Focus issue introduction: Advanced solid-state lasers 2020

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Abstract: This Joint Issue of *Optics Express* and *Optical Materials Express* features 15 articles written by authors who participated in the international online conference Advanced Solid State Lasers held 13–16 October, 2020. This review provides a summary of the conference and these articles from the conference which sample the spectrum of solid state laser theory and experiment, from materials research to sources and from design innovation to applications.

ASSL (Advanced Solid-State Lasers) is the international conference devoted to recent advances in both materials and sources aspects of solid state lasers. Materials encompasses advances in optics, materials science, condensed matter physics and chemistry relevant to the development, characterization and applications of new materials for lasers and photonics. These include crystals, glasses and ceramics, as well as functionalized composite materials, from fibers and waveguides to engineered structures with pre-assigned optical properties. Materials used for fabrication of basic laser components are also a core part of the conference. Coherent and high brightness radiation sources include lasers as well as pump and nonlinear devices from the THz through X-ray spectral regions. Emphasis is on advances in science and technology, for improved power, efficiency, brightness, stability, wavelength coverage, pulse width, cost, environmental impact or other application-specific attributes.

ASSL had its origin the 1980s and has been held every year since, first in the USA and more recently at various locations in North America, Europe and Asia. The conference is now held as part of the OSA Laser Congress, including the Laser Applications Conference and sometimes a third meeting. The 2020 meeting was scheduled to be held in Quebec City, Canada on 13–16 October, however, due to the global health situation, the congress was transformed into a "virtual" event via the internet, bringing both challenges and opportunities. Although the number of submissions to ASSL was reduced somewhat, the quality of work remained high, reflecting the global effort to adapt and maintain scientific and technical activities. The online format and suspension of fees resulted in a 4X increase in registration and 2X in attendees. Although remote attendance made parsing the numbers difficult, it appears that worldwide conference participation was broader, with 10 new countries represented and, for instance, about 25X increase in interest

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from India. The number of female attendees nearly doubled, from 10% in 2018 to 13% in 2019 and 20% in 2020. The conference incorporated experiments in both real-time and recorded global interaction for oral and poster presentations. Thanks go to Kimberly Coerr and the entire OSA conference staff for their rapid adaptation to the online format and conducting a successful meeting. Thanks also go to the Quebec City optics community for transforming tours and other events into "virtual" ones. Lessons learned from the 2020 meeting will certainly be incorporated into future ASSL conferences.

The year 2020 marked 60 years since the first laser demonstration by Ted Maiman, that of an optically-pumped ruby. This anniversary was celebrated in the ASSL plenary presentation by Peter Moulton, "A Journey through 60 Years of Solid State Lasers". We hope readers will enjoy the 15 papers from the conference which are included here. These papers, expanded versions of both oral and poster presentations, represent the breadth of work reported at the 2020 meeting. We thank the authors for their contributions as well as Carmelita Washington and the entire OSA publications staff for their outstanding work in the preparation of this feature issue as well as the review and production processes.

As usual, a survey of the conference technical program revealed a few major themes. Materials, including crystals, glasses, ceramics and engineered structures are central to all solid state lasers. Y. Sato and T. Taira presented a detailed study of the specific heat of YAG vs. temperature [1] while S. Subedi et. al. investigated the spectroscopy of GR1 centers in synthetic diamond [2]. E. Brown and coworkers did spectroscopic characterization of Er:BaF_2 as a host material for mid-IR lasers [3] while C. Brandus and others investigated Nd:LGSB with Cr^{4+}:YAG as a self-doubling, passively Q-switched green laser [4].

Efforts to increase both peak and average laser power have been a continuing theme at ASSL, both by scaling of individual devices in bulk, fiber and thin disk formats and by combining multiple sources. Scaling a single injection-locked CW single frequency Ti:S laser to 10 W output was described by T. Takano, et. al. [5] . At the other end of the spectrum, coherent combination of 81 beams was described in two companion presentations. Q. Du and coworkers explored generation and subsequent combination using a spatial light modulator and diffractive element [6], while D. Wang et. al. described an efficient, machine-learning approach to stabilization [7].

Prominent again this year were reports on eye-safe and Mid-IR sources, both small and large. A. Andrianov and E. Anashkina reported tunable, multi-order Raman lasing in the 1.38–2.01 µm region using chalcogenide glass microspheres [8]. A. Motard and six co-authors described a 195W CW Tm^{3+}, Ho^{3+} co-doped fiber laser at 2.09µm [9]. K. Karki and others reported a high energy, mechanically Q-switched Er:YAG laser delivering 0.8J at 2.94µm with low pulse jitter [10]. D. Martyshkin and the same group used a similar system to pump a high energy, room temperature Fe:ZnSe master oscillator power amplifier operating between 3.8 and 5.0 µm [11]. Finally, the effects of repetition rate and pump energy on output beam quality were studied in a high power 3–5µm $ZnGeP_2$ OPO by M. Piotrowski et. al. [12].

An important component of all ASSL meeting has always been the presentation of novel systems and concepts. This year, these reports included generation of <7 fsec radially polarized beams by compression of the output from a Ti:S laser, by H. Cao and seven colleagues [13]. Theory and realization of structured beams with additional degrees of freedom was considered by Z. Wang et. al. [14]. Another unusual system was reported by S. Chen and co-authors [15]. It incorporated organic dye-treated moth and butterfly wings in low-threshold random lasers for use in low-speckle imaging applications.

We are confident that the robust, global scientific and technological activity within the solid state laser community will continue in 2021 and be reflected in the next ASSL conference, in whatever format it takes place.

Disclosures. The authors declare that there are no conflicts of interest related to this article.

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