



Feature issue introduction: light, energy and the environment, 2017

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Abstract: The editors introduce the feature issue on “Energy, Light and the Environment (LEE) 2017”, which is based on the topics presented at a congress of the same name held in Boulder, CO, US, from November 6 to November 9. This feature issue presents 13 papers selected from the voluntary submissions by attendees who presented at the congress and have extended their work into complete research articles. The feature issue highlights contributions from authors who presented their research at this congress.

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OCIS codes: (350.6050) Solar energy; (040.5350) Photovoltaic; (220.1770) Concentrators; (230.3670) Light-emitting diodes; (060.2370) Fiber optics sensors; (080.4295) Nonimaging optical systems; (140.0140) Lasers and laser optics.

References and links

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We are pleased to introduce the Feature Issue on “Energy, Light and the Environment 2017”, which is based on the topics presented at a congress of the same name held in Boulder, CO, US, from November 6 to November 9. This comprehensive Congress examines the frontiers in the development of optical technologies for energy production, transmission, monitoring, and use. At the Congress, updates on the use of optical and photonic approaches to monitor both energy production and the effect of energy usage on the environment will be augmented by developments in four collocated topical meetings formally known as Optics and Photonics for Energy and the Environment (E2), Optical Nanostructures and Advanced Materials for Photovoltaics (PV), Optics for Solar Energy (SOLAR), and Solid-State Lighting (SSL) [1].

This feature issue presents a collection of 13 papers that highlight the breadth of research topics presented at the 2017 LEE Congress. All presenting authors were invited to submit an extended paper based on the research they presented at the congress. Guest editors represented the program committees of each topical meeting, and submissions were subject to the standard *Optics/Energy Express* peer-review process that emphasizes the highest quality of the published work. Each of the topical meetings is represented by at least one contribution in this feature issue, but the topics covered by these papers provide only a small snapshot of the diverse topics covered at the congress and published in Conference Proceedings on the OSA Publishing website [2]. This meeting was also the very first to offer to all presenting authors an option to record their talks, and all recording are available for viewing as an interactive feature in OSA Conference Proceedings.

This year’s contributions range from fundamental optical and material science through to device and system-level performance modelling and optimization. These contributions can be roughly divided into six intersecting topics like follows:

- Materials for energy applications (2)
- Lasers and Laser Optics (1)
- Photovoltaics (2)
- Solar Energy (4)
- Environmental Monitoring (3)
- Remote sensing and sensors (1)

The numbers given in parentheses denote the number of contributed papers in the corresponding category. It was not easy to divide all the contributed papers into separate categories with no conflict, so some papers have been attributed to more than one topical focus.

Here we give brief introductions of the contributed papers. Primary foci of the papers are given in parentheses:

Materials for energy applications

Riza *et al.* [3] use the AFORS-HET to simulated both single and doubles absorbing layers in amorphous silicon thin film solar cell numerically. A single absorbing layer solar cell with both a-SiH and a-SiGeH is designed, which design parameters are investigated, compared and optimized, and compared with a tandem heterojunction solar cell, a-SiC/a-SiH/a-Si(i)/a-SiGeH. What’s more, the maximum efficiency of them is also predicted and the results are validated by comparing with two different method of analysis. (Thin Film devices and applications)

Wheeler *et al.* [4] have determined the complex refractive index of ceria at ambient temperature by using variable angle spectroscopic ellipsometry for two chemical states-fully oxidized and partially reduced. Partially reduced ceria is shown to have a larger absorption index over a broad spectral range than fully oxidized ceria, including the visible and near IR regions. Particularly, they use a simple model of a directly irradiated particle entrained in a gas flow to demonstrate the consequences of accounting for changes in chemical sate when modeling ceria-based thermochemical process. (Thin Films, optical properties)

Laser and laser optics

Shen *et al.* [5] presents the InGaN/GaN quantum well based dual-section laser diode (LD) consisting of integrated amplifier and laser gain regions fabricated on a semipolar GaN substrate. The threshold current in the laser gain region was favorably reduced from 229mA to 135mA at semiconductor optical amplifier driving voltages of 0V and 6.25V, respectively. The monolithically integrated amplifier-LD paves the way towards the III-nitride on-chip photonic system, providing a compact, low-cost, and multi-functional solution for applications such as a smart lighting and visible light communications. (Semiconductor lasers)

Photovoltaics

Lloyd *et al.* [6] realized a stationary catadioptric concentrating photovoltaic module, which performance followed modeling closely with a peak power conversion efficiency of 26% for direct irradiance, with aperture area over 100cm², geometric concentration of 180x, and collection within 60° of polar incidence. They also accomplished the tracking of the sun via translational micro-tracking completely and it demonstrates the potential for concentrating photovoltaic modules with significant higher efficiency than industry standard silicon photovoltaic. (Geometric optical design, Photovoltaic)

Elshrawy *et al.* [7] proposed quantum dot thin-film cells designed to have significant field waveguiding in the quantum dot stack region and patterned at the rear-side with a sun-wavelength diffraction grating. The design guideline they proposed, which is presented for energy and strength for the second-photon absorption for III-V quantum dots, can also be applied to quantum dot infrared detectors. And they discussed the angle-selectivity in view of applications in concentrator photovoltaic systems and infrared imaging systems. (Photodetectors, Photovoltaic)

Solar Energy

Eisenhauer *et al.* [8] present tailor-made micro-structures for light trapping at the liquid phase crystallization(LPC) silicon back-side, whereby a nano-imprinted resist layer serves as a three-dimensional etching mask in subsequent reactive ion etching. This method allows to produce tailor-made texture independent of grain orientation, contrary to state-of-the-art random pyramid textures produced by wet-chemical etching, and enables the potential to further optimized light trapping in LPC silicon solar cells. (Three-dimensional fabrication, Solar energy)

Russo *et al.* [9] measured the total absorption and emission coefficients of selective solar absorbers under high vacuum conditions from room temperature up to stagnation temperature. They analyze these data to evaluate the solar absorption and thermal emittance at different temperature and these are useful to predict evacuated solar panel performance at operating conditions in turn. (Equipment and techniques, Solar energy)

Diaz *et al.* [10] analyzed the optical and mechanical requirements for optimal efficiency using non-sequential ray tracing techniques. Opto-mechanical tolerances that can be compared to those of traditional solar collectors generated by these results. They also explore ideas on how to relieve tracking tolerances for single-axis solar collectors in order to establish a basis for tolerance required for the fabrication and manufacturing of hybrid solar trough collectors. (Fabrication, tolerancing, Solar energy)

Aho *et al.* [11] studied structured metal/polymer back reflectors for the III-V solar cells with the half-sphere gratings, the blazed grating, and the pyramid grating. Efficient diffraction of light was observed for all the structures, indicating potential for improving the absorption and hence the current generation in thin-film solar cells. (Microstructure fabrication)

Environment monitoring

Yin *et al.* [12] put forward a photosynthetic rate measurement method based on tunable pulsed light induced fluorescence kinetics on the basis of 'Bio-Optical' model. They used the

chlorophyll fluorescence as the probe of photosynthesis process and evaluated the phytoplankton photosynthetic rate by the photosynthetic electron transport rate. It is an effective method to measure the phytoplankton photosynthetic rate in situ, thus possesses a broad prospect for applications in water ecological environment monitoring, marine resource assessment and global climate change prediction. (Instrumentation, measurement and metrology)

Zhao *et al.* [13] studied a method of algae classification and concentration determination based on the discrete three-dimensional fluorescence spectra. They analyzed the discrete three-dimensional fluorescence spectra of twelve common species of algae belonging to five categories, built the discrete three-dimensional fluorescence spectra of five categories, and realized the recognition, classification and concentration prediction of algae categories by the discrete three-dimensional fluorescence spectra coupled with non-negative weighted least squares linear regression analysis. The results show that the accuracies of recognition, classification and concentration prediction of the algae categories were significantly improved. (Spectroscopy, fluorescence and luminescence)

Li *et al.* [14] described an inexpensive, compact instrument for sensitive measurement of nocturnal nitrogen oxides NO_3 and N_2O_5 in ambient air at high resolution. They also analyze the experimental data to verify the performance of the cavity ring-down spectroscopy (CRDS). And the capability of the CRDS instrument to make rapid measurements of atmospheric trace gases and capture their spatial and temporal variability can help us understand the nighttime NO_3 chemistry on a large scale. (Air pollution monitoring)

Remote sensing and sensors

Shen *et al.* [15] proposed an automatic baseline correction method, which is a key step for further spectral on-line analysis, for the open-path Fourier Transform Infrared Spectra by using simple iterative averaging. This method shows a better results than other baseline correction methods when they are applied to FTIR experimental and simulated data. And this method solves the key technology of the real-time on-line spectral analysis of OP-FTIR and improves the capability and adaptability of the unsupervised on-line system effectively. (Remote sensing and sensor)

In summary, this feature issue clearly demonstrates the diverse range of research topics spanned by the OSA Light, Energy and the Environment Congress, and provides a snapshot of some of the ways in which optical design and engineering are playing a role in the development of low-cost renewable energy sources, more efficient lighting, and improved monitoring of our environment, and will contribute to the further expansion of the associated research areas. Finally, the editors would like to all the authors who have contributed to this Feature Issue and to all the peer reviewers for their invaluable time and genuine efforts. We also would like to thank the Program Committee members, the OSA conference organization and journal staff, and all authors, presenters and congress attendees who made the trip to Boulder. We look forward to another successful congress in Sentosa Island, Singapore in November 2018.