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Editorial

Preface for Special Issue: Advancements in Semiconductor Lasers

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We are delighted to present this special issue of "Advancement of Semiconductor Lasers," which features a remarkable collection of 14 papers that explore the diverse and cutting-edge aspects of semiconductor lasers. This collection brings together the latest research and innovations in the field, covering topics ranging from new techniques for understanding laser dynamics to devices design and fabrication, investigation of laser dynamics and their applications, and the characterization of compounded semiconductor materials.

Semiconductor lasers have revolutionized various industries, enabling critical advancements in telecommunications, data communication, sensing, and imaging applications. With a continuous pursuit of higher performance and novel functionalities, the field of semiconductor lasers has witnessed remarkable progress over the years. This special issue showcases some of the most exciting developments and discoveries from leading researchers around the world.

The first section of this issue presents advancement in understanding the underlying determinism of semiconductor lasers, and a new method to distinguish chaotic regimes in a semiconductor laser with feedback. Lenstra et al. offer physical insight into the noise-triggered spiking mechanism in a two-section semiconductor laser under excitable and noisy conditions, with potential implications for studying stochastic spiking in biological neurons [1]. Nguyen at al. develop Temporal And Reversible DYnamical Symmetry (TARDYS) quantifiers, providing a powerful tool for characterizing chaotic regimes in other complex dynamical systems [2].

The second section of this issue presents four papers dedicated to the exploration of new types of semiconductor lasers and devices. Among these, Panajovtov et al. introduce a groundbreaking spin-VCSEL, which embeds a nematic liquid crystal in a second cavity, achieving an astonishing small signal modulation response of several hundreds of GHz [3]. This advancement represents a significant breakthrough, outperforming conventional VCSELs by more than 10 times. Sun at al. focus on the design and fabrication of a trench mode-modulation based edge-emitting laser operating at 650nm [4]. This device not only demonstrates superior beam quality but also maintains high power output. Moreover, Liu et al. reports the successful fabrication of a 792nm semiconductor laser with an impressive output power of 232 W and an electro-optic conversion efficiency of 48.6% [5]. Such high-power lasers hold great promise for various industrial and scientific applications. In another significant contribution, a monolithically integrated multi-section

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semiconductor laser is introduced, showcasing enhanced security with 248 key spaces and a data rate of 2.5 Gb/s [6].

Further expanding on the study of nonlinear dynamics of semiconductor lasers and their applications, Zhao et al. experimentally investigates the nonlinear dynamics of an interband cascade laser under variable-aperture optical feedback, revealing various dynamical states [7]. Additionally, the mode configuration of an excited-state quantum dot laser (ES-QDL) under concave mirror optical feedback, demonstrating selective excitation of longitudinal modes is explored [8]. Bian et al. proposes a simple method using mutually coupled free-running VCSELs to generate broadband polarization chaos [9], while the locking map of a semiconductor laser under the injection of a frequency comb is studied [10]. Moreover, a new technique using feedback-delay signatures of a modulated semiconductor laser for fiber fault detection is introduced to enhance detection sensitivity [11]. The effect of VCSEL temperature on the quality of random number generation is explored [12], and the potential of generating high-quality photonic microwave signals in solitary QD spin-VCSELs with optical feedback is demonstrated [13].

Finally, Mikhailov et al. delve into the characterization of compound semiconductor materials [14], specifically the interband electron transition energy in multiple Hg1-xCdxTe/Hg1-yCdyTe quantum wells (MQWs) at room temperature.

The fascinating array of topics covered in this special issue highlights the vibrancy and dynamism of the field of semiconductor lasers. We would like to thank all the authors who submitted their exceptional work to this Special Issue. Additionally, we would like to extend our appreciation to the reviewers for their outstanding efforts in evaluating the manuscripts and offering valuable feedback. We would also like to acknowledge Photonics for initiating this special Issue, especially, the managing editor Zane Lin for her preparation, editing, and managing of this Special Issue.

We hope this special issue will inspire further exploration and collaboration in the advancement of semiconductor laser technology, fostering continued progress and innovation in the years to come.

Conflicts of Interest: The authors declare no conflict of interest.

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