Feature issue introduction: Light, Energy and the Environment, 2014

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Abstract: This feature issue highlights contributions from authors who presented their research at the OSA Light, Energy and the Environment Congress, held in Canberra, Australia from 2-5 December, 2014.

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.

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The topics of light and energy are intimately connected in today's world as increasing global demand for energy fuels concerns about sustainability, air-pollution and climate change. Optics and optical engineering have a significant role to play in dealing with these issues through the development of more efficient solar energy harvesting, low-energy lighting and illumination technology, and improved monitoring of industrial emissions and environmental pollution. Now in its sixth year, the OSA Light, Energy and the Environment (LEE) Congress (previously the Renewable Energy and the Environment Congress) aims to provide a forum for academic and industry researchers to present the latest advances in each of these areas. Similar to previous years, the 2014 congress comprised four topical meetings: Optical Nanostructures and Advanced Materials for Photovoltaics (PV), Optics for Solar Energy (SOLAR), Solid-State and Organic Lighting (SOLED), and Optics and Photonics for Energy and the Environment (E2).

The 2014 Congress was held at The Australian National University, Canberra, Australia from 2-5 December. This was the first time the congress had been held in the Asia-Pacific region, following previous congresses in Karlsruhe, Germany (2010), Austin, Texas, USA (2011), Eindhoven, The Netherlands (2012), and Tucson, Arizona, USA (2013). The 2015 Congress will be held in Suzhou, China from 2-6 November, before returning to Europe (Germany) in 2016. It is therefore a truly international research conference that continues to evolve each year to reflect international research developments, the composition of the program committees, as well as the local research strengths and interests of the host region. In 2014, these particular 'local' themes included a strong collection of contributions on solar thermal technology from Australian research institutions, and several papers on monitoring and detection of air quality in China.

This feature issue presents a collection of 17 papers that highlight the breadth of research topics presented at the 2014 LEE Congress. All presenting authors were invited to submit an original 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 also published in Conference Proceedings on the OSA Publishing website [1]. 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 the 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 four intersecting themes i) materials for efficient emission and energy transfer, ii) control of thermal radiation, iii) solar concentrator systems and applications, and iv) design and characterization of devices and systems.

Material-related contributions include two papers on modelling thermal emission from structured materials, although from quite different perspectives. In [2] Yue *et al.* focus on the high-temperature radiative properties of porous calcium-based compounds that are used for solar thermochemical capture of CO_2. In particular, they compare four different phenomenological models of surface radiation to evaluate their suitability for analyzing thermal transport in porous materials under high-flux solar irradiation. Surface radiation is also studied in [3], where Didari *et al*. simulate the effect of nanoparticles on near-field thermal radiation, and show that nanoscale surface features can alter significantly the far-field emission properties of a surface. The findings raise questions about the validity of commonly-applied effective medium approximations, and the authors identify possible applications in energy harnessing and radiative cooling. The other two papers in the materials theme relate to novel laser materials; one organic, and the other inorganic. In [4] Zhang *et al*. present a detailed optoelectronic study of starburst oligofluorenes that exhibit low amplified spontaneous emission (ASE) thresholds and high net gain, both of which are necessary requirements for the development of electrically-pumped organic lasers. Solar-pumped lasers

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are the topic of the second paper by Hasegawa *et al.* [5] which reports on the energy transfer efficiency in Nd and Cr doped ceramic lasing materials.

The theme of controlling thermal emission continues, albeit on a much larger scale, in [6] where Asselineau *et al*. present a stochastic optimization approach to model open cavity receiver designs for a large solar dish concentrator. Their optimization algorithm leads to >90% saving on computation time compared to a brute force approach. Modelling of solar concentration systems is also the topic of three other papers in this issue. Gajic *et al.* [7] apply ray-tracing techniques to evaluate reflection losses from evacuated tube receivers in compound parabolic concentrators used for solar thermal applications. They conclude that reflection losses at the receiver are relatively low and approximately constant as a function of incident angle up to angles approaching the concentrator acceptance angle. Wong *et al.* [8] present a systematic approach to minimize current mismatch losses of dense-array concentrator photovoltaic (CPV) receivers under non-uniform illumination. They simulate the spatial flux distribution considering realistic mirror slope errors and circumsolar radiation in order to optimize cell interconnection.. In the final solar concentrator contribution, Bañares-Palacios *et al.* [9] apply ray tracing techniques to analyze the broadband concentration performance of holographic lenses for CPV applications, taking into account both chromatic and angular selectivity.

Half of the contributions in this issue relate to experimental characterization and realistic modelling of complete devices and systems as one would expect for a conference aimed at developing practical technical solutions for energy generation, energy efficiency and environmental monitoring. Contributions span all four topical meetings, and include research on high-efficiency photovoltaic cells [10,11], optimization and modeling of emission properties of solid-state lighting [12–15], evaluation metrics for illumination sources [16], integrated fiber optic sensors [17], and stable compact laser sources suitable for space-based monitoring of atmospheric methane [18]. Particularly notable contributions in this group include the work of Hayashi *et al.* from Panasonic Corporation, who present a micro-concentrator photovoltaic module with the highest conversion efficiency (37%) and lowest optical losses to date [11]. Also of general interest may be the work of Jou *et al.*, which was one of several presentations at the congress related to engineering the emission spectrum of solid-state lighting to achieve the best comfort, color fidelity and energy efficiency. Jou reports the development of an organic light-emitting diode (OLED) with an emission spectrum similar to candlelight [14]. In addition to aesthetic considerations, the title of the paper refers to “blue-hazard free” lighting to highlight potential health issues associated with excessive exposure to blue light from indoor lighting.

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. Finally, we 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 Canberra. We look forward to another successful congress in Suzhou, China in November 2015.

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