Renewable Energy and the Environment Congress

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)

11–14 November 2012
Hotel Pullman Eindhoven Cocagne, Eindhoven, Netherlands

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Welcome

Welcome to the Optical Society of America’s 2012 Renewable Energy and the Environment Optics and Photonics Congress (OPC) in Eindhoven, The Netherlands. This is the third year of this OPC, with last year’s congress in Austin, Texas. The four meetings being held at this Congress are:

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

The primary focus is on energy and its interplay with the environment. The two primary focus areas are solid-state lighting and solar energy. The SOLED conference includes the manufacture and materials issues or traditional and organic LEDs. Additionally, it touches upon the optics and applications within the solid-state lighting community. PV and SOLAR are both within the auspices of the solar energy community, but they present such from different vantage points. PV 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. These two conferences meet together in joint sessions to discuss some common themes. E2 broaches the connection between energy and environmental issues. Energy production naturally has raised a number of concerns, so this conference not only looks into effective optical monitoring techniques, but also energy management and the development of instrumentation for traditional and environmental sources.

On the morning of the second day of the conference, Tuesday, there are two Congress-wide plenary speakers to educate us on some of the challenges that confront us in the energy community:

- **Molecular Semiconductor Materials for Photovoltaic Energy Conversion** – Jenny Nelson, Professor, Centre for Plastic Electronics and Department of Physics, Imperial College London, UK

and

- **The Future of Lighting: Beyond Saving Energy** – Klaas Vegter, Chief Technology Officer, Philips Lighting.

Additionally, there is a total of 65 scheduled invited and meeting-specific plenary between the four meetings. These speakers are leaders in their respective fields, and will introduce or focus on important topics within a given field. There is also a wealth of contributed speakers with numbers exceeding the number of invited presentations. There is a joint poster session on the first day of the conference, Monday, 12 November 2012, with 26 presentations. Finally, postdeadline paper sessions are planned, for which the details will be provided in your registration packets. You will note that we have attendees from all over the planet – the energy topic is of great importance to the world science community.

We are already planning the 2013 onward Renewable Energy and the Environment OPCs. In 2013 we will be meeting in Tucson, Arizona, USA and in 2014 we are tentatively scheduled to be in Australia. If you are interested in assisting or have ideas for this OPC, please contact the meeting chairs, program committees, OSA staff, or me.

I thank the chairs of the four collocated meetings, their program committees, and the OSA staff. It could not have been done without your tireless efforts. A special thanks goes to Bart Salters of Philips who greatly assisted with the development of this meeting in Eindhoven, served on the SOLED program committee, provided great help on setting up local events such as the Philips Tour and City of Light walking tour. A final thank you to you, the attendees – this conference is for you – I know that you will enjoy your stay to Eindhoven.

Regards,

R. John Koshel
OSA Board of Meetings, Chair
jkoshel@optics.arizona.edu
Renewable Energy and the Environment Program Committee

Optical Instrumentation for Energy and Environmental Applications (E2)

General Chairs
Raavi Sai Santosh Kumar, Istituto Italiano di Tecnologia (IIT), Center for Nano Science and Technology (CNST) of IIT@ Polimi, Italy
Michael D. Wojcik, Environmental Sensing and Science, Space Dynamics Laboratory, USA

Committee Members
James Dailey, Photonic Systems Group, Tyndall National Institute, University College Cork, Ireland
Wysocki Gerard, Princeton University, USA
Zuguang Guan, ALOMAR Observatory, Andoya Rocket Range AS, Norway
Mansoor Kamjou, Jet Propulsion Laboratory, California Institute of Technology, USA
Waruna Kulatilaka, Combustion and Laser Diagnostics Research Complex, Air Force Research Laboratory, USA
G. Manoj Kumar, Advanced Center for Research in High Energy Materials (ACRHEM), University of Hyderabad, India
Larry Lüer, IMDEA Nanoscience, Campus Universitario de Cantoblanco, Spain
Phillips Mark, Pacific Northwest National Laboratories, USA
Paulo Barbeitas Miranda, Instituto de Fisica de Sao Carlos, Universidade de Sao Paulo, Brazil
Prof Bishnu P. Pal, Indian Institute of Technology Delhi, India
Luca Palchetti, Istituto di Fisica Applicata Nello Carrara, Italy
Upendra N. Singh, NASA Langley Research Center, USA
Miles Weida, Daylight Solutions, Inc., USA

Optical Nanostructures and Advanced Materials for Photovoltaics (PV)

General Chairs
Thomas Krauss, Univ. of St. Andrews, UK
Albert Polman, FOM Inst. AMOLF, Netherlands
Ralf B. Wehrpohn, Fraunhofer Inst. for Mechanics of Materials and Martin-Luther-Univ. Halle-Wittenberg, Germany

Program Chair
Alexander Sprafke, Martin-Luther-Univ. Halle-Wittenberg, Germany

Committee Members
Lucio Claudio Andreani, Univ. degli Studi di Pavia, Italy
Ihab El-Kady, Sandia Natl. Labs, USA
Falk Lederer, Friedrich-Schiller-Univ. Jena, Germany
Jung-Ho Lee, Hanyang Univ., Republic of Korea
Z.F. Yu, Stanford Univ., USA

Optics for Solar Energy (SOLAR)

General Chairs
Alan Kost, Univ. of Arizona, USA
Raymond Kostuk, Univ. of Arizona, USA
Amanda J. Chatten, Imperial College London, UK

Committee Members
Dick de Boer, Phillips Research, Netherlands
Chih-Hao Chang, North Carolina State Univ., USA
César Domínguez, Universidad Politécnica de Madrid, Spain
Jesse Frantz, Naval Research Laboratory, USA
Nasser Karam, Boeing-Spectrolab, USA
Jun Ke, Beijing Institute of Technology, China
John Koshel, Univ. of Arizona, USA
Ralf Leutz, Concentrator Optics GMBH, Germany
Xinchaol Lu, Chinese Academy of Sciences, China
Patrick Meada, Xerox Palo Alto Research Center Inc., USA
Juan C. Miñano, Universidad Politécnica de Madrid, Spain
Ioannis Papakonstantinou, Univ. College London, UK
Georgios Veronis, Louisiana State Univ., USA
Yong Hang Zhang, Arizona State Univ., USA

Solid State and Organic Lighting (SOLED)

General Chairs
Ian Ferguson, Univ. North Carolina, USA
Jiangeng Xue, Univ. of Florida, USA

Program Chairs
Vida Ilderem, Intel, USA
Michael (Dongxue) Wang, Intel, USA

Committee
Geoff Burns, Intel, USA
Jiangdong Deng, Harvard Univ., USA
Oliver Dross, Philips Research Eindhoven, The Netherlands
Ivan Eliashchivich, NanoTronicsimaging, USA
Jesse Frantz, US Naval Research Laboratory, USA
Peng Jin, Beijing Univ. at Shenzhen, China
John Koshel, Photon Engineering LLC, USA
Rongguang Liang, Univ. of Arizona, USA
Ray Ma, Universal Display Corporation, USA
Bart Salters, Philips Research Eindhoven, The Netherlands
Andrew Skipor, Argonne National Lab, USA
Christian Wetzel, Rensselaer Polytechnic Institute, USA
Jim Zhuang, Motorola Mobility, USA
James Zhou, Peking Univ. Beijing, China
Special Events

Conference Reception and Joint Poster Session
Monday, 12 November 2012, 19:00–20:30
Wintertuin Room

Opening Plenary Session
Tuesday, 13 November 2012, 08:30–10:00
Wintertuin Room

The Future of Lighting: Beyond Saving Energy
The potential of new (LED) lighting technologies to save energy is overwhelming. The impact, however, will be much broader than that. In this talk I will give examples of revolutionary fixture designs and light effects, in which advanced optics play a key role.

Klaas Vegter, Chief Technology Officer, Philips Research Eindhoven, Eindhoven, Netherlands

Molecular Semiconductor Materials for Photovoltaic Energy Conversion
Organic semiconductor materials are of intense interest for low cost photovoltaic solar energy conversion. We will discuss recent advances in understanding of the optoelectronic properties of these materials that have raised the efficiency of organic solar cells to around 10%, and the potential contribution of these materials to power generation.

Jenny Nelson, Centre for Plastic Electronics and Department of Physics, Imperial College London, UK

Networking Lunch
Tuesday, 13 November 2012, 12:30-13:30
Wintertuin Room

Glow: International Forum of Light in Art and Architecture
Tuesday, 13 November 2012, 18:00–23:00
City of Eindhoven

A free, self-guided tour of “installations, performances and events based on the phenomena of artificial light” taking place throughout the city. Installations are within walking distance from hotel. See the registration desk for a map. GLOW Food: Some restaurants or bars have joined the initiative ‘GLOW Food & Drinks’ and will serve you a special GLOW meal, GLOW drink or even a full menu at a friendly price. You can recognize the participants of ‘GLOW Food & Drinks’ by a GLOW beach-flag on the outside of the restaurant or bar.

Klaas Vegter has been the Chief Technology Officer of Philips Lighting since April 2008. Klaas started his career at Philips in 1985 as a Development Engineer in the Advanced Development Laboratories in Eindhoven.

In 1988, he was posted as a Senior Scientist to Briarcliff Labs, New York, where he applied Silicon on Isolator (SOI) technology to design Power IC’s to drive fluorescent lamps. In 1990 onwards, Klaas returned to Philips Lighting in The Netherlands to lead Advanced Development Departments in Eindhoven, and Product Development groups in Roosendaal, and Turnhout.

From 1999, Klaas was the Senior Director of Lighting Research & Development in Somerset, USA, and from 2001 onwards he became Head of Advanced Development in Eindhoven. In 2003, Klaas added to that the role of Chief Technology Officer of the business group Lamps and transitioned to become Chief Technology Officer of Philips Lighting in 2008.

Klaas holds a degree in Physics from the University of Delft in The Netherlands. From: http://www.philips-thecenter.org/livable-cities/blogs/Klaas-Vegter/

Jenny Nelson is a Professor of Physics at Imperial College London, where she has researched novel varieties of material for use in solar cells since 1989. Her current research is focussed on understanding the properties of molecular semiconductor materials and their application to “plastic” solar cells. This work combines fundamental electrical, spectroscopic and structural studies of molecular electronic materials with numerical modelling and device studies, with the aim of optimising the performance of plastic solar cells. Since 2010 she has been working together with the Grantham Institute for Climate Change to explore the mitigation potential of photovoltaic, and other renewable, technologies. She has published over 200 articles in peer reviewed journals, several book chapters and a book on the physics of solar cells. She was awarded the Institute of Physics Joule Prize and Medal (2009) and the Royal Society Armourers and Brasiers’ Company Prize (2012) for her research.
Special Events continued

Philips Tour with Wrap-up Networking Opportunity
Wednesday, 14 November 2012, 13:30–18:30
Sign up at the registration desk for this free tour followed by light refreshments.

Conference Program Update Sheet
All technical program changes will be communicated in the onsite Conference Program Update Sheet. All attendees will receive this information with your onsite registration materials and we encourage you to review it carefully to stay informed on changes to the program.

Postdeadline Papers Book
The 2012 Postdeadline Papers Book, included with a technical registration, compiles the postdeadline paper summaries. Technical attendees will receive a copy of the 2012 Postdeadline Papers Book in their registration bags.

NEW! Early Online Access to the Technical Digest and Postdeadline Papers
Technical attendees now have both EARLY (at least one week prior to the meeting) and FREE perpetual access to the papers online through Optics InfoBase. Access the papers through Optics InfoBase using the same login email address and password provided during the meeting registration process. Access is currently limited to Conference Full Technical Attendees only. If you need assistance with your login information, please use the “forgot password” utility or “Contact Help” link. Visit the conference website for more information on this program and a direct link to the papers.

The organizers of the Optical Instrumentation for Energy & Environmental Applications (E2) would like to thank the following Corporate Contributors for their support:

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EKSPIAL is an ISO9001 certified manufacturer of solid state lasers, laser systems and optoelectronics for basic research and industrial applications. Employing 30 years experience and close partnership with the scientific community, EKSPIAL is focused on high performance advanced solutions. In house design and manufacturing ensures operative development and production of new products. High peak power laser systems; short pulse generation and amplification; tunable nonlinear OPO/OPG/OPA; and nonlinear spectroscopy are among the core competencies of EKSPIAL.

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www.research.philips.com

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Explanation of Session Codes

The first letter of the code designates the meeting (for instance, E=Optical Instrumentation for Energy & Environmental Applications, P=Optical Nanostructures and Advanced Materials for Photovoltaics, S=Optics for Solar Energy, L=Solid State and Organic Lighting, J=Joint). The second element denotes the day of the week (Monday=M, Tuesday=T, Wednesday=W). The third element indicates the session series in that day (for instance, 1 would denote the first parallel sessions in that day). Each day begins with the letter A in the fourth element and continues alphabetically through a series of parallel sessions. The lettering then restarts with each new series. The number on the end of the code (separated from the session code with a period) signals the position of the talk within the session (first, second, third, etc.). For example, a presentation coded ET1A.4 indicates that this paper is part of Optical Instrumentation for Energy & Environmental Applications meeting (E) and is being presented on Tuesday (T) in the first series of sessions (1), and is the first parallel session (A) in that series and the fourth paper (4) presented in that session.
### Agenda of Sessions — Sunday, 11 November

<table>
<thead>
<tr>
<th>Time</th>
<th>Venue</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:00–18:00</td>
<td></td>
<td>Registration Open, Foyer</td>
</tr>
</tbody>
</table>

### Agenda of Sessions — Monday, 12 November

<table>
<thead>
<tr>
<th>Time</th>
<th>Venue</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00–18:30</td>
<td></td>
<td>Registration Open, Foyer</td>
</tr>
<tr>
<td>08:30–10:00</td>
<td>Cocagne I</td>
<td>JM1A • Systems and Applications</td>
</tr>
<tr>
<td></td>
<td>Lumiere</td>
<td>LM1B • Solid State Lighting</td>
</tr>
<tr>
<td></td>
<td>Cocagne II</td>
<td>PM1C • Integral Photon Management I (Begins at 08:45)</td>
</tr>
<tr>
<td></td>
<td>Huygens</td>
<td>Joint Session with SOLAR (See JM1A)</td>
</tr>
<tr>
<td>10:00–10:30</td>
<td></td>
<td>Coffee Break and Exhibits, Foyer</td>
</tr>
<tr>
<td>10:30–12:30</td>
<td>Cocagne I</td>
<td>SM2A • Concentrator Optics and Spectrum Splitting</td>
</tr>
<tr>
<td></td>
<td>Lumiere</td>
<td>LM2B • LED Phosphors (Ends at 12:15)</td>
</tr>
<tr>
<td></td>
<td>Cocagne II</td>
<td>PM2C • Integral Photon Management II (Ends at 11:45)</td>
</tr>
<tr>
<td></td>
<td>Huygens</td>
<td>EM2D • Techniques for Atmospheric Monitoring</td>
</tr>
<tr>
<td>12:30–14:00</td>
<td></td>
<td>Lunch</td>
</tr>
<tr>
<td>14:00–16:00</td>
<td>Cocagne I</td>
<td>Joint Session with PV (See JM3B)</td>
</tr>
<tr>
<td></td>
<td>Lumiere</td>
<td>LM3A • OLED Materials &amp; Devices (Ends at 15:30)</td>
</tr>
<tr>
<td></td>
<td>Cocagne II</td>
<td>JM3B • Photon Management in Solar Cells: Plasmonic Structures I (Ends at 15:45)</td>
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<tr>
<td></td>
<td>Huygens</td>
<td>EM3C • Tools for Solar Cell-characterization (Ends at 15:45)</td>
</tr>
<tr>
<td>16:00–16:30</td>
<td></td>
<td>Coffee Break and Exhibits, Foyer</td>
</tr>
<tr>
<td>16:30–18:30</td>
<td>Cocagne I</td>
<td>Joint Session with PV (See JM4B)</td>
</tr>
<tr>
<td></td>
<td>Lumiere</td>
<td>LM4A • Transparent Conductor &amp; Packaging (Ends at 18:00)</td>
</tr>
<tr>
<td></td>
<td>Cocagne II</td>
<td>JM4B • Photon Management in Solar Cells: Plasmonic Structures II</td>
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<tr>
<td></td>
<td>Huygens</td>
<td>EM4C • Diagnostics Tools for Combustion, Aerosols and Explosives</td>
</tr>
<tr>
<td>19:00–20:30</td>
<td></td>
<td>Conference Reception and JM5A • Joint Poster Session, Wintertuin Room</td>
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</tbody>
</table>

### Key to Conference Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>E2</td>
<td>Optical Instrumentation for Energy &amp; Environmental Applications</td>
</tr>
<tr>
<td>PV</td>
<td>Optical Nanostructures and Advanced Materials for Photovoltaics</td>
</tr>
<tr>
<td>SOLAR</td>
<td>Optics for Solar Energy</td>
</tr>
<tr>
<td>SOLED</td>
<td>Solid State and Organic Lighting</td>
</tr>
</tbody>
</table>

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# Agenda of Sessions  — Tuesday, 13 November

<table>
<thead>
<tr>
<th>Time</th>
<th>Location</th>
<th>Session</th>
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</thead>
<tbody>
<tr>
<td>07:00–17:30</td>
<td>Foyer</td>
<td>Registration Open, Foyer</td>
</tr>
<tr>
<td>08:30–10:00</td>
<td>Wintertuin Room</td>
<td>JT1A • Joint Plenary Session</td>
</tr>
<tr>
<td>10:00–10:30</td>
<td>Foyer</td>
<td>Coffee Break and Exhibits, Foyer</td>
</tr>
<tr>
<td>10:30–12:30</td>
<td>Cocagne I</td>
<td>ST2A • Luminescent/Planar Concentrators</td>
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<tr>
<td></td>
<td></td>
<td>LT2B • OLED Optics &amp; Modeling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT2C • Light Management in Solar Cells: Dielectric Structures I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ET2D • Photovoltaic Cells and Energy Storage (Ends at 12:00)</td>
</tr>
<tr>
<td>12:30–13:30</td>
<td></td>
<td>Networking Lunch (lunch provided)</td>
</tr>
<tr>
<td>13:30–15:30</td>
<td>Cocagne II</td>
<td>JT3A • Scattering, Module Optics and Illumination</td>
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<tr>
<td></td>
<td></td>
<td>LT3B • LED Optics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT3C • Light Management in Solar Cells: Dielectric Structures II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Joint Session with SOLAR (See JT3A)</td>
</tr>
<tr>
<td>15:30–16:00</td>
<td>Foyer</td>
<td>Coffee Break and Exhibits, Foyer</td>
</tr>
<tr>
<td>16:00–18:00</td>
<td>Cocoagne I</td>
<td>ST4A • Luminescence and Up/Down Conversion (Ends at 17:45)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>LT4B • LED Applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT4C • Microtechnology &amp; Material Properties I</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ET4D • Optical Fibers for Energy and Environment</td>
</tr>
<tr>
<td>18:00–23:00</td>
<td></td>
<td>Glow Tour (at your own pace)</td>
</tr>
</tbody>
</table>

## 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  •  11–14 November 2012
**Agenda of Sessions — Wednesday, 14 November**

<table>
<thead>
<tr>
<th>Time</th>
<th>Cocagne I</th>
<th>Cocagne II</th>
<th>Huygens</th>
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</thead>
<tbody>
<tr>
<td>07:00–12:00</td>
<td>SOLAR</td>
<td>PV</td>
<td>E2</td>
</tr>
<tr>
<td>08:15–10:00</td>
<td>JW1A • Efficiency Limits</td>
<td>PW1B • Microtechnology &amp; Material Properties II (Begins at 08:30)</td>
<td>Joint Session with SOLAR (See JW1A)</td>
</tr>
<tr>
<td>10:00–10:30</td>
<td>Coffee Break and Exhibits, Foyer</td>
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<tr>
<td>10:30–12:30</td>
<td>SW2A • New Technology (Ends at 12:00)</td>
<td>PW2B • Spectral Conversion (Ends at 12:15)</td>
<td>EW2C • Optics in Soil, Ocean, and Climate Monitoring</td>
</tr>
<tr>
<td>12:30–13:30</td>
<td>Lunch</td>
<td></td>
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<tr>
<td>13:30–18:30</td>
<td>Philips Tour and Wrap-up Networking Opportunity (with light refreshments)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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
ADVANCED LASER TECHNOLOGIES

- Scientific solid state lasers
- Spectroscopy systems
- Industrial lasers
- Laser optoelectronics
Joint Optics for Solar Energy / Optical Instrumentation for Energy & Environmental Applications

08:30–10:00
JM1A • Systems and Applications
Presider: Amanda J. Chatten; Imperial College London UK

JM1A.1 • 08:30  Invited
A Systems Perspective for Managing Commercial Portfolios of Research and Technology for the Solar Industry, Joseph Morabito; Alcatel-Lucent, USA. A Systems Analysis for photovoltaics identifies positive reinforcements for solar development (global solar value creation). There are three high leverage points: the Solar Industry Supply Chain Consortium, the Energy Internet, and Sustainable Development.

JM1A.2 • 09:00  Invited
Quantifying the Capacity Value and Economics of Distributed Energy Storage for PV, Volker J. Sorger; Electrical and Computer Engineering, School of Engineering and Applied Sciences, The George Washington Univ., USA. Photovoltaic (PV) systems achieve peak production before the grid demand peak. To increase the grid capacity value of decentralized PV, we analyze their economic value-change by dispatching energy from an added storage unit during peak demand.

JM1A.3 • 09:30  Invited
Novel Applications of 40% Efficient Solar Cells, Keith W. Barnham; Imperial College, UK. The good news that the cost of photovoltaic panels is at last in free fall is bad news for smaller 2nd generation manufacturers and developers of 40% efficient triple-junction cells. This talk will discuss the optics of novel building integrated photovoltaic applications where the multi-functionality means the cost dynamics are not simply about undercutting flat panel prices.

08:30–10:00
LM1B • Solid State Lighting
Presider: Ian Ferguson; Univ. of North Carolina at Charlotte, USA

LM1B.1 • 08:30  Invited
Low-cost high-efficiency GaN LEDs on 6-inch Si, Colin Humphreys; Univ. of Cambridge, UK. The main factor limiting the widespread use of LEDs in home and office lighting is cost. This talk will describe the growth of low-cost high-efficiency GaN LEDs on large-area silicon wafers.

LM1B.2 • 09:00  Invited
The Grand Trends and Global Strategic Research Agenda of Solid State Lighting, G.Q. Zhang; Technical Universiteit Delft, Netherlands. This presentation will summarize the grand trends of SSL technology and business development, and highlight the development of Strategic Research Agenda (SRA), which is the concerted action of global experts from industry and academia.

LM1B.3 • 09:30  Invited
The Last Mile for Solid State Lighting, Peng Lin, Jerry Lu; Shenzhen Graduate School of Peking Univ., China; Rave Optoelectronics, USA. LED based solid state lighting (SSL) has been hailed as the third generation lighting technologies following incandescent and fluorescent. It has demonstrated lumen efficacy over 250 lumens per watt, along with other advantage such as long life and environmentally benign. However, the mass adoption of solid state lighting is still pending on cost, system integration and standardization, and more importantly, perfecting the lighting fixture design to offer high quality lighting and great customer experiences. This article reviews the recent academic and industry efforts in China towards mass adoption of solid state lighting, and highlights the last mile of the solid state lighting research.

08:45–10:00
PM1C • Integral Photon Management I
Presider: Thomas Krauss; Univ. of St Andrews, UK

PM1C.1 • 08:45  Invited
Multishell Nanowires for Next-Generation Photovoltaics, Sung-Kyung Kim, Jiho Park, Young-Duk Song, Charles Lieber; Hong-Gyu Park; Physics, Korea Univ., Republic of Korea; Chemistry and Chemical Biology, Harvard Univ., USA. We show how single nanowires and their assembled structures can enable enhanced photovoltaic platforms using synthetically designed nanowires with tunable optical properties. The absorption behavior from functioning nanowire devices and numerical simulations are also studied.

PM1C.2 • 09:15  Invited
Plasmon-induced Enhancement and Spectral Modification of Absorption in Si Nanowire Array, Eunsongyi Lee, Keya Zhou; Ewha Womans Univ., Republic of Korea; Hanyang Univ., Republic of Korea. We investigate optical properties of Si nanowire (NW) array using the FDTD method. Al underlayers can excite localized surface plasmon and surface plasmon polaritons, resulting in enhancement of optical absorption of the NWs.

PM1C.3 • 09:45  Invited
Light Trapping in 1-20 μm-thick Si Solar Cells Using Surface Si Mie Scattering, Pierpaolo Spinelli, Marc A. Verschuuren; Albert Polman; FOM Institute AMOLF, Netherlands; Philips Research Laboratories, Netherlands. We demonstrate light trapping in thin (1-20μm) Si slabs using subwavelength surface Mie scatterers. Photocurrent in 20 μm-thick crystalline-Si solar cells is enhanced by up to 20% with respect to flat cells with a standard Si3N4 coating.

10:00–10:30 Coffee Break and Exhibits, Foyer
Concentration, Free form Optics Applications in Photovoltaic optics to solve the challenges in concentration are the key of the state-of-the-art nonimaging Freeform surfaces on a Diffractive/Refractive Optical Combination, Photo-Voltaic System Using Micro-Optics, Germany

Invited Remote self-tracking and concentrating solar light onto a Diffractive/Refractive Optical Combination, Photo-Voltaic System Using Micro-Optics, Germany

SM2A • Concentrator Optics and Spectrum Splitting
Presider: Ralf Leutz; Concentrator Optics GmbH, Germany

10:30–12:30
SM2A • Concentrator Optics and Spectrum Splitting
Invited Phosphor-Converted White LED Modeling Using Near-Field Chromatic Luminance Data, University of Liège, Belgium.

10:30–11:15
PM2B • Integral Photon Management II
Presider: Thomas Krauss; University of St Andrews UK

PM2B.1 • Invited Dielectric Optical Antenna Solar Superabsorbers, Linyu Cao; North Carolina State Univ., USA. The key challenge for massive utilization of solar energy is the high cost of existing solar conversion devices. Enhancing solar absorption by light trapping consists of a major strategy for the cost reduction and efficiency improvement of the devices. Regardless the significant advances that have been achieved so far, techniques to trap solar light more efficiently is needed to further lower the cost. We demonstrate a new approach to achieve extraordinary enhancement in the absorption of sunlight by exploring core-shell nanostructures. The core-shell structure consists of absorbing semiconductors and non-absorbing dielectric materials, such as ZnO, Si3N4. We thoroughly examine the fundamental physics underlying this strong absorption enhancement, and, building on the fundamental understanding, propose new designs of high-performance light trapping for practical solar cells.

PM2B.2 • Invited Broad-band Light-trapping in Thin Film Crystalline Silicon Solar Cells with Engineered Disordered Photonic Structures, Angelo Borsella, Marco Liscidini; University of Padua, Italy. We theoretically investigate light trapping in thin-film crystalline silicon solar cells. By using one-dimensional photonic patterns and adding Gaussian disorder, the short-circuit current is increased up to values that nearly approach the Lambertian limit.

PM2B.3 • Invited Disordered Photonic Structures for Light Trapping in Thin Films, Ching-Yi Chen; National Taiwan University, Taiwan. Two-dimensional disordered photonic materials are shown to constitute an efficient and flexible strategy for broadband and wide-angle light trapping in thin films.

PM2C • Optical Nanostructures and Advanced Materials for Photovoltaics

10:30–11:45
PM2C • Optical Nanostructures and Advanced Materials for Photovoltaics
Invited Optical Analysis of Thin-Film Silicon Solar Cells on 1-D Periodic Gratings with Non-Conformal Layers, Serge Solntsev; University of Liège, Belgium. We theoretically investigate light trapping in thin-film silicon solar cells. We show that the non-conformal nature of the gratings investigated is important for achieving significant light trapping in thin-film silicon solar cells.

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PM2C.4 • Invited Optical Analysis of Thin-Film Silicon Solar Cells on 1-D Periodic Gratings with Non-Conformal Layers, Serge Solntsev; University of Liège, Belgium. We theoretically investigate light trapping in thin-film silicon solar cells. We show that the non-conformal nature of the gratings investigated is important for achieving significant light trapping in thin-film silicon solar cells.

SM2A.2 • 10:45 Study of a Solar Concentrator for Space Based on a Diffractive/Refractive Optical Combination, Cécile Michel, Jerome Loiseau, Fabian Langen, Alexandra Mastroni, Serge J. Habraken; Centre Spatial de Liège, Belgium; Hololab, Univ. of Liège, Belgium. This paper presents a new design of a planar solar concentrator at 10x with spectral splitting focusing on two separated PV cells, allowing independent control. Optical elements, blazed diffraction grating and Fresnel lens, are optimized.

SM2A.3 • 11:00 Free form Optics Applications in Photovoltaic Concentration, Juan C. Minano; Universidad Politécnica de Madrid, Spain. Freeform surfaces are the key of the state-of-the-art nonimaging optics to solve the challenges in concentration photovoltaics. Different families (FK, XR, FX3) will be presented, based on the SMS 3D design method and Köhler homogenization.

SM2A.4 • 11:30 Phase-change Actuator for Self-tracking Planar Solar Concentrator, Eric J. Tremblay, Damien Loterie, Christophe Moser; École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. We present a reversible in-plane actuator for solar focus activated lightguide coupling. By actuating at the location of focused sunlight, this device aims to adaptively self-track and concentrate solar light into a planar waveguide.
Experimental Results of Hybrid and Refractive Achromatic Doublets Made of PC and PMMA, Fabian Languy1, Cédric Lenaerts2, Jérôme Loicq2, Serge Habraken1; 1Physics - Hololab, Univ. of Liege, Belgium; 2Centre Spatial of Liege, Univ. of Liege, Belgium. To combine achromatic system with cost-effective technology, we propose the use or hybride (refractive/diffractive) and refractive doublets Fresnel lenses. These two technologies have been compared experimentally from an optical point of view.

Chromatic-Thermal-Optic-Electric Integration Model of High Power Color LEDs, Tsung-hsun Yang1, Chao-Yuan Chih1, Hong-Yu Chou1, Ching-Cherng Sun 1; 1Dept. of Optics and Photonics, National Central Univ., Taiwan. An empirical model is proposed to dynamically evaluate all of the junction temperature, the optic flux, and the chromaticity of LEDs with high accuracy as only measuring the forward voltage and the driving electric current.

Broadband Diffractive Optics for Efficient Light Management in Photovoltaics, Rajesh Menon1; 1Univ. of Utah, USA. A micro-structured broadband diffractive optic efficiently concentrated and separated sunlight into spectral bands that were incident upon laterally separated single-junction photovoltaic devices. An increase in electrical power output was demonstrated with Si/GaAs and CIGS devices.

Enhancement of Emission Intensity of Y3Al5O12:Ce3+ Phosphor by Surface Modification of Wet Etching, Zhijiang HE1, Ou Qiong-rong1, Liang Rongqing 1; 1Fudan Univ., China. The modified phosphor presents higher emission intensity (increased by 8.5%) and lower backscattering light. These are contributed by surface passivation and removal of surface defects after etched by the NH4F and HNO3 mixture solution.

The Applications of Fibre-optic Sensor Technology in Railway Systems and Wind Turbines, Hwa Yaw Tam1; 1Hong Kong Polytechnic Univ., Hong Kong. Fiber Bragg grating technology has been attracting substantial interests due to the versatility of the FBGs. Transducers based on FBGs are being deployed to measure a multitude of parameters for railway and wind turbine monitoring.
Joint Optical Nanostructures and Advanced Materials for Photovoltaics / Optics for Solar Energy

Presider: Ralf Wehrspohn; Fraunhofer ISE, Jülich GmbH, Germany; 1IEK-5 Photovoltaik, Forschungszentrum Jülich GmbH, Germany; 2Institute of Physics (1A), RWTH Aachen University, Germany. The prototyping and optical simulation of plasmonic reflection-grating back contacts in thin-film silicon solar cells is identified. An improvement potential of the short-circuit current density by 4 mA/cm² in comparison with conventional light-trapping is identified.

Plasmonic Enhancements in Thin-Film Organic Solar Cells by Broadband Transient Absorption Spectroscopy, Fredric Laquai1; CatchPlanck-Institut für Polymerforschung, Germany. I will discuss the efficiency-limiting processes in different polymer/fullerene photovoltaic blends that we have recently studied by broadband (500 - 2200 nm) transient absorption pump-probe spectroscopy in a dynamic range from femto- to millisecond.
Long He1, Fan Xiaoxuan1, Ou Qiongrong1,2, Liang Rongqing1,2; Films Treated by Oxygen Plasma Immersion Ion Implantation, X-ray Photoemission Spectroscopy Studies of Indium-tin-oxide (ITO) Films.

Synthesis of Transparent Conductive Thin Films of In2O3 and SnO2 by DC Magnetron Sputtering, Alvaro Bedoya 1,2, Alejandra Torres-Castro 1,2, Manuel Garcia-Mendez 1,2, Ubaldo Ortiz-Mendez 2; 1Facultad de Ingeniería Mecánica y Eléctrica, Universidad Autónoma de Nuevo León, Mexico; 2CIDIT, Universidad Autónoma de Nuevo León, Mexico. We demonstrate effective mode coupling by light scattering from periodic Ag nanoparticle arrays printed onto a complete anti-reflection-coated thin-film a-Si:H solar cell. The photocurrent is enhanced by 10% compared to a flat reference cell.

X-ray Photoemission Spectroscopy Studies of Indium-tin-oxide (ITO) Films Treated by Oxygen Plasma Immersion Ion Implantation, Long He1, Fan Xiaoxuan1, Ou Qiongrong1, Liang Rongqing1,2; Laser Thermometry Techniques for Combustion Diagnostics, Frank Bryae1; 1Mechanical Engineering, Imperial College London, UK. Several laser techniques with different characteristics for remote gas phase thermometry in the harsh environment of practical combustion devices - such as internal combustion engines and gas-turbine combustors - are presented, and their virtues and limitations discussed.
Quantum Corrections for Raman Scattering, Antônio Carlos A. Faria, Vladislav Jovanović, Uweol Palanchoski, Rahul Dewan, Henning Kurz, Philip Obermeyer, Helmut Stiebig, Dietmar Knipp. Research Center for Functional Materials and Nanomolecular Science, Electronic Devices and Nanophotonics Laboratory, Jacobs University, Bremen, Germany. Light trapping and plasmonic effects in silicon thin-film solar cells were investigated experimentally and numerically. The performances of microcrystalline and amorphous silicon solar cells strongly depend on the morphology of the metal back contact.

Optimizing Gaussian Disorder at Rough Interfaces to Obtain Light Trapping in Thin-Film Solar Cells, Piotr Kowalczewski, Marco Liscidini, Lucio C. Andreani. Dept. of Physics, Univ. of Pavia, Italy. We present a theoretical study of rough interfaces to obtain light trapping in thin-film silicon solar cells. Disorder parameters were optimized by rigorous calculations with short-circuit current density as a figure of merit.

Comparison of the numerical results of Monte Carlo codes, with three different phase functions, Edmundo Reynoso Lara, Manuel Rendón Martínez, José Antonio Díaz-Patlé, Luis Ángel Martínez Bejarano, Marco Liscidini, Maximino Luis Arroyo Castillo. Electronics, Benemérita Universidad Autónoma de Puebla, Mexico; Physics-Mathematics, Benemérita Universidad Autónoma de Puebla, Mexico; Optics, Instituto Nacional de Astrofísica, Optica y Electrónica, INAOE, Mexico. We do a comparison of the numerical results of two Monte Carlo codes, using simple and modified Stokes vectors. We optimize the computing time using a auxiliary function, Sin(x), that best fit the original phase function.

Photon Management in Solar Cells: Plasmonic Structures II—Continued, Matthew J. Berg. Particle-Assisted Light Concentration for Solar Photovoltaics, Antonio C. Faria, Torell. Here we demonstrated that an optimization of the optical properties of the layers in the polymer solar cell is essential to further improve the photovoltaic performance of high performance thin film OPV devices.
JM5A • Joint Poster Session—Continued

JM5A.11
3-D Modeling of Triple Junction Solar Cells on 2-D Gratings with Optimized Intermediate and Back Reflectors, Olindo Isabella1, Mostafa El-Shinawy2, Sergei Solntsev2, Miro Zeman3, Photovoltaic Materials and Devices/Dimes, Delft Univ. of Technology, Netherlands. Superstrate thin-film silicon-triple junction solar cells on 2-D gratings were optimized using opto-electrical modeling. Tuning the thickness of intermediate and back reflectors and the band gap of the middle cell resulted in 17% initial efficiency.

JM5A.12
Submicron Structures Formation at Initially Polished and Roughened Silicon Surface Irradiated by Nanosecond Laser Pulses in Distilled Water, Malte Sobhani1, Mohammad Hossein Mahdavi2, Iran Univ. of science and technology, Islamic Republic of Iran. Initially polished and rough silicon were irradiated by nanosecond laser beam in distilled water. Analysis of SEM images and reflectivity results show that the structures density and reflectivity of silicon are influenced by laser pulse number and target characteristics.

JM5A.13
Nitrogen Concentration Dependence on Two-Step Photocurrent Generation in GaNASiGaAs Solar Cells, Martin Elbing1, Manfumi Jo1, Takeshi Noda1, Takaki Mano1, Yoshihiko Sakuma1, Kazuaki Sakoda1; National Institute of Materials Science, Japan; Graduate School of Pure and Applied Science, Univ. of Tsukuba, Japan. The photocurrent characteristics of GaNASiGaAs solar intermediates, Band Solar Cells are investigated. The photocurrent is increased by a two-step photon absorption process and distinct differences in the bias dependence for different nitrogen concentrations are presented.

JM5A.14
Porous Silicon with Metal Nanoparticles for Silicon Solar Cells, Alexander Chekhov1, Tatiana Murzina1, Alexander Chekhov2, Tatiana Murzina1; Skobelev Institute of Nuclear Physics, M. V. Lomonosov Moscow State Univ., Russian Federation. Composite solar cells formed by a crystalline Si with a thin mesoporous silicon layer infiltrated by plasmonic nanoparticles are studied. Measurements show an increase of quantum efficiency as a result of local field enhancement near nanoparticles due to plasma resonance.

JM5A.15
3D Optical Modeling of Thin-film a-Si/a-Si Tandem Solar Cells with Random Textured Interfaces using FEM, Martin Hammerschmidt1, Christian Schwanke1, Christoph Schwanne1, Simon Kime2, Sonya Calla1, Bernd Stannowski1, Bernd Reich1; Computational Nano, Optics, Zuse Institut Berlin (ZIB), Germany; Helmholtz-Zentrum Berlin für Materialien und Energie, Germany. We present a FEM based simulator for 3D rigorous optical modeling of a-Si/a-Si tandem thin-film solar cells with randomly textured layer interfaces. Our focus lies on a detailed analysis of the numerical error.

JM5A.16
The Effect of Diffraction Gratings on Absorption in P3HT:PCBM Layers, Byron Cecchini1, Akram Amoozadi2, Stava Shahin1, Mafujo Jo1, Takao Yonekura1, Robert A. Norwood1, Javan Thomas1, Binh Au Thanh Duong2; Optical Sciences, Univ. of Arizona, USA; Nanoscience Technology Center, Univ. of Central Florida, USA. An integrating sphere is used to measure the absorption of P3HT:PCBM layers with 700 nm period gratings on the reverse side of the substrate. Gratings that do not exploit TIR adversely affect the absorbance.

JM5A.17
Plasmonic Effects of Nanoholes in a Silver Back Reflector for Improved Light Trapping in Thin Film Amorphous Silicon Solar Cells, Luwren van Dijk1, Marcel Di Vecce1, Dick Van Dijk1, Karine van der Werf1, Ruud Schroppel1; Debye Institute for Nanomaterials Science, Utrecht, Netherlands. Improved light management of solar cells is possible by interaction of light with dielectric contrast of nanoholes in the back reflector, which include plasmonic effects. Angular resolved EQE measurements are compared with FDTD simulations.

JM5A.18
Plasmonic Black Gold and Black Metals, Thomas Sondergaard1, Alexandre Chekhov1, Tatiana Murzina1, Olindo Isabella1, Karine van der Werf1, Ruud Schroppel1; Debye Institute for Nanomaterials Science, Utrecht, Netherlands. Plasmonic black gold and black metals with a beam-spreading optics was numerically treated by angular contrast of nanoholes in the back reflector, which include plasmonic effects. Angular resolved EQE measurements are compared with FDTD simulations.

Wintertuin Room

Joint Poster Session

JM5A.22
Assessment of solar spectral irradiance in the IEC 61853-1 norm, Luca Bezzatato1, Wilfried van Sark1, Alexander Les2; Management, EKO Instruments Europe B.V., Netherlands; Sustainable Development, Univ. of Utrecht, Netherlands. This research, based on measured data, investigates the conformity assessment described in the 61853-1 IEC norm, especially at low-irradiance condition and critically analyses the fixed Air Mass 1.5 spectral radiation distribution.

JM5A.23
Ultra-compact Dispersive Concentrator Concept for Laterally-arrayed Multi-junction PV Cells, Tian Gu1, Michael Haney2; Univ. of Delaware, USA. A novel ultra-compact, high-efficiency dispersive solar concentrator concept is evaluated that spectrally splits the incident sunlight onto laterally positioned multiple band-gap PV cells while maintaining the physical profile of a normal lens.

JM5A.24
Impact of Two Competing Energy Transfer Mechanisms on Spectra in Organic Light Emitting Diodes, Kenichi Kasahara1, Syugo Kawasaki1, Yunsuke Horikoshi1, Akira Yamazaki1; Ritsumeikan Univ., Japan. We have investigated the emission spectra and intensity of a-NPD/Aiqi organic light emitting diodes. It is shown that they are offspiring affected by the plasmon absorption/scattering and Förster energy transfer.

JM5A.25
Spectral Analysis of Angular Color Uniformity in a White LED Based on a Yellow Phosphor, doanhun Mun1, Hyemin Park2, Da-Chan Kim1, Boom-Hoon Ohnbo1, Se-Geun Park3, E-Hang Lee1, Seung Guk Lee1, Seung-a Choi1, Seokchan Hong1; Univ. Inha, Republic of Korea; Samsung Electronics Co., LTD, Republic of Korea. The color ring phenomenon observed at a white LED with a beam-spreading optics was numerically treated by angular spectrum analysis, and could be explained with the coincidence of emission points of blue and yellow lights.

JM5A.26
Photocurrent Analysis In Bulk Heterojunction Organic Photovoltaic Devices (OPVs), Douglas Jose Coutinho1, Roberto M. Faria1; Physics, IFSC-USP, Brazil. We present a transport analysis for OPVs. The carrier mobility, measured by photo-CELIV, is the main parameter that governs the JSC and the power conversion efficiency and helped us to modulated J-V curves.
Optics for Solar Energy

10:30–12:30

ST2A • Luminescent/Planar Concentrators
Presider: Dick de Boer; Philips Research Europe, Netherlands

ST2A.1 • 10:30
Geometrical Design of Luminescent Solar Concentrators for Application in the Built Environment, Luca Patrignani1, Keith W. J. Barnham1, Amanda J. Chatten1; ’Dept. of Physics, Imperial College London, UK. We have developed a practical program for assessing the best shape of a luminescent solar concentrator, considering its possible size and orientation constraints.

ST2A.2 • 10:45
Performance of Flat and Bent Luminescent Concentrators, Dick K. de Boer1, Arno J. Ras1, Bhuvana Viovanathan1, Helmut Zahn1; ’Philips Research, Netherlands. Flat and bent 100x100 mm2 prototype luminescent solar concentrators were made and their performance was evaluated at various angles of incidence. The measured efficiencies are 0.029 (flat) and 0.024 (bent).

Lumiere

10:30–12:30

LT2B • OLED Optics & Modeling
Presider: Rajiv Singh, Univ. of Florida, USA

LT2B.1 • 10:30
Hybrid White Organic Light-emitting Diodes with High Color-rendering Index and Stable Color, Dongge Ma1, ‘Changtian Cao of Applied Chemistry, China. In this paper, we realized high efficiency hybrid white organic white light-emitting diodes (WOLEDs) for high color-rendering index (CRI) and stable color by the design of device structures. We will give detailed design and results.

Cocagne II

10:30–12:30

Optical Nanostructures and Advanced Materials for Photovoltaics

PT2C • Light Management in Solar Cells: Dielectric Structures I
Presider: Albert Polman; FOM Inst for Atomic & Molecular Physics, Netherlands

PT2C.1 • 10:30
Invited
Optics and Device Performance - A Trade-off, Franz-Josef Haug1, Céline Pahud1, Christophe Ballif1; ’Institute of Microengineering, École Polytechnique Fédérale de Lausanne, Switzerland. We present an experimental study of light scattering back reflectors in thin film silicon solar cells. The results suggest that novel strategies based on localized plasmon resonances in silver nano-particles cannot rival conventional reflector geometries.

PT2C.2 • 11:00
Absorption Enhancement in Ultrathin Solar Cells with Antireflection and Light-Trapping Nanocone Gratings, Ken Xinxi Wang1, Zongfeng Yu1, Victor Liu1, Yi Cui1; ’Stanford Univ., USA; ’SLAC National Accelerator Laboratory, USA. We combine optimized front gratings primarily for antireflection at shorter wavelengths and back gratings primarily for light-trapping at longer wavelengths in ultrathin crystalline silicon solar cells to achieve near Yablonskii limit absorption.

Huygens

10:30–12:00

ET2D • Photovoltaic cells and Energy Storage
Presider: Sai Santosh Kumar Raavi; Istituto Italiano di Tecnologia (IIT), Center for Nano Science and Technology (CNST) of IIT@PolMi, Italy

ET2D.1 • 10:30
Invited
Environment Effects on the Long-time Stability of a Bulk-heterojunction (BHJ) Organic Photovoltaic Cells, Larry L. Luer1; ’Madrid Institute for Advanced Studies, Spain. The environmental stability of organic solar cell must be improved to increase their market potential. We present our approach highlighting transient absorption spectroscopy allowing detailed look on the loss processes caused by degradation.

Optical Probing of the Ultrafast Charge Carrier Motion Dynamics in Organic Solar Cells, Vaidmantas Gužnaitis1; ’Center for Physical Sciences and Technology, Institute of Physics, Lithuania. We demonstrate application of the electric field-induced second harmonic generation as a probe of ultrafast electric field dynamics in thin molecular film, used for investigation of the charge carrier mobility in organic solar cells.
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**ST2A • Luminous/Planar Concentrators—Continued**

**ST2A.4 • 11:15**

*Using Photonic Crystals to Modify the Emission in Luminous Solar Concentrators, Johannes Gutmann1,2, Hans Zappe1, Jan Christoph Goldschmidt1,2; Fraunhofer Institute for Solar Energy Systems ISE, Germany, Laboratory for Micro-optics, Dept. of Microsystems Engineering - IMTEK, Univ. of Freiburg, Germany.* To increase the efficiency of luminous concentrators, we use photonic crystals to redistribute emission directionally and spectrally. The presented theoretical framework allows calculating these effects and is applied to dye doped PMMA opals.

**ST2A.5 • 11:30**

*Fabrication of One-Dimensional Photonic Crystals for Luminous Solar Concentrators, Janina Löffler1, Johannes Gutmann1, Jan Christoph Goldschmidt1,2; Fraunhofer Institute for Solar Energy Systems ISE, Germany.* Luminous materials embedded in photonic crystals can form advanced luminous concentrators. We prepared spin-coated and PECVD multilayers with alternating refractive index and developed a theoretical description of their performance.

**ST2A.6 • 11:45**

*Opto-Fluidic Waveguide Coupling, Volker Zagolla1, Eric J. Tremblay2, Christophe Moser3, Peter Jenkins2, Fabien Chanzy2; 1FPF, EPFL, Switzerland. Light induced vapor bubble generation inside a liquid, serves as a coupling mechanism into a waveguide slab. We show an optical-to-optical efficiency of 40% in the concentrator as well as light induced passive tracking.*

**LT2B • OLED Optics & Modeling—Continued**

**LT2B.3 • 11:15**

*Enhancing OLED Light Extraction with Polymer Micromolds Arrays, Jiangeng Xue1, Materials Science and Engineering, Univ. of Florida, USA.* The light extraction efficiency in organic light-emitting devices was enhanced using polymer micromolds arrays fabricated by a soft lithography method. A maximum of 2.6-fold increase in efficiency was achieved in the top-emitting device geometry.

**LT2B.4 • 11:30**

*Efficient ITO-free Down-conversion White LEDs with a Good Color Rendering Property, Seunghyup Yoo1, Korean Advanced Institute of Technology, Republic of Korea.* Efficient down conversion white LEDs with good color-rendering capability are demonstrated based on cavity-enhanced ITO-free blue LEDs and color-conversion phosphors embedded into micro-lens arrays. These devices exhibit an excellent flexibility when built on plastic substrates.

**LT2B.5 • 11:45**

*Modulated Surface Textures for Enhanced Scattering in Thin-Film Silicon Solar Cells, Olindo Isabella1,2, Corin Battaglia1, Christophe Ballif3, Miro Zeman1; 1Photovoltaic Materials and Devices/Dimes, Delft Univ. of Technology, Netherlands, 2Institute of Microwechnology (IMT), Photovoltaics and Thin Film Electronics Laboratory, Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland.* Nano-scale randomly textured front transparent oxides are superposed on micro-scale etched glass substrates to form modulated surface textures. The resulting enhanced light scattering is implemented in single and double junction thin-film silicon solar cells.

**PT2C • Light Management in Solar Cells: Dielectric Structures I—Continued**

**PT2C.3 • 11:15**

*3D Photonic Crystal Intermediate Reflectors for Enhanced Light-trapping in Tandem Solar Cells, Johannes Upping1, Andrea A. Bielow1, Alexander N. Spratke1, Ralf Wehrspohn1, Thomas Beckers2, Reinhard Carstoiu1, Uwe Rau1, Stefan Fahr1, Carsten Rockstuhl1, Falk Lederer2, Matthias Kroll3, Thomas Persch1, Lorenz Stein1, Rudolf Zentel1; 1Institute of Physics, Martin-Luther-Universität Halle-Wittenberg, Germany, 2Fraunhofer IWM, Germany, 3Forschungszentrum Jülich, Germany, 4Institute of Condensed Matter Theory, Friedrich-Schiller-Univ. Jena, Germany, 5Institute of Applied Physics, Friedrich-Schiller-Univ. Jena, Germany, 6Institute of Organic Chemistry, Johannes-Gutenberg-Univ., Germany.* The concept of 3D photonic crystals embedded in tandem solar cells as intermediate reflective layers is investigated. Numerical as well as experimental results will be presented.

**PT2C.4 • 11:30**

*Tuning Light Scattering Properties of Thin-Film Silicon Solar Cells by Means of Scalar Scattering Theory, Karsten Botzka1, Markus Bergsmark1, Melissa S. Pinto1, Paulo B. Miranda2, 1Instituto de Quimica de Sao Carlos, Universidade de Sao Paulo, Brazil, 2Departamento de Quimica de Sao Carlos, Universidade Federal de Sergipe, Brazil,* We have used nonlinear vibrational spectroscopy to investigate the ethanol-platinum interface, showing that ethanol electro-oxidation is very complex and viability of these fuel cells remains a challenge.
Luminescent/Planar Luminescent Solar Concentrators—Continued

ST2A.7 • 12:00
Anisotropic Light Emissions in Luminescent Solar Concentrators, Paul P.P.C. Verbust1, Carlos Sanchez-Somolinos2, Dirk J. Borel1, Michael G. Debije3; 1Functional Materials & Devices, Cem. Engin. & Chem, Eindhoven Univ. of Technology, Netherlands; 2Instituto de Ciencia de Materiales de Aragon, Universidad de Zaragoza-CSI, Spain. The emission of randomly oriented dichroic dyes illuminated with a collimated beam results in a non-isotropic emission distribution. We demonstrate this can have significant impact on the surface losses and edge output of luminescent solar concentrators.

LT2B.5 • 12:00
FEM Simulations of Light Extraction from Nanostructured Organic Light-emitting Diodes, Lin Zachiedrich1, Horst Greiner2, Jan Pompe1, Martin Hammerschmidt1, Jven Burgener1, Frank Schmidt1; 1ICMabre GmbH, Germany; 2Philips Research Europe, Germany. Zone Institute Berlin, Germany. We present simulation results on light extraction from nanostructured light-emitting devices and demonstrate convergence of the methods to high levels of numerical accuracy.

LT2B.6 • 12:15
Quantitative Description of the Scattering Angles in Electrically-driven OLEDs Fabricated on Periodically Corrugated Substrates, Cornelius Fuchs1, Tobias Schwa1, Reinhard Scholza1, Andrés-Fabian Lasagni2,3, Simon Hofmann1, Bjorn Liess1, Lars Müller-Meskm1, Karl Leo1, Malte C. Gath1, 1Institut für Angewandte Photopysik, Technische Universität Dresden, Germany; 2Institut für Fertigungstechnik, Technische Universität Dresden, Germany; 3Fraunhofer-Institut für Werkstoff- und Strahlaeschnik IWS Dresden, Germany. Using bottom-emitting OLEDs grown on periodically corrugated substrates, we demonstrate efficient Bragg scattering of waveguide modes into the air cone. The angular position of scattered modes is in excellent agreement with theoretical predictions.

PT2C.6 • 12:00
Combining Rough Diffusers with Periodic Nanostructures for Light Trapping Purposes, Aimi Abas1, Marc Burgelman2, Bjorn Maes3; 1Electronics and Information Systems, Solar cells group Ghent Univ., Belgium; 2Physics, Micro- and Nanophotonic Materials Group Univ. of Mons, Belgium. Light trapping possibilities of rough diffusers combined with periodic grating structures are investigated. A full wave simulation technique which does not require having random geometry and thereby avoiding a huge computational domain is proposed.

PT2C.7 • 12:15
Highly Efficient Transparent Organic Cells Integrating a Non-periodic One-dimensional Photonic Crystal, Pablo Romero-Gomez1, Alberto Martinez-Otero1, Rafael Betancur1, Xavier Elias1, Jordi Martorell1,2; 1Organic nanostructured photovoltaics, ICFO - Institut de Ciències Fotòniques, Spain; 2Physica i Enginyeria Nuclear, Universitat Politècnica de Catalunya, Spain. We report on the fabrication of a transparent cell that incorporates light trapping from an electrode that combines a thin metal with an ad hoc photonic crystal, which increases the efficiency while maintaining the transparency.

12:30–13:30 Networking Lunch (lunch provided)

NOTES
Diffuse Scattering Designs of Dye Solar Cells, Hernan Miguez; Institute of Materials Science of Seville (ICMS-CSIC), Spain.

The optical transmission of silicon nitride/polymer multilayer permeation barriers was measured and compared with model calculations. With this model the individual layer thicknesses can be tailored to create cyanalyst benin geometries working better in the morning and afternoon, while flat panels work better around noon.

Cylindrical and Flat Solar Collector Geometries: Theory and Experiment, John Koshel1,2, Greg Smestad 3, Daniel Shull 4, Peter Cocagne I Lumiere

Solid State and Organic Lighting

Optical Modeling of Solar Cell Encapsulation with the Adding-doubling Method, Sven Leyne1, Guy Durinck2, Daudal Shell; Peter Stephens4, Tim Healy4; Solar Cells, USA; 4Electrical Engineering Dept., Santa Clara Univ., USA. Comparisons between theory, ray-tracing, and experiments for flat and cylindrical PV-panels are made. Results show agreement, optimized designs for different combinations of electrode thickness and electron diffusion length being proposed.

Optical Transmission in a Silicon Nitride/Polymer Multilayer Permeation Barrier made by Hot-Wire CVD: Model and Experiment, Sven Leyne1, Guy Durinck2, Kristof Proost3; University of North Carolina at Charlotte, USA.

Enhanced Light Extraction in OLEDs using Novel Chemical Mechanical Polishing Assisted Methods, Rajiv Singh; 1Univ. of Florida, USA. The efficiency of OLED devices is largely limited by the out-coupling efficiency. This talk will focus on chemical mechanical polishing based techniques for surface textures and planarization in glass substrates for out-coupling of both active layer and substrate modes.

Improving Light Extraction Efficiencies of Light Emitting Diodes by Using Self-Assembled Subwavelength Gratings, Peng Jiang; 1Univ. of Florida, USA. We have developed an inexpensive and scalable non-lithographic technological platform based on colloidal self-assembly for fabricating subwavelength-structured gratings for improving light extraction efficiencies of both inorganic and organic light emitting diodes.

Combined Grating Structures in Thin Film Solar Cells for Broadband Light Absorption, Siyao Guo1, Guangyao Su1, Deng Xiao1, Zhaoyu Zhang1; Peking Univ., China. A novel method is used to predict the reflection losses in cover glass for PV-modules. For vertical south oriented modules the method predicts that asymmetric Y-grooves improve annual transmission by 1.3% compared to symmetric V-grooves.
New York, USA.

A liquid filled prismatic louver façade design is presented for (a) redirecting sunlight deeper into an office space and thus enhancing indoor natural lighting, and (b) harnessing solar energy for heat gain.

**Liquid Filled prismatic Louver Façade for Enhanced Indoor Lighting—Continued**

**JT3B.6 • 15:00**

Improving CPV efficiency through sun lighting: Hybrid Lighting—CPV, Ruben Nunez1, Ignacio Antón1, Gabriel Sala2; Solar Energy Institute, Technical Univ. of Madrid, Spain. A Hybrid CPV module which produces electricity and injects concentrated light into optical guides for lighting is proposed. Illumination from sunlight does not require energy conversion allowing efficient lighting using just small area of the CPV system.

**Invited**

**JT3B.4 • 15:00**

New Use of LED Light: Intense Concentration into a Small Focal Spot, Ivan Moreno1, Nayeli Rodriguez2; School of Physics, Univ. Autónoma de Zacatecas, Mexico. For decades, optics for focusing laser and solar light has been developed. Here, we explain the radiometry and discuss the nonimaging optics for efficient concentration of LED light into an intense and small focal spot.

**Optimization of Antireflection Coatings using a Linear Graded Dielectric Structures II—Continued**

**PT3C.6 • 15:00**

Optimization of Antireflection Coatings using a Linear Graded Dielectric Structures II—Continued

**Invited**

**PT3C.7 • 15:15**

The Scalar Scattering Theory: A Multi-Functional Tool for Optimizing Scattering in Thin-Film Silicon Solar Cells, Klaus Jaeger1, Rene van Swaaij2, Miro Zeman1; Technische Universität Delft, Netherlands. The scalar scattering theory is applied in thin-film silicon solar cell research. It is used for predicting the scattering properties of nano-textured interfaces, optimizing their morphology, and for studying their effect on the solar cell performance.
16:00-17:45 ST4A • Luminescence and Up/Down Conversion
Presider: Juan Minano; Universidad Politecnica de Madrid, Spain

ST4A.1 • 16:00 Invited
Inorganic Rare Earth Based Luminescent Materials for Spectral-conversion and Luminescent Solar Concentrator Applications, Erik van der Kolk1; Technische Universiteit Delft, Netherlands. We report on Si-O-N based thin films obtained by combinatorial reactive magnetron co-sputtering for spectral-conversion and on the characteristic and modeling of all light transport steps in a large Stokes shift Eu3+ based thin film LSC.

ST4A.2 • 16:30
Deposition of Luminescent CaxSi2N2O4:Eu2+ Thin Films Using Combinatorial DC/CrI Magnetron Sputtering, Michiel de Jong1, Erik van der Kolk2; Radiation, Detection and Medical Imaging, T.U. Delft, Netherlands. CaxSi2N2O4:Eu2+ spectral conversion thin films were deposited using reactive combinatorial magnetron co-sputtering. A gradient in film composition is found in the deposited films, with areas showing emission of visible light under UV excitation.

ST4A.3 • 16:45
Manipulating Photon Energy with Si Nano-crystals, Dolf Timmerman1, Tuan M. Trinh1, Wieteke D. de Boer2, Kat Dohnalova1, Tom Gregorkiewicz3; van der Waals-Zeeman Institute, Univ. of Amsterdam, Netherlands. We will discuss how Si nanocrystals embedded in a SiO2 matrix can be used for shifting and cutting of photon energy, with an eye on their possible applications for spectral shaping in photovoltaics.

ST4A.4 • 17:00 Invited
Spectral Leverage: Enhancing the Photoluminescent Quantum Yield of Upconversion via Broadband Excitation, Sean K. MacDougall1, Aruna Ivaturi2, Jose Marques-Hueso1, Bryce S. Richards1; Scottish Institute for Solar Energy Research (SISER) and School of Eng. and Physical Science, Heriot-Watt Univ., UK. Upconversion is a promising concept for lowering transmission losses and overcoming the Shockley-Queisser limit, however efficiencies remain low under monochromatic characterisation. Broadband illumination, similar to the sun, not only enhances this process but is inherent to its application.

16:00-18:00 LT4B • LED Applications
Presider: Rajiv Singh; Univ. of Florida, USA

LT4B.1 • 16:00 Invited
Solid-State Area Light Sources and Lighting Solutions for Office Applications, Christian Zacharias1; Central Research, OSRAM AG, Germany. Solid state lighting is expected to replace fluorescent lighting in offices in the next decade. Innovative solutions using edge-lit and direct-lit light sources, context-aware controls, and daylighting will increase efficiency and enhance user experience.

LT4B.2 • 16:30
The Status of the Ray-File Standard for LED Lighting, Andreas Kliem2, Federico M. Ferrari1,2; University of Cambridge, UK; Graphene is emerging as a viable alternative to conventional optoelectronic, plasmonic, and nanophotonic materials. The interaction of light with carriers creates an out-of-equilibrium distribution, which relaxes on an ultrastable timescale to a hot Fermi-Dirac distribution, that subsequently cools via phonon emission. We will discuss the current results on this topic.

16:00-18:00 PT4C • Microtechnology & Material Properties I
Presider: Alexander Sprafke; Martin-Luther Univ. Halle, Germany

PT4C.1 • 16:00 Invited
Graphene Interaction with Light, Andrea C. Ferrari1, Jose Marques-Hueso1, Bryce S. Richards1; Swiss Institute of Technology and Mechanics, Chinese Academy of Science, China. An all-fiber pulsed coherent Doppler lidar is developed to measure wind profiles. The maximum horizontal and vertical range for wind speed is 4.2km and 2km with speed accuracy of 0.2m/s.

PT4C.2 • 16:30
Integration of Periodic Optical Nanostructures in Dye Sensitized Solar Cells: Towards Efficient and Transparent Cells, Hernan Miguez1; Inst de Estructura de la Materia, Spain. In this talk, the effect of different types of periodic optical nanostructures on the conversion efficiency of dye solar cells will be presented and discussed. Both photonic crystals and surface relief patterns acting as optical gratings are integrated in the nanocrystalline titania electrode of the cell giving rise to a significant enhancement of the photogenerated current as a result of the longer path travelled by strongly back reflected light. At the same time, transparency of the device at frequencies below and above the absorption band of the dye is almost unaffected. Integration of optimized one-dimensional photonic crystals and surface optical gratings do not alter the porosity of the supporting electrode, thus not hindering dye loading or electrolyte diffusion through the cell, preserving the rest of electrical parameters of the photovoltaic device intact.

PT4C.3 • 17:00
On the Role of Semiconductor Polymer as Hole-transport Layer in Solid-state Dye Sensitized Solar Cells, Hajime Sakata1, Junya Araki1, Tomoyoshi Numan1, Masahiro Tomiki1, Shizuoka Univ., Japan. Q-switching and tuning operations of TM-doped fiber lasers are demonstrated by employing dynamic fiber microbend. Pulse peak power of 1.45 W and tunable range of 100 nm are obtained around 1.9 μm with 100 mW-class pump laser diode.

16:00-18:00 ET4D • Optical Fibers for Energy & Environmental Applications
Presider: Michael Wojcik; Energy Dynamics Laboratory, USA

ET4D.1 • 16:00 Invited
Development of All-fiber Coherent Doppler Lidar to Measure Atmosphere Wind Speed, Jiagao Liu1, Weihao Chen1, Xiaopeng Zhu1; Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Science, China. The all-fiber pulsed coherent Doppler lidar is used to measure wind speed profiles. The presentation will focus on two aspects. One is how to use fiber-optic sensors such as RQTDR, Fabry-Perot sensor, and FBG to help oil companies enhance the heavy oil recovery. The other is how to use the fiber-optic sensors to protect the reservoir and wells from the threat of oil leakage or water/gas breakthrough etc.
Quantum tripling was observed in the BaLa2-xTmZnO5 phosphor. This effect greatly enhances germanium solar cell efficiency by producing three photons for each photon absorbed, which could greatly enhance germanium solar cell efficiency. Quantum tripling was observed in the BaLa2-xTmZnO5 phosphor, which shows promise for improving solar cell efficiency.

**Optics for Solar Energy**

**Lumiere**

**Solid State and Organic Lighting**

**Cocagne II**

**Optical Nanostructures and Advanced Materials for Photovoltaics**

**Cocagne I**

**Optical Instrumentation for Energy & Environmental Applications**

**Huygens**

**PT4C • Microtechnology & Material Properties I—Continued**

**PT4C.4 • 17:15**

**Temperature Tuning During the Fabrication of Microstructured Aluminum Substrates for Solar Cell**

Yao-Chung Tsao1, Thomas Sondergaard1, Thomas G. Pedersen1; 1Dept. of Physics and Nanotechnology, Aalborg Univ., Denmark. Various microstructured aluminum substrates were obtained by citric acid anodization while tuning the anodization temperature. It was found that the light trapping ability varies significantly after coating 100nm amorphous silicon films on these substrates.

**PT4C.5 • 17:30**

**Inorganic Passivation and Doping Control in Colloidal Quantum Dot Photovoltaics**

Sjoerd Hoogland1, 2, Ulrich Kramer1, Zhijun Ning1, Andre Labelle1, Kang Wei Kramer1, Zhitomsky1, Ratan Debnath 1, Larissa Levina 1, Lisa Rollyn1, Armin Fischer 1, Kyle Kemp 1, Huan Liu1, Huan Li1, Alex Ip1, David Zlotomirsky1, Ratan Debnath1, Larsosa Levin1, Lisa Rollyn1, Armin Fischer1, Kyle Kemp1, Huan Kramer1, Zhijun Ning1, Andre Labelle1, Kang Wei Kramer1, Aram Amassian1, Edward Sargent1; Electrical and Computer Engineering, Univ. of Toronto, Canada; 1Physical Sciences and Engineering Division, King Abdullah Univ. of Science and Technology (KAUST), Saudi Arabia. We discuss strategies to reduce midgap trap states densities in colloidal quantum dot films and requirements to control doping type and magnitude. We demonstrate that these improvements result in colloidal quantum dot solar cells with certified 7.0% efficiency.

**PT4C.6 • 17:30**

**Near-Infrared Distributed-Feedback Laser Sources and System for Gas Sensing Based on Stimulated Brillouin Scattering**

Kun Zhou1, Baojun Wang1, Daibing Zhou1, Lingjuan Zhao1, Huolei Wang1, Ying Ding2, Maria Ana Cataluna2, Qingsong Cui2, Wen Xiao1, Key Laboratory of Semiconductor Materials, Institute of Semiconductors, Chinese Academy of Sciences, China; 2Ultrafast Photonics Research Group, Univ. of Dundee, UK. We present a distributed Brillouin fiber sensor system to capture the pressure changes in soil subsurface. Utilizing pulse propagation time and load related Brillouin frequency shift (BFS), the location of deformation is identified and the pressure change in soil subsurface is captured.

**LT4B • LED Applications—Continued**

**LT4B.4 • 17:30**

**AUBELE - Self-sufficient LED Street Light Powered by Fuel Cells**

H.P. Fischer1; 1HarOptics GmbH, Germany. Energy saving, in connection to renewable energy sources is an important topic. The project AUBELE represents a small step in this direction - a self-sufficient LED street lighting, powered by hydrogen via a fuel cell.

**LT4B.5 • 17:45**

**Optical Design of Bicycle Head Lamp for K-mark Regulation Based on White LEDs**

Tsung-hsun Yang1, Yi-Chien Lo1, shih-Tien Feng1, Tuen-hsun Yang1, Ching-Cherng Sun1; 1Dept. of Optics and Photonics, National Central Univ., Taiwan. In this research, we designed a bicycle headlamp to meet the K-mark regulation using a high-power white LED. A prototype performed a contrast of 42 across the cut-off line and a special lighting pattern for roadway illumination.

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**18:00–23:00  Glow Tour (at your own pace)**

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**Renewable Energy and the Environment • 11–14 November 2012**

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**Tuesday, 13 November**

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**18:00–23:00  Glow Tour (at your own pace)**
Light-trapping schemes are essential for high efficiency thin-film Silicon devices. Implementation of various light-trapping/scattering elements will be discussed. An optimum textured of the TCO layers and a high optical transparency are necessary for highest efficiency.

We present high efficiency solar conversion devices based on novel hierarchical quasi-1D nanostructures, grown by Pulsed Laser Deposition. Improved performances are ascribed to the peculiar light scattering and trapping capabilities of the fabricated photoelectrodes.

For decades solar-cell efficiencies have remained below the thermodynamic limits. However, new approaches to light management that systematically minimize thermodynamic losses will enable ultrahigh efficiencies previously considered impossible.

Ultrahigh-efficiency Solar Cells Based on Nanophotonic Design, Albert Polman; FOM Inst for Atomic & Molecular Physics, Netherlands. For decades solar-cell efficiencies have remained below the thermodynamic limits. However, new approaches to light management that systematically minimize thermodynamic losses will enable ultrahigh efficiencies previously considered impossible.

Towards Low-cost >15% Efficient Film c-Si Solar Cells: Progress & Challenges, Charles Teplin; National Renewable Energy Laboratory, USA. We report progress towards >15% c-Si solar cells using a “seed and epitaxy” approach. While 9% solar cells on test substrates prove feasibility, improved seeds and light trapping will be required to achieve >15%.

Enhanced Multijunction Cell and System Conversion Efficiency through Heterogeneous Micro-system Integration Techniques, Gregory N. Nielson; Sandia National Laboratories, USA. We report on unique heterogenous multijunction solar cell structures being created with advanced micro- and nano-system technologies with the potential for enhanced efficiency by removing or reducing losses present in traditional monolithic multijunction solar cells.

Passivation of Optically Black Silicon Wafers by Atomic Layer Deposited Al2O3 Films, Martin Otto; Matthias Kroll; Roland Salzer; Johannes Ziegler; Alexander N. Sprafke; Ralf Wehrspohn; Martin-Luther Univ. Halle, Germany; Friedrich-Schiller-Universität Jena, Germany; Fraunhofer Institute for Mechanics of Materials Halle, Germany. Optically black silicon nanostructures show excellent light trapping properties. Towards the integration of these structures into a solar cell device, the passivation performance of atomic layer deposited thin Al2O3 films is investigated.

Doped Silicon Oxide Layers for Tandem Silicon Solar Cells, P. Babal; H. J. van Veen; M. Workum; A. H. M. Smet; and M. Zeman; PVMD, Delft Univ. of Technology, Netherlands. We report on the optimization and current-enhancing properties of p- and n-doped microcrystalline silicon oxide layers.
The platform is designed for utility-scale deployment and delivers the advantages are detailed.

Dot Material Band-Gap Engineering, Simon Fafard

Solar Cell Production and Optimization using III-V Quantum Nanowire Device Concepts for Thin Film Photovoltaics, Silke Meersch, TOTAL S.A., France.

This presentation reviews how multi-junction III-V cells are optimized for performance and cost, using further improvement of cell parameters such as Voc to 600-700 mV and a power conversation efficiency of >15%. We will discuss the potential of TTA-UC for device application.

We report on the coupling between bright and dark modes in which the fiber is embedded. Then, “optical fiber nervous systems” are realized to sense damages induced in materials/structures, such as fiber Brillouin scattering. Then, “optical fiber nervous systems” are realized to sense damages induced in materials/structures, in which the fiber is embedded.

Absolute upconversion quantum yield of NaYF4:Er3+ under broad band excitation in dependence on the erbium concentration - Measurements and Simulations, Benjamim Freiichi, Stefan Fischer, Heiko Steinkemper, Jan Christoph Goldschmidt, Karl Kramer, Fraunhofer ISE, Germany.

We investigated the upconversion quantum yield of NaYF4:Er3+ under broad band excitation both experimentally and theoretically. The upconversion quantum yield strongly depends on the erbium concentration, and shows a maximum for an erbium concentration of 25%.

Absolute upconversion quantum yield of NaYF4:Er3+ under broad band excitation in dependence on the erbium concentration - Measurements and Simulations, Benjamin Freiichi, Stefan Fischer, Heiko Steinkemper, Jan Christoph Goldschmidt, Karl Kramer, Fraunhofer ISE, Germany.

We investigated the upconversion quantum yield of NaYF4:Er3+ under broad band excitation both experimentally and theoretically. The upconversion quantum yield strongly depends on the erbium concentration, and shows a maximum for an erbium concentration of 25%.

Enhancement of silicon nanocrystals luminescence by plasmonic structures for photovoltaic application, Julie Goffard, Davy Gerard, Patrice Miska, Anne-laurin Baudrin, Michel Vergnies, Jerome Flamin, Technical Univ. of Aachen, Germany; 2National Lab, France. We report on the coupling between bright and dark modes of gold nanoparticles plamons with nanocrystals luminescence. This was obtained with an original fabrication method of the samples.
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