

Editorial

Special Issue on Solid State Lasers Materials, Technologies and Applications

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1. Introduction

Even though more than half a century has already passed since the first demonstration of laser action in ruby crystal, solid-state lasers are still a hot research topic. Their unique versatility has made them irreplaceable tools in many fields. The list of actual or potential applications is continuously being updated at a pace that is set by the rate of advancing research. This virtuous cycle is only made possible by the favorable interplay between continuous research progress, enabling new exciting applications, and the emergence of new needs from industrial markets and fundamental research fields, fostering the study of new materials, the development of new technologies, and the fast maturation of the existent ones.

2. Solid State Lasers Materials, Technologies and Applications

In light of the above, this special issue was introduced to collect the latest research on relevant topics and reviews on the most recent technology developments and applications. There were 20 papers submitted to this special issue, and 14 papers were accepted. Of these, three were review papers and the remaining 11 were research articles.

Regarding solid-state lasers' materials and technologies, the first paper, authored by N. G. Boetti, D. Pugliese, E. Ceci-Ginistrelli, J. Lousteau, D. Janner and D. Milanese presents a comprehensive review on the recent advances in phosphate fiber laser technology [1]. The second paper provides another review on state of the art high-power solid-state deep ultra-violet lasers, authored by H. Xuan, H. Igarashi, S. Ito, C. Qu, Z. Zhao and Y. Kobayashi [2]. Nonlinear optics applications of high power lasers are presented in [3], where H. Su, Y. Peng, J. Chen, Y. Li, P. Wang, and Y. Leng present a Master Oscillator Power Amplifier (MOPA) laser at 1064 nm, delivering hundreds of mJs, 50-ps pulses at 100 Hz, designed to work as a pump for Optical Parametric Amplification (OPA) experiments. Two other articles describe MOPA laser systems operating at 1 μm . In particular, a very flexible, temporally programmable, arbitrary pulse shape hybrid MOPA laser was described by M. Nie, Q. Liu, X. Cao, and X. Fu in [4], whereas an industrial grade, picosecond regenerative amplifier based on Nd:YVO₄ is presented by Z. Bai, Z. Bai, Z. Kang, F. Lian, W. Lin, and Z. Fan in [5].

Mid-Infrared laser sources are present in two papers of this special issue. In particular, direct nanosecond pulse generation in a Q-Switched Er:Y₂O₃ ceramic laser is reported by X. Ren, Y. Wang, J. Zhang, D. Tang, and D. Shen in [6], whereas parametric down-conversion is exploited in a cw-OPO based on a periodically-poled Lithium Niobate crystal to generate a multi-Watt output tunable between 2.4–2.9 μm or 3.14–3.45 μm , depending on the nonlinear crystal poling period (Y. Liu, X. Xie, J. Ning, X. Lv, G. Zhao, Z. Xie, and S. Zhuin in [7]).

Coherent beam addition is addressed in two papers. D. Malka, E. Cohen, and Z. Zalevsky propose a novel concept for power beam combining in Photonic Crystal Fibers [8], whereas a fast frequency acquisition and phase locking method for high spectral purity nonplanar ring oscillator is presented by Y. Wang, C. Wang, Y. Tao, Y. Liu, Q. Zouh, J. Su, Z. Wang, S. Shi, and Q. Qiu in [9]. The proposed

technique can be used to enhance the performance of optical phase locking loops used in space coherent optical communication systems and active coherent laser beam combiners.

A detailed study on the impact of subsurface impurity defects introduced in the polishing process of fused-silica optics, and the beneficial effect of HF acid etching in the defect removal and laser-induced damage threshold enhancement, is presented by J. Cheng, J. Wang, J. Hou, H. Wang, and L. Zhang in [10].

Applications of solid state lasers, in particular in the field of laser welding and laser cladding, are presented in four papers published in this special issue. The first one is a review paper from M. Jiang, W. Tao, and Y. Chen [11]. In this paper, a comprehensive overview on laser welding under vacuum is presented, which is a recently re-discovered laser welding technique [12] that can help in fully exploiting the potential of recently available high-power and high-brightness solid-state fiber and disk lasers. A study on high-power (10 kW) fiber laser welding of stainless steel T-joint focused on the investigation of the impact best fiber core diameter selection is presented by A. Unt, I. Poutiainen, S. Grunenwald, M. Sokolov, and A. Salminen in [13]. The effect of welding position on the quality of the laser welds is investigated in detail by B. Chang, Z. Yuan, H. Pu, H. Li, H. Cheng, D. Du, and J. Shan in [14], where a high-power (6 kW) fiber laser is used to weld titanium alloys. Finally, a study on the effect of Molybdenum content on the microstructures and properties of stainless steel coatings by laser cladding is reported by K. Wang, B. Chang, J. Chen, H. Fu, Y. Lin, and Y. Lei in [15].

3. Future Perspectives

The large diversification of the topics covered by the review paper and research articles published in this special issue is clear evidence of the exceptional flexibility, potential and variety of application of solid-state lasers. Based on what we saw happening in recent decades, the research on new materials, the advances in photonics technologies and the increasing demand for speed, cleanliness and high-precision in industrial processes will contribute to propelling the research in this exciting field in the foreseeable future.

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