • 11:30 Invited

Use of PLD-grown Moth-eye ZnO Nanosurfaces as Templates for MOVPE Growth of InGaN-Based Photovoltaics, Dave Rogers1, 2; F. Hosseini Teherani1, S. Gautier1, G. Oura1, T. Moudakir1, M. Molinari1, M. Trogler1, M. Pere1, M. J. Soares1, A. J. Neves1, T. Montoro1, D. McGrouther1, J. N. Chapman1, H. J. Draugh1, M. Razeghi1, A. Ougazzaden3; Nanovation, France; 1Center for Quantum Devices, Northwestern University, USA; 2LSI, Ecole Polytechnique, France; 3EMAPS, University de Metz & Supélec, France; 4Supélec/UMI 2958, Georgetech-CNRS, France; 5LIMN, University de Reims Champagne Ardennes, France; 6Departamento De Fisica/1LN, Universidade de Aveiro, Portugal; 7Department of Physics & Astronomy, University of Glasgow, United Kingdom; 8Georgia Institute of Technology, Georgia Tech-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. Wehrspohn1, 2, Johannes Upping1, Andreas Bielawny1; Institute of Physics, University of Halle, Germany; Fraunhofer Institute for Mechanics of Materials, Germany. Unbalanced currents in serial-connected tandem solar cells are a major 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. Martini1, 2; Jianying Zhou1, Thomas Krauss1; Physics and Astronomy, University of St. Andrews, United Kingdom; 2State 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.

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

PWB6 • 12:30

Performance of Large Period Engineered Grating for Solar Cell Applications, Emiliano R. Martini, Jianying Zhou, Thomas Krauss; Physics and Astronomy, University of St. Andrews, United Kingdom; 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.

1Invited
Wednesday, 2 November

SRWC1 • 14:00
A CPV Thesis, David Schultz; 1Banyan Energy, Inc., USA; 2Kyoto Institute of Technology, Japan. 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 Wheeler; 1College of Optical Sciences, University of Arizona, USA. This paper presents a novel design of a solar concentrator that incorporates a lenticular Köhler integrator to achieve high efficiency and low cost. The limitations of the CAP metric are discussed in the context of CPV systems with mixed module and receiver cells.

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

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

SDWC1 • 14:00
Organic Electronics: A World of Interfaces, Antoine Kahn; 1Princeton 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 OLEDs Outcoupling, Arfat Pratada; 1Integrated 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; 1Boyoung Koo; 2Xing Xing, Zhiqun Chen, Bo Qiu, Qihuang Gong; 1Peking 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
Conductive Low-Index Layer: A New Opportunity for Outcoupling Enhancement in OLEDs, Seonghyup Yoo; 1Electrical 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.

SDWC5 • 14:45
Optimization of Silicon Solar Cells using Backside Diffraction Gratings, Markus Wollenhaupt; 1Bircher-Hänscher GmbH, Switzerland. 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.

PWDC1 • 14:00
Light Trapping in Thin Film Silicon Solar Cells with Mono and Bidimensional Photonic Patterns, Angelo Bozio; 1Marco Liscidini, Lucio C. Andreani; 1University 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.

PWDC2 • 14:15
Optimization of Silicon Solar Cells using Backside Diffraction Gratings, Markus Wollenhaupt; 1Bircher-Hänscher GmbH, Switzerland. This numerical study 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)

PWDC3 • 14:30
Decreasing the Thickness of Crystalline-Silicon Solar Cells below 40 µm and Increasing their Light Absorption with Surface Nanophotonic Textures, Victor Depuydt; 1Omni El Daif; 2Dries Van Gestel; 3Kris Van Nieuwenhuysen; 4Christos Trompoukis; 5Frederic Dross; 6Ivo Gordon; 7Jeroen van Hulst; 8IMEC, 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.

PWDC4 • 15:00
Combining Front and Back Grating Structures for Broadband Absorption Enhancement in Thin-Film Silicon Solar Cells, Aimi Abass; 1Khai Q. Le; 2Peter Bieniasmam; 3Andreas Als; 4Bjorn Maas; 5Marc Burgelman; 6Department of Electronics and Information Systems, Ghent University, Belgium; 7Department of Electrical and Computer Engineering, The University of Texas at Austin, USA; 8Department of Information Technology, Ghent University-imec, Belgium; 9Department of Photonics, 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.

ECWC1 • 14:00
Chirped Laser Dispersion Spectroscopy for Remote Sensing of Trace-gases, Gerard Wysokii, Michiel Nihoul; 1Electrical Engineering, Princeton University, USA. A chirped laser dispersion spectroscopy system configured for remote sensing of chemicals is presented. Using a 4.52 µm quantum cascade laser and 100 µm optical pathlength an N2O detection limit of <1 ppb/Hz1/2 has been achieved.

ECWC2 • 14:15
Dynamic Aerosol In-Situ Imager (DAISI), Alan Marchant; 1Jef Simmons; 2Thomas Aepplidale; 3Energy Dynamics Lab, University of Washington 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.

ECWC3 • 14:30
Spectroscopic Instruments for Airborne Measurements of Atmospheric Trace Gases, Alan Fried; 1Dirk Richter; 2Petter Weibring; 3James DeLuisi; 4Scott Spuler; 5Matthew Teachman; 6National Center for Atmospheric Research, USA; 7Applied Physics Group, National Security Division, Pacific Northwest National Laboratory, USA. A novel instrument based upon difference frequency generation absorption spectroscopy to carry out such investigations on various airborne platforms.

ECWC4 • 15:00
Atmospheric Vertical Profiling of Multiple Chemicals with an External Cavity Quantum Cascade Laser Heterodyne Radiometer, Tracy Toat; 1Damien Weidmann; 2Neil Nason; 3Rebecca Ruse; 4Gerard Wysokii; 1Electrical Engineering, Princeton University, USA; 5Space Science and Technology, STFC Rutherford Appleton Laboratory, United Kingdom. We present a 64 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 lifetimes.
Components—Continued
SRWC • CPV Design and Components—Continued

1College of Optical Sciences, The University of Arizona, USA; 2Steward 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.

1Sandia National Lab, USA.

SRWC5 • 15:30
Defining System Conversion Efficiency for Dish-Based Solar Concentrator PV, Blake Coughenour1, Guillaume Butel 1, Roger Angel 2,1; Blake Defining System Conversion Efficiency for SRWC5 • 15:30

SDWC • OLED Device Physics—Continued

1School of Electrical and Computer engineering, Georgia Institute of Technology, USA; 2School of Chemistry and Biochemistry, 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.

SDWC5 • 15:30
Efficient Green and Blue Electrophosphorescent Light Emitting Diodes using a Combination of Solution and Vacuum-Processed Materials, Wojciech Haské1, Sung-Jin Kim1, Deniz Cai1, Ehsan M. Najafzadeh2, Canek Fuentes-Hernandez1,2,2, Bernard Kippelen1,2,3 Julie Leroy1,2,3 Carlos Zuniga1,2,3, Yadong Zhang1,2,3, Anna belle Scarpace1,2,3, Huifang Li1,2,3, Lingyun Zhu1,2,3, John S. Sears1,2,3, Stephen Barlow1,2,3, Jean-Luc Bredas1,2,3, Seth R. Marder1,2,3; 1School of Electrical and Computer engineering, Georgia Institute of Technology, USA; 2Center for Organic Photonics and Electronics, GA Institute of Technology, USA; 3Center 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
Concentrating Photovoltaic Systems Using Micro-Optics, William Sweatt1, Greg Nielson1, Marat Okandan1; 1Sandia 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.

SDWC • OLED Device Physics—Continued

1Materials 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.

1Materials 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.

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 Lewicki1, Longwen Gong2, Robert Griffin3, Timothy Day4, Frank K. Tittel5; 1Electrical and Computer Engineering, Rice University, USA; 2Civil and Environmental Engineering, Rice University, USA; 3Daylight 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
Measuring Atmospheric Carbon Dioxide from Space: The GOSAT and OCO-2 Missions, David Crisp1; 1Jet Propulsion Laboratory, California Institute of Technology, USA. The Japanese Greenhouse gases Observing Satellite is providing new insights in atmospheric carbon dioxide trends. The NASA Orbiting Carbon Observatory-2 Mission will build on this record with increased sensitivity, resolution and coverage.
Solid State and Organic Lighting

SDWD • Quantum Dot LEDs
SeungHyup Yoo; Korea Advanced Institute of Science and Technology, South Korea, Presider

SDWD1 • 16:30
Steady Progress of Colloidal Quantum Dot LED (QLED) Technologies, Vladimir Bulovic; Electrical Engineering and Computer Science, MIT, 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
Quantum Dot Based Light Emitting Diodes, Changhee Lee; 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.

Optical Nanostructures and Advanced Materials for Photovoltaics

Capital Ballroom A

16:30–17:00
PWD • Photon Management in Solar Cells: Plasmonic Nanostructures
Thomas Krauss; University of St. Andrews, UK, Presider

PWD1 • 16:30
Plasmonic and High Dielectric Constant Nanostructures for Light Trapping, Mark Brongersma; Stanford University, USA. Nanometric 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
Absorption Enhancement in Guided-Mode-Resonant Hydrogenated Amorphous Silicon Thin-Film Solar Cells, Tanzina Khaleque, Jaewoong Youl, Wenhua Wu, Robert Magnusson; Electrical Engineering, University of Texas at Arlington, USA. We present measured absorption characteristics of GMR hydrogenated amorphous silicon (a-Si:H) thin-film solar cells. About 22% integrated absorption enhancement compared to planar reference solar cell is observed for 450-730nm wavelength range.

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 Hasnani; 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 Hasnani; OPTIS, France. OPTIS has developed an editor for LED phosphor dyes which take into account physics based measureable spectra information as well as the volume scattering by the Henyey-Greenstein equations.

JWE3
Design Method of High Efficient LED Freeform Optical System for Aeronautical Ground Light, Shuang Wang, Fei Chen, Quan Chen, Zhili Zhu, Zeng Qin, Sheng Liu; 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, Shun-Lung Chang, Shu Chi Huang; Chemical Engineering, National Chang Kung University, Taiwan. When doping with Eu2+ as an activator, optical adsorption from 420 to 650nm was observed. By using a light at 380 nm as an excitation source, a luminescent radiation from 220 to 500nm.

JWE5
13.6-N-sulfanylacetamidopentacene based Fully Encapsulated Low Voltage Vertical Short Channel OFFET, Munshi Puri, Sanjukta Bhunia; EE, USF, USA. 13.6-N-sulfanylacetamidopentacene based low cost fully encapsulated OFFET 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, Chaolun Kan, Xiaowu Sun; 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, Matthias Kröll, Thomas Käsebier, Marcus Ernst, Roland Sailer; Ralf B. Weiherhöfer; µMD group - Institute of Physics, Martin Luther University Halle-Wittenberg, Germany; Institute of Applied Physics, Friedrich Schiller University Jena, Germany; Institute for Solarenergyforschung Hameln ISEF, Germany; Fraunhofer Institute for Mechanics of Materials IVM, Germany. Black silicon (bSi) surfaces can be effectively passivated by thermal ALD. The nanotextures 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. Martín; Juntau Li, Abdul Shakoor, Thomas Krauss; Physics and Astronomy, University of St. Andrews, United Kingdom. We propose a simple post-fabrication treatment aiming at scattering loss reduction in silicon sub-wavelength gratings. The gratings lines are smoothed by the treatment and the measured responses indicate a reduction in the scattering losses.

JWE9
Optimization of Broadband Absorption in Semiconductor Nanowire Arrays for Photovoltaic Applications, Ning Feng Huang, Chenxi Liu, Michelle L. Povilaitis; 'Meng 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 Oxynitride Glass-Ceramics, A-Yong Moon1, Mo-Iron Yol1, Dae-Young Lee1, Woon-Yong Lee1, Ki-Soo Lim1, P. Babu2; 1Physics Department, Chungbuk National University, Republic of Korea; 2Goet. Degree and Ph. D. College, India. Oxynitride 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 Liu1, Di Qu1, Qi Xu1, Wanlu Xie1, Yidong Huang1; 1Fundamental Instrument Unit, National Ecological Observatory Network, USA; 2Institute of Plasma Physics, Chinese Academy of Sciences, 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 Buencuerpo1, María Luisa Muniesa-Camacho1, Pablo A. Postigo1; 1MBE, IMM-CNMCSCIC, Spain. We investigate 1D-2D photonic crystals for light absorption enhancement on thin film photovoltaics (Si, GaAs and 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, Níng Gu1, Karthik Sasihithlu2, Arvind Narayanaswamy1; 1Dept of Electrical Engineering, Columbia University, USA; 2Dept 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 Coward1; NASA-JSC/ESCG-JACOBS, USA. Pollution is 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, Maxgung Liu1, Michael Wujic2, Harri Latvakoski1, Martin Mlynczak2; 1National Ecological Observatory Network, USA; 2Infrared Dynamics Laboratory, USA. The QCL based emissivity monitor was designed to obtain emissivity uncertainty goal of ±0.00015 (3σ) for the CORSAIR blackbody which 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. Taylor1; 1Ed. Ayres1; 2Hongmei Luo2; 1Henry W. Loecher2; 1Fundamental Instrument Unit, National Ecological Observatory Network, USA; 2Institute 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, Liyong Ren1, Huayun Wei1, Yan Li2; 1Precision 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 Vargas1, Roberto R. Puente1; 1FIU, USA; 2Centro de Tecnología de la Información 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 Wang1, Clinton Smith2, Stephen Seo1, Elie Bou-Zeid1, Gerard Wysocki1; 1Electrical Engineering, Princeton University, USA; 2Carnegie Mellon 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 Bouchardeau1, Simon Thibault2; 1CPM, Université 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 CBF1r(ppy)3-based Organic Light Emitting Diodes, Kenichi Kasahara1, Takaaki Saito1, Akira Yamazaki1; 1Ritsumeikan University, Japan. The overshoot of CBF1r(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. Sekhon1; 1Physics, SLSIT Longowal, India. Copper oxide (s) nanoparticle 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, Nikita I. Petropov1, Victor Danilov2, Boris Ustevich2; 1Russia R&D Lab, LG Electronics, Russian Federation; 2General Physics Institute, Russian Federation; 3Physics 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 periodic and random boundary surfaces are calculated.

JWE24
Spectroscopic Investigation of Nd3+-doped ZBLAN Glass for Solar Pumped Lasers, Takenobu Takenobu Suzuki1, Hiroki Kawai1, Hiroaki Nasa1, Shintaro Mizuno1, Hiroshi Ita1; 1Toyota Technological Institute, Japan; 2Toyota 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.
08:00-10:00

JThA • Joint Plenary Session
Bernard Kippelen; Georgia Tech, United States, Presider

JThA1 • 08:00

Theory and Practice for Nanophotonic Light Trapping, Shanhui Fan; 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

Sustainable Energy & Optical Methods for Monitoring Air Pollution, Matthew Fraser; “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

Opportunities for Optical Designs in Driving Concentrating Photovoltaic Technology, Sarah Kurtz; “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

Promises and Challenges in Light-Emitting Diodes for High-Power Lighting Applications, E. Fred Schubert; Jaypee Choi; “Berea College, 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

10:30–12:30

SRThB • Planar Optical Concentrators and High Efficiency Concepts
Raymond Kostuk; University of Arizona, United States, Presider

SRThB1 • 10:30

A Review of Photovoltaic Cavity Converter Optics and its Impact on Multi-junction and Multi-bandgap Systems, Ugur Ortabasi; 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.

SRThB2 • 10:45

Optimal Design of Aperiodic, Vertical Silicon Nanowire Structures for Photovoltaics, Chensi Lin, Michelle L. Povinelli; “Ming Huh 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.

SDThB • 10:30

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

10:30–12:30

SDThB • Nanostructured Materials and Devices
Jin-Young Jung, Keya Zhou; 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.

PThB1 • 10:30

A Relation Between a Filling Ratio and a Length of Silicon Nano Wires on their Solar Cell Performances, Jin-Yong Jung, Keya Zhou, Hsin-Dan Uni, Sang-Won Jee, Kwang-Tae Park; Yoon-Ho Nam, Sun-Mi Shin, Jung-Ho Lee; Chemical Engineering, Hanyang University, Republic of Korea. The relation between filling ratio and length of Si nano wires was 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

Real-Time Sensing of Fluorocarbons Using an External Cavity Quantum Cascade Laser, Mark C. Phillips, Bruce E. Bernacki, Matthew S. Taubman; B. D. Cannon, J. T. Schiffern, T. L. Myers; Pacific Northwest National Laboratory, USA. We present results demonstrating real-time sensing of fluorocarbons at ppb-levels using an external cavity quantum cascade laser.
Concentrators and High
SRThB • Planar Optical
Jose E. Castillo1, Juan M. Russo2, Glenn Rosenberg1, centra
tor Regions in Photovoltaic Modules,
Thermal Effects of Holographic Planar Con-
SRThB3 • 11:15
designed for a reactive self-tracking solar concentra-
tor allows for wide-angle acceptance
without violating étendue.

Concentrator allows for wide-angle acceptance
without violating étendue.

Raymond Kostuk; 1Prism Solar Technologies, Inc.,
USA; 2Electrical 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 con-
tersion efficiency and reduce packaging costs in
high-performance PV modules.

SDThB4 • 11:30
Common-Focal Plane Spectrum-Splitting Concentrator
Photovoltaic Module Design and Development,
Tian Gu1, Michael W. Hiney1,
1Electrical 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 con-
tersion efficiency and reduce packaging costs in
high-performance PV modules.

SDThB3 • 11:30
Process Development for Synthesis of High-
Performance Dye-sensitized Phosphores,
Shyan-Lung Chang1, Shu Chih Huang2,
1Chemical Engineering, National Cheng Kung
University, Taiwan; 2Chemical Engineering,
National Cheng Kung University,
Taiwan. We report the development of a new
method for the synthesis of a yellow oxynitride
phosphor (i.e., Ca2Si2O7Cl2−2H2O) based on
SWS reactions. The synthesized product emits
in 400–670nm centered at 555nm upon excita-
tion at 380nm.

SDThB4 • 11:45
Optical Thin Film Filters for UV and Blue
LEDs, Dong Xue (Michael) Wang1, 1Central Res-
search 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).

SRThB5 • 11:45
Spectral Characterization of the Temperature
Performance of Silicon Solar Cells, Juan M.
Russo1, Deming Zhang2, Shelby D. Vornsham3,
Oztin Zarse1, Raymond Kostuk1; 1Electrical and
Computing Engineering, University of Arizona,
USA. The solar spectrum illuminating silicon
photovoltaic cells is modified to eliminate ultra-
violet and infrared spectral bands. The effect of
modifying the spectrum on cell temperature and
electrical performance is evaluated.

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Computing Engineering, University of Arizona,
USA. The solar spectrum illuminating silicon
photovoltaic cells is modified to eliminate ultra-
violet and infrared spectral bands. The effect of
modifying the spectrum on cell temperature and
electrical performance is evaluated.

SRThB4 • 11:10
Reactive Self-Tracking Solar Concentration,
Katherine Baker1, Jason Karp1, Justin Hallas1,
Joseph Ford1; 1UC, San Diego, USA. We present a
design for a reactive self-tracking solar concentra-
tor. 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.

SRThB4 • 11:30
Common-Focal Plane Spectrum-Splitting Concentrator
Photovoltaic Module Design and Development,
Tian Gu1, Michael W. Hiney1,
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CPV concept is described. Within each unit
cell, spectrally selective elements are laterally
displaced on a common plane to enhance con-
tersion efficiency and reduce packaging costs in
high-performance PV modules.

SDThB3 • 11:30
Process Development for Synthesis of High-
Performance Dye-sensitized Phosphores,
Shyan-Lung Chang1, Shu Chih Huang2,
1Chemical Engineering, National Cheng Kung
University, Taiwan; 2Chemical Engineering,
National Cheng Kung University,
Taiwan. We report the development of a new
method for the synthesis of a yellow oxynitride
phosphor (i.e., Ca2Si2O7Cl2−2H2O) based on
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in 400–670nm centered at 555nm upon excita-
tion at 380nm.

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Optical Thin Film Filters for UV and Blue
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search Labs, OSRAM Sylvania, USA. A model
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Oztin Zarse1, Raymond Kostuk1; 1Electrical and
Computing Engineering, University of Arizona,
USA. The solar spectrum illuminating silicon
photovoltaic cells is modified to eliminate ultra-
violet and infrared spectral bands. The effect of
modifying the spectrum on cell temperature and
electrical performance is evaluated.
SRThB • Planar Optical Concentrators and High Efficiency Concepts—Continued

Concentrators and High SRThB • Planar Optical diffraction-based, is discussed as well. Concentrators: Challenges and Progress, Dick de Boer; Philips Research, Eindhoven University 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.

Another type of lightguide-based concentrators, mized. New phosphors and filters facilitate this. losses by reabsorption and escape could be mini-

SRThB6 • 12:00 Invited Luminescent and Non-Luminescent Solar Concentrators: Challenges and Progress, Dick de Boer; Philips Research, 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.

SDThB • LED Materials and Devices—Continued

SDThB • LED Materials and Devices—Continued

SDThB5 • 12:00 A Novel LED Light Extraction Technique Based on Evanescent Wave Coupling, Jiao-Lun Wang1, Guo-Dong Hao1, Tokio Takahashi1; 1Nanotechnology 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, Zeng Qiu1,2, Xin Wang3, Shang Yang1, Sheng Liu1,2; 1Division of MOEMS, Wuhan National Laboratory for Optoelectronics, China; 2School of Mechanical Science and Engineering, Huazhong University of Science & Technology, China; 3School 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.

SDThB8 • 12:15 Absorption of Silicon Nanowire Arrays on Silicon and Silica Substrates, Bjorn C. Sturmberg1, Kokow B. Dossou1, Lindsay C. Botten2, Ara A. Ananyan2, Christopher C. Poulton2, C. Martijn de Sterke1, Ross C. McPhedran1; 1CUDOS and IPQ, School of Physics, University of Sydney, Australia; 2CUDOS 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.

SDThB8 • 12:15 Fluorescent Borate Glasses as Potential Substrates for CdTe Thin Film Solar Cells, Franziska Steudel1, Marcel Dyba1, Stefan Schweitzer2; 1Fraunhofer Center for Silicon Photovoltaics CSP, Germany; 2Centre 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%.

12:30–14:00 Lunch (on your own)

NOTES

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20 Renewable Energy and the Environment • 2–3 November 2011
New Approaches for Cost-Effective Organic Luminescence-Based Lighting, Max Stein; 1Materials 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.

All new: New Photonic Materials and Devices for Solar Energy Conversion, Harry A. Atwater; 1Resnick Institute and 2Kavli 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.

SDThC • Novel Devices and Lighting Systems

14:00–15:30

14:00–16:00

JThC • Concepts of Light Trapping and Photon Transport

Raymond Kostuk; University of Arizona, United States, Presider

JThC1 • 14:00

Invited

Efficient LED Design, Dong (pronounced Young) Daung; Darren McCoy; 1Illumitex, 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 luminous per watt, but more importantly, they offer the ability to precisely control the intensity distribution. Ultimately, this improved optical beam control leads to more luminous at the task plane. While high luminous per watt at the LED package level has been the primary LED efficiency metric in the emerging LED Lighting systems, it will be introduced and its characteristics and stage of development analyzed and discussed.

JThC2 • 14:30

Plasmonic Photovoltaics: Linking Nanophotonics with Carrier Transport Considerations, Stefan Maier; 1Imperial College London, United Kingdom. The direct linking of electrodynamics 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; 1Clairborne O. McPheters; 2Xiaohua Li; 3Daniel M. Schaudt; Donghee Huh; 1Midwest Electronics Research Center, University of Texas at Austin, USA; 2Kerbrie 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-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; 1Bozlu Ilhan; 2David F. Kelsey; 1UC 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; 1Antonio Martí; 2Antonio Luque; 2ETS.T. Telecommunicacion, Instituto de Energia Solar, Universidad Politecnica de Madrid, Spain. We explore the near-field concentration properties of dielectric spheroid scatterers with wavelength sizes, using a separation-of-variables method. Such “mesoscopic lenses” are optimized for maximum light enhancement in photovoltaic applications.

SDThC1 • 14:00

Invited

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

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. Nedly; 1Todd Johnson; 2Lora Nugent-Glander; 2Florida Adler; 3Scott Diddams; 3LISA 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 NO2 concentrations in atmospheric conditions are described.

EThC2 • 14:15

Compact Quantum Cascade Laser Instrument for High Precision Trace Gas Measurements, John B. McMaster; 1Mark Zahniser; 2David D. Nolte; 3Ryan M. McGinnis; 2Mike Avena; 3William F. Brower; 3Aerodyne Research, Inc., USA. Results from a new generation of mid-infrared quantum cascade laser based trace gas instrument are reported. The 11 noise for ambient NO2 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 Falbynowicz; 1USURF, 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, Warrnana D. Kulatilaka; 1Hans U. Staffier; 2Sukesh Roy; 1James R. Gord; 2Spectral Energies, LLC, USA; 3Air 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

Beyond FTIR - Using Broadly Tunable QC Lasers to Extend Spectroscopic Monitoring Capabilities in Energy and Environmental Applications, Mike Weide; 1Peter R. Buer; 2Brumston Instruments Inc; 3Daylight 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

Thursday, 3 November
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; 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; 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, Khan Q. Le, Aimi Abass, Bjorn Maes, Peter Bienstman, Andrea Alu; Electrical and Computer Engineering, The University of Texas at Austin, USA; Ghent University, Belgium; 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; 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, David S. Ginger, Yong Zhang, Kang-Shih Chen, Hin-Lap Yip; Alex K.Y. Jen; Chemistry, University of Washington, USA; 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, Giulia Granchini, Agnese Abruzzi, Henry Smith; Center for Nano Science and Technology of IT4Institute, Italy; Department of Physics, Politecnico di Milano, Italy; 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.

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

- **EThD1 • 16:30** Spectroscopic Techniques to Probe the Charge Generation and Recombination in Solid-State Dye Sensitized Solar Cells, Sai Santosh Kumar Raavi; 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** Using Sunlight for Affordable Indoor Illumination, Lorne Whitehead; 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** Rapid and Nondestructive Testing of Solar Cells for Manufacturing Environment, Richard K. Ahrenkiel; 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 be the focus of this presentation.

- **EThD4 • 18:00** Testing of Solar Thermal Systems, Saranpal “Sunny” Rai; 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)

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| Angel, Roger-SRWB, SRWC3, SRWC5 | Apedale, Thomas-EWC2 | Asatryan, Ara A-PThB5 | Atwater, Harry A.-JThC1 | Ayres, Ed.-JWE16 | | | |
Postdeadline Session

Senate


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. Dey1, E.V. Bordatchev2, M. Tauhiduzzaman2, H. Reshef2. 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. Solgaard1, R. Dauskardt2. 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. Leitch1, T. Valle2, C. Hardesty2, T. Delker1, B. Baker1, J. Eskin1, K. Chance1, X. Liu2, S. Janz1, K. Pickering3, J. Wang4; 1Ball Aerospace, USA; 2Smithsonian Institution/Smithsonian Astrophysical Observatory, USA; 3NASA/Goddard Space Flight Center, USA; 4University 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, T. Schwab1, S. Hofmann1, M. Thomschke1, K. Leo1, B. Lüssem1. TU Dresden, Institut für Angewandte 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

B

Baker, B.-JWD3

Bordatchev, E.V.-JWD1

C

Chance, K.-JWD3

D

Dauskardt, R.-JWD2

Delker, T.-JWD3

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E

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V

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Optics for Solar Energy (SOLAR)
Solid State and Organic Lighting (SOLED)

Paper Submission Deadline:
8 July 2012 (12:00 EDT; 16:00 GMT)