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Front Matter: Volume 8065

, "Front Matter: Volume 8065," Proc. SPIE 8065, SPIE Eco-Photonics 2011: Sustainable Design, Manufacturing, and Engineering Workforce Education for a Green Future, 806501 (13 May 2011); doi: 10.1117/12.899720

SPIE.

Event: SPIE Eco-Photonics, 2011, Strasbourg, France

PROCEEDINGS OF SPIE

SPIE Eco-Photonics 2011

Sustainable Design, Manufacturing, and Engineering Workforce Education for a Green Future

Pierre Ambs
Dan Curticapean
Claus Emmelmann
Wolfgang Knapp
Zbigniew T. Kuznicki
Patrick P. Meyrueis
Editors

28–30 March 2011
Strasbourg, France

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Published by
SPIE

Volume 8065

Proceedings of SPIE, 0277-786X, v. 8065

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

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *SPIE Eco-Photonics 2011: Sustainable Design, Manufacturing, and Engineering Workforce Education for a Green Future*, edited by Pierre Ambs, Dan Curticapean, Claus Emmelmann, Wolfgang Knapp, Zbigniew T. Kuznicki, Patrick P. Meyrueis, Proceedings of SPIE Vol. 8065 (SPIE, Bellingham, WA, 2011) Article CID Number.

ISSN 0277-786X

ISBN 9780819486516

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) • Fax +1 360 647 1445

SPIE.org

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Printed in the United States of America.

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

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Contents

ix	Conference Committee
xiii	Introduction to SPIE Eco-Photonics 2011
xv	Introduction to Sustainable Energy Engineering
xvii	Introduction to Sustainable Manufacturing Development and Process
xix	Introduction to Education for a Sustainable Engineering Workforce
xxi	Introduction to Photonics in Sustainable Product Design

PLENARY SESSION I: SUSTAINABLE ENERGY ENGINEERING

8065 02	Energy saving through LED in signaling functions for automotive exterior lighting (Invited Paper) [8065-100] A. Bony, K. Hamami, F. Tebbe, J. Mertens, Daimler AG (Germany)
---------	---

SESSION 1 SUSTAINABLE ENERGY ENGINEERING I

8065 03	Monitoring the energy systems of sustainable buildings (Invited Paper) [8065-01] E. Bollin, Univ. of Applied Sciences Offenburg (Germany)
8065 04	Design a linear irregular Fresnel lens to thin an LED-based direct-type backlight module and improve the illuminance and uniformity of LCD panel [8065-02] W.-G. Chen, Yung Ta Insitute of Technology and Commerce (Taiwan)
8065 05	Simulation of silicon thin-film solar cells for oblique incident waves [8065-03] C. Jandl, K. Hertel, C. Pflaum, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany); H. Stiebig, Malibu GmbH & Co. KG (Germany)
8065 06	Monitoring applications of power generators for the increase of energy efficiency using novel fiber optical sensors [8065-04] M. Villnow, M. Willsch, T. Bosselmann, Siemens AG (Germany); B. Schmauss, Friedrich-Alexander-Univ. Erlangen-Nürnberg (Germany)
8065 07	Study of spectrum-splitting solar photovoltaic system [8065-05] Y. Zhao, Fudan Univ. (China) and Shanghai Second Polytechnic Univ. Shanghai (China); M.-Y. Sheng, Fudan Univ. (China) and Shanghai Business School (China); W.-X. Zhou, Y. Shen, E. T. Hu, J. B. Chen, M. Xu, Y.-X. Zheng, Fudan Univ. (China); Y.-P. Lee, Hanyang Univ. (Korea, Republic of); D. W. Lynch, Iowa State Univ. (United States); L.-Y. Chen, Fudan Univ. (China)

SESSION 2 SUSTAINABLE ENERGY ENGINEERING II

- 8065 08 **Current collection from different Si devices based on nanoscale Si-layered systems containing a new metamaterial for photovoltaics** [8065-06]
M. Hosatte, M. Basta, Ecole Nationale Supérieure de Physique de Strasbourg (France); A. Sieradzki, Wroclaw Univ. of Technology (Poland); P. Meyrueis, Z. T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)
- 8065 09 **Optimising efficiency in diamond turned Fresnel mould masters** [8065-07]
J. L. Allsop, A. Mateboer, P. Shore, Cranfield Univ. (United Kingdom)
- 8065 0A **Enhanced light trapping in realistic thin film solar cells using one-dimensional gratings** [8065-08]
A. Naqavi, K. Söderström, F.-J. Haug, V. Paeder, T. Scharf, H. P. Herzig, C. Ballif, Ecole Polytechnique Fédérale de Lausanne (Switzerland)
- 8065 0B **Transparent conductive oxides for nano-SiS solar cells** [8065-09]
K. Fuchs, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); A. Bingel, Friedrich-Schiller-Univ. Jena (Germany); N. Kaiser, Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany); A. Tünnermann, Friedrich-Schiller-Univ. Jena (Germany) and Fraunhofer-Institut für Angewandte Optik und Feinmechanik (Germany)
- 8065 0C **Microalgae photonics** [8065-10]
T. Floume, Imperial College London, South Kensington (United Kingdom); T. Coquil, J. Sylvestre, PhotoFuel SAS (France)
- 8065 0D **A silicon-based metamaterial for light-to-electricity conversion (Invited Paper)** [8065-11]
Z. T. Kuznicki, Photonic Systems Lab. (France)

SESSION 3 SUSTAINABLE ENERGY ENGINEERING III

- 8065 0E **CO₂: a future chemical fuel: key questions about this project (Invited Paper)** [8065-12]
J. Amouroux, ENSCP, Univ. Pierre et Marie Curie (France) and European Materials Research Society (France); P. Siffert, European Materials Research Society (France)
- 8065 0F **Minimum energy per bit in high bit rate optical communications and quantum communications (Invited Paper)** [8065-13]
P. Gallion, Ecole Nationale Supérieure des Télécommunications (France) and CNRS, LTCI (France); F. J. Mendieta, CICESE (Mexico)
- 8065 0G **Novel solar cogeneration trough system based on stretched microstructured mylar film** [8065-55]
V. Hejmadi, M. Shin, B. Kress, USI Photonics Inc. (United States); A. Giliberto, Consultant (United Arab Emirates)
- 8065 0H **Enhancement of spectral response of visible light absorption of TiO₂ synthesis by femtosecond laser ablation** [8065-15]
A. S. Mahmood, K. Venkatakrishnan, M. Alubaidy, B. Tan, Ryerson Univ. (Canada)

- 8065 0I **Optical properties of crystalline and amorphous Si:P for device fabrication and structural modeling** [8065-16]
M. Basta, Z. T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France);
A. Sieradzki, Wroclaw Univ. of Technology (Poland)

PLENARY SESSION II: SUSTAINABLE MANUFACTURING DEVELOPMENT AND PROCESSES

- 8065 0L **Bionic lightweight design by laser additive manufacturing (LAM) for aircraft industry** [8065-106]
C. Emmelmann, M. Petersen, J. Kranz, Technische Univ. Hamburg-Harburg (Germany);
E. Wycisk, Laser Zentrum Nord GmbH (Germany)

SESSION 4 EDUCATION FOR A SUSTAINABLE ENGINEERING WORKFORCE

- 8065 0N **Photonics education for a green future: connecting the dots of the Arizona STEM education experiment (Invited Paper)** [8065-23]
S. M. Pompea, National Optical Astronomy Observatory (United States); L. W. Fine, Science Foundation Arizona (United States); P. Meystre, B2 Institute, The Univ. of Arizona (United States)
- 8065 0O **Green activities to interest high school students in electro-optics (Invited Paper)** [8065-24]
F. Zhou, Indiana Univ. of Pennsylvania (United States); D. Hull, National Ctr. for Optics and Photonics Education (United States)
- 8065 0P **Enabling virtual reality on mobile devices: enhancing students' learning experience (Invited Paper)** [8065-25]
M. E. Feisst, The Univ. of Nottingham (United Kingdom)
- 8065 0Q **National education program for energy efficient illumination engineering (Invited Paper)** [8065-26]
C. E. Walker, S. M. Pompea, National Optical Astronomy Observatory (United States)
- 8065 0R **New aspects of using eyetracking in education of optics and photonics** [8065-27]
U. Rohbock, M. Jagoda, Univ. of Applied Sciences Offenburg (Germany)
- 8065 0S **Interactive lecture demonstrations, active learning, and the ALOP project (Invited Paper)** [8065-28]
V. Lakshminarayanan, Univ. of Waterloo (Canada)

SESSION 5 SUSTAINABLE MANUFACTURING DEVELOPMENT AND PROCESSES I

- 8065 0T **Eco-efficiency of laser welding applications (Invited Paper)** [8065-17]
S. Kaierle, M. Dahmen, O. Gündükkurt, Fraunhofer-Institut für Lasertechnik (Germany)

- 8065 OU **Glue-free assembly of glass fiber reinforced thermoplastics using laser light (Invited Paper)** [8065-18]
C. Binetruy, Institute Carnot MINES, Ecole des Mines de Douai (France); S. Clement, Cooperation Laser Franco-Allemande (France); M. Deleglise, Institute Carnot MINES, Ecole des Mines de Douai (France); C. Franz, Fraunhofer-Institut für Lasertechnik (Germany); W. Knapp, Cooperation Laser Franco-Allemande (France); M. Oumarou, J. Renard, Institute Carnot MINES, Ecole des Mines de Douai (France); A. Roesner, Fraunhofer-Institut für Lasertechnik (Germany)
- 8065 OV **Improvement of mechanical properties and life extension of high reliability structural components by laser shock processing (Invited Paper)** [8065-19]
J. L. Ocaña, M. Morales, J. A. Porro, D. Iordachescu, M. Díaz, L. Ruiz de Lara, C. Correa, Univ. Politécnica de Madrid (Spain)
- 8065 OW **Wavefront analysis and optimization from conventional liquid crystal displays for low-cost holographic optical tweezers and digital holographic microscopy** [8065-20]
A. Weber, V. Ortega Clavero, W. Schröder, Univ. of Applied Sciences Offenburg (Germany)
- 8065 OX **Reliable laser welding of highly reflective materials (Invited Paper)** [8065-21]
C. Rüttimann, R. Holtz, LASAG AG (Switzerland)

SESSION 6 SUSTAINABLE MANUFACTURING DEVELOPMENT AND PROCESSES II

- 8065 OZ **Energy efficiency in thermal joining processes (Invited Paper)** [8065-34]
J. Wilden, Niederrhein Univ. of Applied Sciences (Germany); A. Oestreicher, B. Kaya, T. Röhrich, Technische Univ. Berlin (Germany)
- 8065 10 **Robust, precise, high-resolution Fourier transform Raman spectrometer** [8065-30]
V. Ortega Clavero, Univ. of Applied Sciences Offenburg (Germany) and Univ. of Strasbourg (France); W. Schröder, Univ. of Applied Sciences Offenburg (Germany); P. Meyrueis, Univ. of Strasbourg (France); A. Weber, Univ. of Applied Sciences Offenburg (Germany)
- 8065 11 **Optical glass and the EU directive RoHS** [8065-31]
P. Hartmann, SCHOTT AG (Germany); U. Hamm, Carl Zeiss GmbH (Germany)
- 8065 12 **Communication of the multi laser tracker system used as position feedback sensor** [8065-32]
T. T. Nguyen, A. Amthor, C. Ament, Technische Univ. Ilmenau (Germany)
- 8065 13 **Holographic microscope using conventional low-cost liquid crystal display in transmissive setup** [8065-33]
A. Weber, V. Ortega Clavero, W. Schröder, Univ. of Applied Sciences Offenburg (Germany)
- 8065 14 **Virtual reality to simulate large lighting with high efficiency LEDs** [8065-54]
T. Blandet, Ecole Nationale Supérieure de Physique de Strasbourg (France); G. Coutelier, Pixium Sàrl (France); P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)

SESSION 7 PHOTONICS IN SUSTAINABLE PRODUCT DESIGN I

- 8065 15 **Green photonics: the role of photonics in sustainable product design (Invited Paper)** [8065-35]
B. Wessler, OSRAM GmbH (Germany); U. Tober, VDI Technologiezentrum GmbH (Germany)
- 8065 16 **Improving the energy efficiency of telecommunication networks (Invited Paper)** [8065-36]
C. Lange, A. Gladisch, Deutsche Telekom Labs. (Germany)

SESSION 8 PHOTONICS IN SUSTAINABLE PRODUCT DESIGN II

- 8065 17 **Fully controlled helicopter for 3D-reconstruction of buildings and survey applications** [8065-37]
R. Lehmann, S. Staiger, W. Schröder, Univ. of Applied Sciences Offenburg (Germany)
- 8065 18 **Mobile display backlight light guide plates based on slanted grating arrays** [8065-38]
J. Kimmel, T. Levola, Nokia Research Ctr. (Finland)
- 8065 19 **Real-time implementation of square 16-QAM transmission system** [8065-39]
A. M. Al-Bermani, Univ. Paderborn (Germany); C. Wördehoff, Bielefeld Univ. (Germany);
S. Hoffmann, K. Puntari, Univ. Paderborn (Germany); U. Rückert, Univ. Bielefeld (Germany);
R. Noé, Univ. Paderborn (Germany)
- 8065 1B **The European ICT-BOOM project: silicon photonic Tb/S routers for improved energy efficiency in optical networks** [8065-42]
A. Pagano, E. Riccardi, Telecom Italia (Italy); C. Stamatidis, National Technical Univ. of Athens (Greece); L. Stampoulidis, K. Vysokinos, H. Avramopoulos, National Technical Univ. of Athens (Greece)
- 8065 1C **'No power' (green) electrowetting display** [8065-43]
M. Jentsch, J. Rawert, D. Jerosch, Advanced Display Technology GmbH (Germany);
K. Blankenbach, Pforzheim Univ. (Germany)

POSTER SESSION

- 8065 1F **Optimization of Pd surface plasmon resonance sensors for hydrogen detection** [8065-48]
C. Perrotton, N. Javahiraly, Univ. de Strasbourg (France); M. Slaman, Technische Univ. Delft (Netherlands) and Vrije Univ. Amsterdam (Netherlands); H. Schreuders, B. Dam, Technische Univ. Delft (Netherlands); P. Meyrueis, Univ. de Strasbourg (France)
- 8065 1G **The design of a wireless batteryless bflash installation with high power LEDs** [8065-49]
J. Cappelle, W. De Geest, KaHo Sint-Lieven Univ. College (Belgium); P. Hanselaer, KaHo Sint-Lieven Univ. College (Belgium) and ESAT-ELECTA, Katholieke Univ. Leuven (Belgium)
- 8065 1I **Improving the performance of the NIST five axis goniospectrometer for measurements of bidirectional reflectance distribution function** [8065-51]
V. B. Podobedov, M. E. Nadal, C. C. Miller, National Institute of Standards and Technology (United States)

- 8065 1J **Nanolayers of a PV metamaterial buried within a single crystal Si: SEM and reflectivity observations** [8065-52]
M. Basta, Ecole Nationale Supérieure de Physique de Strasbourg (France); B. S. Witkowski, M. Godlewski, Institute of Physics (Poland); Z. T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)
- 8065 1K **Characterization of multi-interface, multi-layer, heavily doped Si:P nanostructures using electromagnetic propagation** [8065-53]
Z. T. Kuznicki, M. Basta, Ecole Nationale Supérieure de Physique de Strasbourg (France)

Author Index

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Plenary Session I: Sustainable Energy Engineering

Patrick P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Zbigniew T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)

- 1 Sustainable Energy Engineering I
Zbigniew T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Patrick P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)
- 2 Sustainable Energy Engineering II
Zbigniew T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Patrick P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)
- 3 Sustainable Energy Engineering III
Patrick P. Meyrueis, Ecole Nationale Supérieure de Physique de Strasbourg (France)
Zbigniew T. Kuznicki, Ecole Nationale Supérieure de Physique de Strasbourg (France)

Plenary Session II: Sustainable Manufacturing Development and Processes

Wolfgang Knapp, Cooperation Laser Franco-Allemande (France)
Claus Emmelmann, Technische Universität Hamburg-Harburg (Germany)

- 4 Education for a Sustainable Engineering Workforce
Dan Curticapean, University of Applied Sciences Offenberg (Germany)
- 5 Sustainable Manufacturing Development and Processes I
Claus Emmelmann, Technische Universität Hamburg-Harburg (Germany)
Wolfgang Knapp, Cooperation Laser Franco-Allemande (France)
- 6 Sustainable Manufacturing Development and Processes II
Wolfgang Knapp, Cooperation Laser Franco-Allemande (France)
Claus Emmelmann, Technische Universität Hamburg-Harburg (Germany)
- 7 Photonics in Sustainable Product Design I
Pierre Ambs, Université de Haute Alsace (France)
- 8 Photonics in Sustainable Product Design II
Pierre Ambs, Université de Haute Alsace (France)

Introduction to SPIE Eco-Photonics 2011

34 years ago, In 1977, the first SPIE conference in Europe opened in Strasbourg. This conference gathered 700 attendees and was dedicated to optical metrology, 3D displays, and emerging optical telecom. It was held in the amphitheatre of the new building of the Council of Europe that was not yet used by the European representatives.

So it can be said that Strasbourg and its European organization represent a tradition of hospitality for new events in photonics considered as enabling technologies—it is now acknowledged as one of the five KET (key enabling technologies) by the European Union as it was said by Mr. Rubig from the European Parliament (president of the STOA group).

Thirty-four years ago photonics was quite far from ecology which was just emerging as a marginal concept. Now photonics enable active and relevant ecologic applications through engineering. This is a mature way for photonics to contribute to human welfare. Now at least photonics ecology technology, also called green photonics or ecophotonics technology, plays a role to progressively reduce the worsening of some earth inhabitants' living conditions that can result from an inappropriate management of the stock of materials that constitute energy resources (uranium, coal, petrol, gas, etc.).

We are “borrowing the Earth from our children” author de Saint Exupéry said. To return to our children an Earth in which they can have the best chance to have a satisfactory life there are two approaches: to reduce all the activities consuming energy, for instance: traveling, heating, communicating, computing, etc. by organizing a “negative growth”; or to induce a smart growth by using enabling tools, such as photonics, to spend less of Earth's stored energy resources and using more renewable energy, and by using devices allowing the same, or even better service than previous device generations, with less energy and pollution for manufacturing, using, and recycling. Rare materials have to be avoided in new product to preserve their strategic uses in the future, as well as poisonous ones to avoid destroying any part of the Earth's potential. This positive approach can be effectively controlled by using appropriate technologies including photonics.

In this first ecophotonics conference a range of photonics technologies used or to be used for the purposes introduced above are presented. Many innovations proposed in the conference are disruptive. They show that what was previously considered as being utopic are progressively becoming reality. This is the case, for example, of the doubling of efficiency of solar cells, and provide the hope of rapidly reaching a grid parity challenging nuclear electricity, at least as a beginning, at peak hours.

In fact we realize that photonics progress is giving birth to a lot of innovations in other domains (for instance: progress in the design and control of an electric or telecom network to provide electricity exchanges between electricity users instead as providing only a one way access from the power station to the subscriber, and to minimize the electricity consumption of a telecom network by a smart control of its capacity.

Into new large human systems organizations, including education, social constraints will be induced in areas where the advantages of ecophotonics are provided. It will be, for instance, possible to exchange energy between individuals as messages are exchanged through the internet, inducing a new social relation with energy.

It is clearly perceived now that the concern for ecophotonics technologies will lead to significant changes in transportation, biomedicine, communications, media, etc.

This proceedings volume presents a limited number of papers that were selected for coverage of some advanced examples of ecophotonics' main concerns for this first green photonics conference. This conference showed the interest that exists in this program as this first experimental conference opens the way.

We have no doubt that the conference met the expectations of the ones who worked to prepare it and the attendees, and that the proceedings will raise the interest of all its readers waiting to be involved in one way or another in ecophotonics progress.

The next conference on this topic will be larger in 2012 and will include new topics linking photonics and ecology through science and technology without forgetting business.

**Pierre Ambs
Dan Curlicapean
Claus Emmelmann
Wolfgang Knapp
Zbigniew B. Kuznicki
Patrick P. Meyrueis**

Introduction to Sustainable Energy Engineering

We had the privilege and the pleasure to chair this session of the first European conference on Ecophotonics that was opened by a European Parliament address.

It is sometimes difficult to be the first in a row and to open the way. Even if ecology is now a well recognized discipline in Europe, the wedding with photonics, one of the five key enabling technologies acknowledged by the European Union, is not yet really celebrated. We hope that this conference will constitute an international wedding celebration and that after this wedding many offspring will follow. Such will be the case in the framing of the next Photonics Europe in Brussels.

There is no doubt that ecophotonics will rapidly become, because of many needs, a leading photonics discipline. The strong interest among young scientists and engineers in future European developments expected in ecophotonics is a strong signal.

Ecophotonics is a young discipline having a bright future based on a pluridisciplinary approach centered on photonics. Ecophotonics concern almost all the photonics applications already validated in which ecophotonics will bring new paradigms.

The purpose of an R&D program is becoming more and more not just the excellence of the performance results of the outputs of the R&D. Traditional R&D results lead to a product that proceeds faster, with more accuracy, is more friendly for its user, provides more services etc. Because of increasingly important ecologic concerns, it will be excellent if it is also better in saving energy; if it is free of pollution of any kind in its operation, manufacturing, and recycling; and if the amount of rare material involved in its realization is low, and beyond all that—if the workers produce it in acceptable working conditions.

In fact it is a new ecoculture that is arising, associated with a new ecotechnology and a new ecobusiness, in which photonics could be showing the way. That is what we explore in this session as well as all the other ones in this ecophotonics conference.

In this session very important new advances in solar energy conversion are disclosed for the first time. In the race for ecoefficiency of solar light to electricity conversion some validated results show that the leadership in the efficiency race could be in Europe with European disruptive technology.

Patrick P. Meyrueis
Zbigniew T. Kuznicki

Introduction to Sustainable Manufacturing Development and Processes

This session provides an overview on how photonics based manufacturing technologies will impact environmental friendly production of the future.

Plenary presentations from the European Laser Institute and the European Photonics Industry Consortium show the importance of photonic manufacturing being a key component of agile, lean, and green manufacturing. The European technology platform Photonics'21 serves to prepare the future European research agenda.

Plenary and technical presentations demonstrate the wide range of manufacturing applications, from new energy efficient generation of high power laser light to more efficient direct manufacturing techniques in aerospace applications, to the improvement of mechanical properties, lifetime extension of high reliability of structural components, and environmentally friendly assembly of thermoplastic materials. Furthermore, technical presentations cover the impact of European environmental directives for glass manufacturing as well as the importance of virtual reality to simulate large lighting with high efficiency LEDs.

**Wolfgang Knapp
Claus Emmelmann**

Introduction to Education for a Sustainable Engineering Workforce

In our consideration of the global perspective of eco-photonics, we consider Education for a Sustainable Engineering Workforce as one of the most important tasks of the conference.

The focus of the invited papers was set on the global outreach activities, promoting worldwide photonics education. The view was not only focused on the academic (university) level, but rather tried to cover all levels. Also, the efforts of the UNESCO in promoting the physics and especially the photonics courses were underlined by the speakers. Using modern optical devices, like touch screens and optical fiber, the classrooms can be outsourced onto mobile devices, and mobile learning is a new paradigm in teaching optics and photonics. The next generations of scientists will grow up in a world with education in optics and photonics for a green future. They will understand as schoolchildren how solar cells, lasers, quantum computers, and complicated optical devices work, and will be able to improve their efficiency and to discover new and fantastic effects in optics and photonics.

Patrick P. Meyrueis
Dan Curticapean

Introduction to Photonics in Sustainable Product Design

The SPIE Eco-Photonics Symposium demonstrated that photonics is an important actor for a "green" future and, therefore, photonics must be included at the design stage of eco-products.

The session "Photonics in Sustainable Product Design" covers areas where photonic devices and systems are designed into products because of their improved performance, longer lifetime, ease of disposal, better overall economics, etc.

Eight papers were presented including one keynote and two invited papers. The different papers illustrate the increasingly significant role of photonic technologies in reducing our environmental impact. Examples concerning a broad field are discussed, for example, laser manufacturing, solid-state lighting, solar cells, and optical communications.

Several papers are related to telecommunications and to improvement of the energy efficiency of telecommunication networks. They show the importance of photonic technology for this task.

Display technology is another field where photonics has a key role in the design of sustainable and energy efficient products.

In conclusion, all the papers of this session show that photonics has an important potential in the design of "greener" and sustainable products in a large number of industries.

Pierre Ambs