Introduction to the Issue on Solid-State Lasers

WELCOME TO the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (JSTQE) Issue on Solid-State Lasers. Advances in solid-state lasers and nonlinear frequency conversion provide powerful tools for an increasingly broad range of applications including spectroscopy, metrology, remote sensing, security, material processing, astronomy, medicine, biology, display, and ignitions. In particular, the high-peak power achievable with giant pulses from Q-switching and amplified mode-locking enable fruitful nonlinear interactions.

The object of this JSTQE Issue on Solid-State Lasers is to highlight recent progress and trends in innovative leading-edge solid-state laser technology development. The papers published in this issue cover a broad range of advanced solid-state laser areas summarized in the following sections:

1) *Laser Physics:* Spectroscopy, theory, and modeling for materials and cavities.
2) *Laser Materials:* Single crystal, glass, semiconductor, and microstructured ceramics.
3) *Power Scaling*: Slab, disk, fiber, waveguide, and other microstructures.
4) *Short Pulse Lasers*: Mode-locking, Q-switching, and filling the gap in pulse width (*Pulse-Gap*) typically achievable between these two techniques.
5) *Wavelength Extensions*: New materials and nonlinear optics.

These key research topics are highlighted as comprehensive overviews of the current status and future trends, as well as original results and recent developments in the field of solid-state lasers.

This issue contains 58 papers, including 14 invited and 44 contributed papers authored by well-established research groups and promising scientists from all over the world. The invited papers include extended reviews on recent solid-state laser sciences and developments in the areas of high-power lasers, short-pulse lasers, and new wavelength lasers including nonlinear optics. The contributed papers cover a broad variety of key solid-state laser research areas including recently obtained original results.

We hope you will find this JSTQE Issue on Solid-State Lasers to be an interesting and useful reference that will impact, stimulate, and promote further advances in Solid-State Lasers.

ACKNOWLEDGMENT

This issue was made possible by dedicated efforts of a number of people. First, we would like to thank the authors of all the papers in this issue as well as many reviewers around the world who, despite their many other commitments, provided high-quality reviews of the manuscripts. We would like to thank the IEEE publications staff for their general support, and C. T. Lutz, in particular, for her prompt help, boundless energy, and excellent organization skills in helping us meet the deadlines. We would like to thank Dr. J. Cartledge, Editor-in-Chief of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS, for his stimulating encouragements for this Issue.

TAKUNORI TAIRA, *Primary Guest Editor*
Laser Research Center for Molecular Science
Institute for Molecular Science
Okazaki 444-8585, Japan
(e-mail: taira@ims.ac.jp).

TSO YEE FAN, *Guest Editor*
Laser Technology and Applications Group
MIT Lincoln Laboratory
Lexington, MA 02420 USA.

GÜNTER HUBER, *Guest Editor*
Institute of Laser Physics
University of Hamburg
22761 Hamburg, Germany

Digital Object Identifier 10.1109/JSTQE.2015.2393331

Takunori Taira (F'14) was born in Fukui, Japan, in 1960. He received the B.E. and M.E. degrees in electrical engineering from Fukui University, Fukui, Japan, in 1983 and 1985, respectively, and the Ph.D. degree in communication engineering from Tohoku University, Sendai, Japan, in 1996. In 1985, he joined the LSI Research and Development Laboratory of Mitsubishi Electric Company, Itami, Japan. From 1989 to 1998, he was a Research Associate at Fukui University, a Visiting Researcher at Stanford University, during 1993 to 1994. He is currently an Associate Professor with the National Institutes of Natural Sciences, Institute for Molecular Science, Okazaki, Japan, and an Invited Professor at Pierre and Marie Curie University (Paris VI), Paris, in 2006, and Universite Joseph Fourier, in 2011, and Ecole Nationale Supérieure de Chimie de Paris (ENSCP)—Chimie ParisTech, Paris, France, in 2013.

Prof. Taira was a Member of the Program Committee of Advanced Solid-State Photonics on the Optical Society of America (OSA) from 2005 to 2014 (2008 Program Chair, 2009 General Chair), while serving as a Member of the CLEO Subcommittee #4, of Application Nonlinear Optics (2006–2008), CLEO Science and Innovations 2: Solid-State, Liquid and Gas Lasers (2010–2013), Program Committee of Nonlinear Optics on OSA from 2006 to 2011 (2009 Program Chair, 2011 General Chair), Laser Ignition Conference from 2013 to 2015 (General Chair), the Council of Board of Meetings on OSA from 2014, the board of Associate Editors for *Optical Materials* (OPTMAT), ELSEVIER, Amsterdam, The Netherlands from 2010 to 2013, and the board of Senior Associate Editors of the *Journal of Optical Materials Express* (OMEx), OSA, Washington, DC, USA from 2010 to 2016. He received the "2004 Commendation" Award of the Ministry of Education, Culture, Sports, Science, and Technology of Japan, for scientific and technological research merits (Japan) in 2004, "The 24th Kenjiro Sakurai Memorial Prize: Award of The Optoelectronic Industry and Technology Development Association (OITDA) (Japan) in 2008, "OSA Fellow" in 2010, and "SPIE Fellow" in 2012.

Tso Yee Fan (S'82–M'87–SM'96) received the S.B. degree from the Massachusetts Institute of Technology, Cambridge, MA, USA, in both electrical engineering and materials science and engineering. He received M.S. and Ph.D. degrees in electrical engineering from Stanford University, Stanford, CA, USA.

He is an Associate Leader of the Laser Technology and Applications Group at MIT Lincoln Laboratory, Lexington, MA, USA, and joined MIT Lincoln Laboratory as a Staff Member in 1987. He is widely recognized in the laser community for his pioneering work in diode-pumped solid-state lasers, in advances in cryogenic lasers for improving average-power scalability, in characterization of laser and nonlinear optical materials, and in advances in laser beam combining.

Dr. Fan served as an Elected Member of the IEEE/LEOS Board of Governors from 1994–1996 and was the Topical Editor, Lasers for *Optics Letters* from 1994–1999. He also was the Division Editor for *Applied Optics* from 2005–2007. He has served in numerous roles on conference committees, including as the Chair of the LEOS Annual Meeting, and as the Chair of the Topical Meeting on Advanced Solid-State Lasers. He received the 2009 MIT Lincoln Laboratory Technical Excellence Award for his work on Yb lasers, cryogenic lasers, and laser beam combining and the 2011 MIT Lincoln Laboratory Best Invention Award. He is a corecipient of the Berthold Leibinger Innovationspreis 2012, first prize. He is a Fellow of the Optical Society of America.

Guenter Huber received the Diploma degree in physics from Karlsruhe University, Germany, and the Ph.D. degree in physics from Stuttgart University, Germany in 1973 and 1975, respectively. He was research staff member of the Max Planck Institute for Solid State Research in Stuttgart/Germany, of the Institute of Applied Physics of Hamburg University/Germany, and became a Professor of Physics at Hamburg University in 1982. In 1986/1987, he was a Guest Professor at Ginzton Lab., Stanford University, USA. He became the Director of the newly established Institute of Laser Physics (1991–1999), the Vice Dean (1999–2003), and the Dean of the Faculty of Physics at Hamburg University (2003–2006). Since 2008, he has been board member of the University Council of Hamburg University.

He has served on the Board of Directors of the Optical Society of America (1999–2002), the Board of the Quantum Electronics and Optics Division of the European Physical Society (1998–2003). He was the Chair of the Electronics and Optics Division of the European Physical Society (2001–2003), the Chair of international conferences like CLEO/EUROPE-EQEC, LPHYS, EUROPHOTON, Advanced Solid State Photonics, and Advanced Solid State Lasers. Since 1994 he is a Co-Editor of Applied Physics B.

His research in experimental laser physics is focused on the development and fundamental characterization of transition metal ion and rare earth ion solid state lasers in the visible and near infrared spectral region. These activities include crystal growth of oxides and fluorides, thin film epitaxy of waveguides, optical spectroscopy, new diode pumped bulk and waveguide lasers for various applications, and nonlinear frequency conversion of solid state lasers. In particular, major results have been obtained in the following areas of materials science (Czochralski crystal growth, HEM crystal growth at ultrahigh melting temperatures, epitaxy of crystalline dielectric laser materials), tunable transition metal ion lasers (Ti^{3+}, Cr^{2+}, Cr^{3+}, Cr^{4+}), near infrared rare earth ion lasers (Nd^{3+}, Tm^{3+}, Ho^{3+}, Er^{3+}, Yb^{3+}), visible rare earth ion lasers (Er^{3+} up-conversion lasers, (Ga,In)N-diode pumped Pr^{3+} lasers), intracavity frequency doubled lasers (Nd^{3+}, Pr^{3+}), and crystalline waveguide lasers fabricated with ultrashort laser pulses (Nd^{3+}, Yb^{3+}, Pr^{3+}). The results of these activities have been documented in more than 240 peer reviewed journal publications.

Prof. Huber is a Fellow of the Optical Society of America and European Physical Society. He received the Quantum Electronics and Optics Prize of the European Physical Society in 2003 and the Charles Hard Townes Award of the Optical Society of America in 2013.